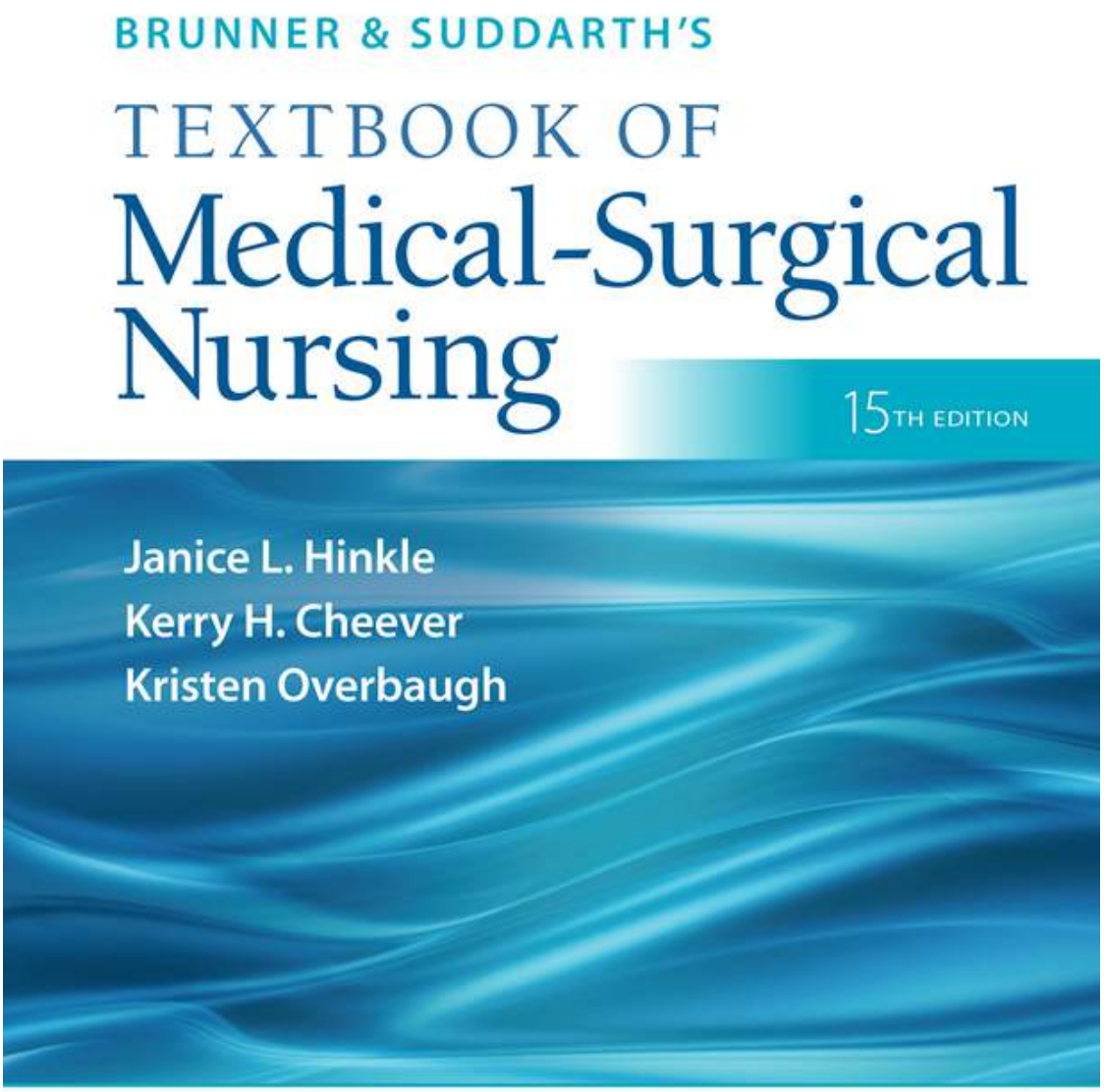
BRUNNER & SUDDARTH'S

TEXTBOOK OF Medical-Surgical Nursing

15TH EDITION

Janice L. Hinkle
Kerry H. Cheever
Kristen Overbaugh

Wolters Kluwer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Janice L. Hinkle, PhD, RN, CNRN
Fellow
Villanova University M. Louise Fitzpatrick College of Nursing
Villanova, Pennsylvania

Kerry H. Cheever, PhD, RN
Professor *Emerita*
Helen S. Breidegam School of Nursing
Moravian University
Bethlehem, Pennsylvania

Kristen J. Overbaugh, PhD, RN, ACNS-BC, CHPN
Assistant Professor
School of Nursing and Health Sciences
La Salle University
Philadelphia, Pennsylvania

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To our fellow nurses who provide comfort and care,
and who instill hope for a healthier world . . .

To our nursing faculty colleagues who nurture,
guide, and steer the future of our profession . . .

To nursing students who challenge themselves with
courage and conviction . . .

You inspire us!

Contributors

Contributors to the 15th Edition

Marianne T. Adam, PhD, RN, FNP, CNE
Associate Teaching Professor of Nursing
Campus Coordinator, Nursing
Pennsylvania State University Schuylkill
Schuylkill Haven, Pennsylvania

Chapter 38: Assessment of Digestive and Gastrointestinal Function

Rachel Barish, RN, MSN, ANP-BC, AACC
Nurse Practitioner, Division of Cardiology
MedStar Georgetown University Hospital Physicians Group
Washington, District of Columbia

Chapter 24: Management of Patients with Structural, Infectious, and Inflammatory Cardiac Disorders

Jennifer L. Bartlett, PhD, RN-BC, CNE, CHSE
Associate Professor
Georgia Baptist College of Nursing of Mercer University
Atlanta, Georgia

Chapter 39: Management of Patients with Oral and Esophageal Disorders

Susan Bartos, PhD, RN, CCRN
Adjunct Professor
Egan School of Nursing & Health Sciences
Fairfield University
Fairfield, Connecticut

Chapter 25: Management of Patients with Complications from Heart Disease

Cynthia Bautista, PhD, APRN, FNCS, FCNS
Associate Professor
Egan School of Nursing and Health Studies
Fairfield University

Fairfield, Connecticut

Chapter 63: Management of Patients with Neurologic Trauma

Tricia Bernecker, PhD, RN

Associate Professor
DeSales University
Center Valley, Pennsylvania

Chapter 22: Management of Patients with Arrhythmias and Conduction Problems

Lisa Bowman, RN, MSN, CRNP, CNRN

Nurse Practitioner
Jefferson Hospital for Neuroscience
Thomas Jefferson University Hospital
Philadelphia, Pennsylvania

Chapter 62: Management of Patients with Cerebrovascular Disorders

Carolyn Bradley, MSN, RN, CCRN

Heart & Vascular Center Nursing Professional Development Specialist
Yale New Haven Hospital
New Haven, Connecticut

Chapter 21: Assessment of Cardiovascular Function

Sherry Burrell, PhD, RN, CNE

Assistant Professor
Villanova University M. Louise Fitzpatrick College of Nursing
Villanova, Pennsylvania

Chapter 12: Oncologic Management

Theresa Capriotti, DO, CRNP, MSN, RN

Clinical Professor
Villanova University M. Louise Fitzpatrick College of Nursing
Villanova, Pennsylvania

Chapter 10: Fluid and Electrolytes
Chapter 33: Assessment and Management of Patients with Allergic Disorders

Jean Colaneri, ACNP-BC, CNN

Acute Care Nurse Practitioner
Albany Medical Center Hospital

Albany, New York

Chapter 48: Management of Patients with Kidney Disorders

Linda Carman Copel, PhD, RN, PMHCNS, BC, CNE, ANEF, NCC, FAPA

Professor
Villanova University M. Louise Fitzpatrick College of Nursing
Villanova, Pennsylvania

Chapter 3: Health Education and Health Promotion
Chapter 5: Stress and Inflammatory Responses
Chapter 53: Assessment and Management of Patients with Male Reproductive Disorders

Patricia Dillon, PhD, RN

Chair of Graduate, RN to BSN, and RN to MSN Programs, & Professor
School of Nursing and Health Sciences
La Salle University
Philadelphia, Pennsylvania

Chapter 56: Management of Patients with Dermatologic Disorders

Nancy Donegan, MPH, RN

Independent Consultant
Washington, District of Columbia

Chapter 66: Management of Patients with Infectious Diseases

Paulette Dorney, PhD, RN, CCRN-K

Associate Professor & Director, Accelerated BSN Program
Helen S. Breidegam School of Nursing
Moravian University
Bethlehem, Pennsylvania

Chapter 19: Management of Patients with Chest and Lower Respiratory Tract Disorders

Phyllis Dubendorf, MSN, RN, CCNS, CNRN, ACNP-BC

Clinical Nurse Specialist
Hospital of the University of Pennsylvania
Philadelphia, Pennsylvania

Chapter 61: Management of Patients with Neurologic Dysfunction

Kimberly Silver Dunker, DNP, MSN, RN, CNE, CNEcl

Dean of Nursing
Fortis Institute
Nashville, Tennessee

Unit-opening case studies

Elizabeth C. Evans, CNP, DNP

Nephrology Nurse Practitioner
Renal Medicine Associates
Albuquerque, New Mexico

Chapter 27: Assessment and Management of Patients with Hypertension

Janice Farber, PhD, RN, CNOR

Associate Professor
Helen S. Breidegam School of Nursing
Moravian University
Bethlehem, Pennsylvania

Chapter 4: Adult Health and Physical, Nutritional, and Cultural Assessment

Eleanor Fitzpatrick, DNP, RN, CCRN, AGCNS-BC, ACNP-BC

Clinical Nurse Specialist
Thomas Jefferson University Hospital
Philadelphia, Pennsylvania

Chapter 43: Assessment and Management of Patients with Hepatic Disorders

Chapter 44: Management of Patients with Biliary Disorders

Anessa M. Foxwell, MSN, CRNP, ACHPN

Predoctoral Fellow, NewCourtland Center for Transitions & Health
University of Pennsylvania School of Nursing
Nurse Practitioner, Clinical Practices of the University of Pennsylvania
Philadelphia, Pennsylvania

Chapter 13: Palliative and End-of-Life Care

Stacy M. Fusner, DNP, APRN, CNP

Assistant Professor of Clinical Practice
The Ohio State University College of Nursing
Columbus, Ohio

Chapter 58: Assessment and Management of Patients with Eye and Vision Disorders

Trudy Gaillard, PhD, RN, CDCES, FAHA
Associate Professor
Nicole Wertheim College of Nursing and Health Sciences
Florida International University
Miami, Florida

Chapter 46: Management of Patients with Diabetes

Dawn M. Goodolf, PhD, RN
Associate Professor and Chairperson
Helen S. Breidegam School of Nursing
Moravian University
Bethlehem, Pennsylvania

Chapter 35: Assessment of Musculoskeletal Function
Chapter 67: Emergency Nursing
Chapter 68: Disaster Nursing

Beth Gotwals, PhD, RN
Associate Professor
Helen S. Breidegam School of Nursing
Moravian University
Bethlehem, Pennsylvania

Chapter 2: Medical-Surgical Nursing

Karen D. Groller, PhD, RN, CV-BC, CMSRN
Assistant Professor
Helen S. Breidegam School of Nursing
Moravian University
Bethlehem, Pennsylvania

Chapter 42: Assessment and Management of Patients with Obesity

Debbie A. Gunter, APRN, FNP-BC, ACHPN
Family & Palliative Care Nurse Practitioner
Emory Healthcare Cognitive Neurology Clinic
Nursing Instructor
Emory University School of Nursing
Atlanta, Georgia

Chapter 18: Management of Patients with Upper Respiratory Tract Disorders

Jamie Heffernan, MSN, RN, CCRN-K, NE-BC

Burn Program Manager
New York-Presbyterian Weill Cornell Medicine
New York, New York

Chapter 57: Management of Patients with Burn Injury

Kristina Hidalgo, ACNP-BC
Nurse Practitioner, Division of Cardiology/Electrophysiology
MedStar Washington Hospital Center
Washington, District of Columbia

Chapter 24: Management of Patients with Structural, Infectious, and Inflammatory Cardiac Disorders

Janice L. Hinkle, PhD, RN, CNRN
Fellow
Villanova University M. Louise Fitzpatrick College of Nursing
Villanova, Pennsylvania

Chapter 34: Assessment and Management of Patients with Inflammatory Rheumatic Disorders

Michael Johnson, PhD, RN, PMH-BC, CNE
Assistant Professor
Director of Clinical Partnerships
School of Nursing
Nevada State College
Henderson, Nevada

Chapter 54: Assessment and Management of Patients Who Are LGBTQ

Debra P. Kantor, PhD, RN, CNE
Associate Professor of Nursing
Molloy College
The Barbara H. Hagan School of Nursing and Health Sciences
Rockville Centre, New York

Chapter 45: Assessment and Management of Patients with Endocrine Disorders

Sarah Kweeder, MSN, RN-BC, CNOR
Lead Clinical Nurse Educator, Surgical Services
Main Line Health
Bryn Mawr, Pennsylvania

Chapter 14: Preoperative Nursing Management

Chapter 15: Intraoperative Nursing Management
Chapter 16: Postoperative Nursing Management

Audra Lewis, PhD, RN, CHSE
Director, Highland Campus Regional Simulation Center
Austin Community College
Austin, Texas

Chapter 59: Assessment and Management of Patients with Hearing and Balance Disorders

Mary Beth Flynn Makic, PhD, CCNS, CCRN-K, FAAN, FNAP, FCNS
Professor
University of Colorado College of Nursing
Aurora, Colorado

Chapter 11: Shock, Sepsis, and Multiple Organ Dysfunction Syndrome

Jane F. Marek, DNP, MSN, RN
Assistant Professor
Frances Payne Bolton School of Nursing
Case Western Reserve University
Cleveland, Ohio

Chapter 41: Management of Patients with Intestinal and Rectal Disorders

Katrina Nice Masterson, DNP, RN, FNP-BC, DCNP
Educational Coordinator
Randall Dermatology
West Lafayette, Indiana

Chapter 55: Assessment of Integumentary Function

Jennifer McCaughey, MSN, BS, RNC-MNN, CCE
Clinical Educator
Women and Children's Services
Inova Fair Oaks Hospital
Fairfax, Virginia

Chapter 50: Assessment and Management of Patients with Female Physiologic Processes
Chapter 51: Management of Patients with Female Reproductive Disorders

Salimah H. Meghani, PhD, MBE, RN, FAAN
Professor & Term Chair of Palliative Care

University of Pennsylvania School of Nursing
Philadelphia, Pennsylvania

Chapter 13: Palliative and End-of-Life Care

Carin Molfetta, MSN, CRNP, BC
Nurse Practitioner
Penn Medicine Lancaster General Health
Lancaster, Pennsylvania

Chapter 52: Assessment and Management of Patients with Breast Disorders

Sue Monaro, PhD, MN, RN
Vascular Clinical Nurse Consultant
Concord Repatriation General Hospital
Concord
Senior Clinical Lecturer
Susan Wakil School of Nursing and Midwifery
University of Sydney
New South Wales, Australia

Chapter 26: Assessment and Management of Patients with Vascular Disorders and Problems of Peripheral Circulation

Melissa V. Moreda, MSN, APRN, ACCNS-AG, CCRN, CNRN, SCRN
Diabetes Educator Clinical Nurse Specialist
Duke Raleigh Hospital
Raleigh, North Carolina

Chapter 65: Management of Patients with Oncologic or Degenerative Neurologic Disorders

Kathleen Nokes, PhD, RN, FAAN
Professor *Emerita*
Hunter College and Graduate Center, CUNY
New York, New York

Chapter 32: Management of Patients with Immune Deficiency Disorders

Geraldine M. O'Leary, MSN, RN, FNP-BC
Clinical Instructor
School of Nursing and Health Sciences
La Salle University
Philadelphia, Pennsylvania

Chapter 23: Management of Patients with Coronary Vascular Disorders

Mae Ann Pasquale, PhD, RN
Associate Professor
School of Nursing
Cedar Crest College
Allentown, Pennsylvania

Chapter 37: Management of Patients with Musculoskeletal Trauma

Sue Pugh, MSN, RN, CNRN, CRRN, CNS-BC, FAHA
Neuro Clinical Nurse Specialist/Stroke Coordinator
Sinai Hospital of Baltimore
Baltimore, Maryland

Chapter 64: Management of Patients with Neurologic Infections, Autoimmune Disorders, and Neuropathies

Katrina A. Pyo, PhD, RN, CCRN
Associate Professor
Robert Morris University
Moon Township, Pennsylvania

Chapter 17: Assessment of Respiratory Function

Ann Quinlan-Colwell, PhD, RN-BC, AHN-BC
Pain Management Clinical Nurse Specialist
Educator and Consultant
Wilmington, North Carolina

Chapter 9: Pain Management

Rebecca Wildman Repetti, RN, ANP-BC
Nurse Practitioner, Thoracic Oncology Service
Memorial Sloan Kettering Cancer Center
New York, New York

Chapter 31: Assessment of Immune Function

Denise Rhew, PhD, RN, CNS, CEN
Clinical Nurse Specialist – Emergency Services
Director, Neuro-Progressive Care
Cone Health
Greensboro, North Carolina

Chapter 8: Management of the Older Adult Patient

Marylou V. Robinson, PhD, FNP-C
Olympia, Washington

Chapter 36: Management of Patients with Musculoskeletal Disorders

Tami J. Rogers, PhD, DVM, RN, CNE
Professor of Nursing, Curriculum QA/Course Development
Rasmussen University
Bloomington, Minnesota

Chapter 28: Assessment of Hematologic Function and Treatment Modalities

Sally Russel, MN, CMSRN, CNE
Director, Education Services
American Nephrology Nurses Association
Pitman, New Jersey

Chapter 49: Management of Patients with Urinary Disorders

Catherine Sargent, PhD, RN, BC, AOCNS
Assistant Professor
Gwynedd Mercy University
Gwynedd Valley, Pennsylvania

Chapter 30: Management of Patients with Hematologic Neoplasms

Susan Parnell Scholtz, PhD, RN
Associate Professor
Helen S. Breidegam School of Nursing
Moravian University
Bethlehem, Pennsylvania

Chapter 1: Professional Nursing Practice

Lindsey R. Siewert, RN, MSN, APRN, CCNS, SCRN
Clinical Nurse Specialist Neuroscience/Stroke Coordinator
Norton Healthcare
Louisville, Kentucky

Chapter 60: Assessment of Neurologic Function

Suzanne C. Smeltzer, RN, EdD, ANEF, FAAN

Richard and Marianne Kreider Endowed Professor in Nursing for Vulnerable Populations
Villanova University M. Louise Fitzpatrick College of Nursing
Villanova, Pennsylvania

Chapter 7: Disability and Chronic Illness

Nancy Colobong Smith, MN, ARNP, CNN
Clinical Nurse Specialist – Renal, Dialysis, Transplant
University of Washington Medical Center
Seattle, Washington

Chapter 47: Assessment of Kidney and Urinary Function

Kimberly A. Subasic, PhD, MS, RN, CNE
Professor & Chairperson
Swain Department of Nursing
The Citadel
Charleston, South Carolina

Chapter 6: Genetics and Genomics in Nursing

Mindy L. Tait, PhD, MBA, CRNP, FNP-BC
Associate Professor
School of Nursing and Health Sciences
La Salle University
Philadelphia, Pennsylvania

Chapter 40: Management of Patients with Gastric and Duodenal Disorders

M. Eileen Walsh, PhD, APRN, CVN, FAHA
Associate Dean, Research and Scholarship
Director, College of Nursing Honors Program
Professor, College of Nursing
University of Toledo
Toledo, Ohio

Chapter 26: Assessment and Management of Patients with Vascular Disorders and Problems of Peripheral Circulation

Camille Wendekier, PhD, CNE, RN
Program Director, MSN Leadership/Education
Department of Nursing
St. Francis University

Loretto, Pennsylvania

Chapter 20: Management of Patients with Chronic Pulmonary Disease

Mary Lynn Wilby, PhD, MPH, MSN, CRNP, ANP-BC, RN

Associate Professor
School of Nursing and Health Sciences
La Salle University
Philadelphia, Pennsylvania

Chapter 29: Management of Patients with Nonmalignant Hematologic Disorders

Contributors to the 14th Edition

Marianne Adam, PhD, RN, CRNP

Schuylkill Haven, Pennsylvania

Chapter 43: Assessment of Digestive and Gastrointestinal Function

Julie Adkins, DNP, APN, FNP-BC, FAANP

West Frankfort, Illinois

Chapter 63: Assessment and Management of Patients with Eye and Vision Disorders

Jennifer L. Bartlett, PhD, RN-BC, CNE, CHSE

Atlanta, Georgia

Chapter 45: Management of Patients with Oral and Esophageal Disorders

Tara Bilofsky, ACNP-BC, MS

Allentown, Pennsylvania

Chapter 21: Respiratory Care Modalities

Susan Bonini, MSN, RN

Aurora, Colorado

Chapter 31: Assessment and Management of Patients with Hypertension

Lisa Bowman, RN, MSN, CRNP, CNRN

Philadelphia, Pennsylvania

Chapter 67: Management of Patients with Cerebrovascular Disorders

Jo Ann Brooks, PhD, RN, FAAN, FCCP

Indianapolis, Indiana

Chapter 23: Management of Patients with Chest and Lower Respiratory Tract Disorders
Chapter 24: Management of Patients with Chronic Pulmonary Disease

Sherry Burrell, PhD, RN, CNE
Villanova, Pennsylvania

Chapter 46: Management of Patients with Gastric and Duodenal Disorders

Wendy Cantrell, DNP, CRNP
Birmingham, Alabama

Chapter 61: Management of Patients with Dermatologic Disorders

Lauren Cantwell, RN, MS, ACNP-BC, ACNPC, CNS, CCNS, CCRN, CHFN
Falls Church, Virginia

Chapter 28: Management of Patients with Structural, Infectious, and Inflammatory Cardiac Disorders

Kim Cantwell-Gab, MN, ACNP-BC, ANP-BC, CVN, RVT, RDMS
Medford, Oregon

Chapter 30: Assessment and Management of Patients with Vascular Disorders and Problems of Peripheral Circulation

Patricia E. Casey, MSN, RN, CPHQ, AACC
Washington, District of Columbia

Chapter 26: Management of Patients with Dysrhythmias and Conduction Problems

Jill Cash, RN, MSN, APRN-BC
Franklin, Tennessee

Chapter 38: Assessment and Management of Patients with Rheumatic Disorders
Chapter 64: Assessment and Management of Patients with Hearing and Balance Disorders

Kerry H. Cheever, PhD, RN
Bethlehem, Pennsylvania

Chapter 1: Health Care Delivery and Evidence-Based Nursing Practice
Chapter 47: Management of Patients with Intestinal and Rectal Disorders
Chapter 48: Assessment and Management of Patients with Obesity

Elise Colancecco, MSN, RN
Bethlehem, Pennsylvania

Chapter 42: Management of Patients with Musculoskeletal Trauma

Moya Cook RN, MSN, APN
Marion, Illinois

Chapter 13: Fluid and Electrolytes: Balance and Disturbance

Linda Carman Copel, PhD, RN, PMHCNS, BC, CNE, ANEF, NCC, FAPA
Villanova, Pennsylvania

Chapter 4: Health Education and Health Promotion
Chapter 6: Individual and Family Homeostasis, Stress, and Adaptation
Chapter 59: Assessment and Management of Problems Related to Male Reproductive Processes

Elizabeth Petit deMange, PhD, RN
Villanova, Pennsylvania

Chapter 52: Assessment and Management of Patients with Endocrine Disorders

Nancy Donegan, MPH, RN
Washington, District of Columbia

Chapter 71: Management of Patients with Infectious Diseases

Paulette Dorney, PhD, RN, CCRN
Bethlehem, Pennsylvania

Chapter 21: Respiratory Care Modalities

Diane Dressler, MSN, RN, CCRN-R
Milwaukee, Wisconsin

Chapter 27: Management of Patients with Coronary Vascular Disorders
Chapter 29: Management of Patients with Complications from Heart Disease

Debra Drew, MS, RN-BC (retired), ACNS-BC (retired), AP-PMN
Minneapolis, Minnesota

Chapter 12: Pain Management

Phyllis Dubendorf, MSN, RN, CCNS, CNRN, CRNP-BC
Philadelphia, Pennsylvania

Chapter 66: Management of Patients with Neurologic Dysfunction

Susan M. Fallone, MS, RN, CNN
Albany, New York

Chapter 53: Assessment of Kidney and Urinary Function

Janice Farber, PhD, RN, CNOR
Bethlehem Pennsylvania

Chapter 7: Overview of Transcultural Nursing

Eleanor Fitzpatrick, RN, MSN, CCRN, AGCNS-BC, ACNP-BC
Philadelphia, Pennsylvania

Chapter 49: Assessment and Management of Patients with Hepatic Disorders
Chapter 50: Assessment and Management of Patients with Biliary Disorders

Trudy Gaillard, PhD, RN, CDE
Cincinnati, Ohio

Chapter 51: Assessment and Management of Patients with Diabetes

Dawn Goodolf, PhD, RN
Bethlehem, Pennsylvania

Chapter 39: Assessment of Musculoskeletal Function

Beth Gotwals, PhD, RN
Bethlehem Pennsylvania

Chapter 2: Community-Based Nursing Practice
Home Care Checklists

Theresa Lynn Green, PhD, MScHRM, BScN, RN
Queensland, Australia

Chapter 10: Principles and Practices of Rehabilitation

Debbie Gunter, MSN, APRN, ACHPN
Atlanta, Georgia

Chapter 22: Management of Patients with Upper Respiratory Tract Disorders

Jamie Heffernan, MSN, RN, CCRN-K, NE-BC
New York, New York

Chapter 62: Management of Patients with Burn Injury

Janice L. Hinkle, PhD, RN, CNRN
Villanova, Pennsylvania

Chapter 55: Management of Patients with Urinary Disorders

Lisa J. Jesaitis, RN, MS, CHFN, ACNP
Washington, District of Columbia

Chapter 28: Management of Patients with Structural, Infectious, and Inflammatory Cardiac Disorders

Tamara Kear, PhD, RN, CNS, CNN
Villanova, Pennsylvania

Chapter 54: Management of Patients with Kidney Disorders

Elizabeth Keech, RN, PhD
Villanova, Pennsylvania

Chapter 11: Health Care of the Older Adult

Kathleen Kelleher, DMH, WHNP-BC, CBCN, DVS
Pompton Plains, New Jersey

Chapter 58: Assessment and Management of Patients with Breast Disorders

Lynne Kennedy, PhD, MSN, RN, RNFA, CHPN, CNOR, CLNC, CHTP, Alumnus CCRN
Fairfax, Virginia

Chapter 17: Preoperative Nursing Management
Chapter 18: Intraoperative Nursing
Chapter 19: Postoperative Nursing Management

Mary Beth Flynn Makic, PhD, CNS, CCNS, CCRN-K, FAAN, FNAP
Professor
Denver, Colorado

Chapter 14: Shock and Multiple Organ Dysfunction Syndrome

Katrina Nice Masterson, RN, DNP, FNP-BC, DCNP
West Lafayette, Indiana

Chapter 60: Assessment of Integumentary Function

Jennifer McCaughey, MSN, BS, RNC-MNN, CCE
Fairfax, Virginia

Chapter 57: Management of Patients with Female Reproductive Disorders

Melissa V. Moreda, BSN, RN, CCRN, CNRN, SCRN
Raleigh, North Carolina

Chapter 70: Management of Patients with Oncologic or Degenerative Neurologic Disorders

Donna Nayduch, MSN, RN, ACNP, TCRN
Ocala, Florida

Chapter 72: Emergency Nursing
Chapter 73: Terrorism, Mass Casualty, and Disaster Nursing

Kathleen Nokes, PhD, RN, FAAN
New York, New York

Chapter 36: Management of Patients with Immunodeficiency Disorders

Kristen J. Overbaugh, PhD, RN, ACNS-BC, CHPN
San Antonio, Texas

Chapter 20: Assessment of Respiratory Function

Janet Parkosewich, DNSc, RN, FAHA
New Haven, Connecticut

Chapter 25: Assessment of Cardiovascular Function

Mae Ann Pasquale, PhD, RN
Allentown, Pennsylvania

Chapter 40: Musculoskeletal Care Modalities

Beth A. Bednarz Pruski, RN, MSN, CCRN
Washington, District of Columbia

Chapter 26: Management of Patients with Dysrhythmias and Conduction Problems

Sue Pugh, MSN, RN, CNRN, CRRN, CNS-BC, FAHA
Baltimore, Maryland

Chapter 69: Management of Patients with Neurologic Infections, Autoimmune Disorders, and Neuropathies

JoAnne Reifsnyder, PhD, RN, FAAN
Kennett Square, Pennsylvania

Chapter 16: End-of-Life Care

Rebecca Wildman Repetti, RN, ANP-BC
New York, New York

Chapter 35: Assessment of Immune Function

Marylou V. Robinson, PhD, FNP
Tacoma, Washington

Chapter 41: Management of Patients with Musculoskeletal Disorders

Erin Sarsfield, MSN, RN, CCRN-K
Hershey, Pennsylvania

Chapter 44: Digestive and Gastrointestinal Treatment Modalities

Susan Scholtz, PhD, RN
Bethlehem, Pennsylvania

Chapter 3: Critical Thinking, Ethical Decision Making, and the Nursing Process
Ethical Dilemma charts

Lindsey R. Siewert, RN, MSN, APRN, CCNS, CCRN-K
Louisville, Kentucky

Chapter 65: Assessment of Neurologic Function

Suzanne C. Smeltzer, RN, EdD, ANEF, FAAN
Villanova, Pennsylvania

Chapter 9: Chronic Illness and Disability

Jennifer Specht, PhD, RN
Chester, Pennsylvania

Chapter 5: Adult Health and Nutritional Assessment
Chapter 48: Assessment and Management of Patients with Obesity

Cindy Stern, RN, MSN, CCRP
Philadelphia, Pennsylvania

Chapter 15: Management of Patients with Oncologic Disorders

Julie G. Stover, RN, MSN, CRNP
Lancaster, Pennsylvania

Chapter 56: Assessment and Management of Female Physiologic Processes

Kimberly A. Subasic, PhD, MS, RN
Scranton, Pennsylvania

Chapter 8: Overview of Genetics and Genomics in Nursing
Genetics in Nursing Practice charts

Carole Sullivan, DNP, RN
Eldorado, Illinois

Chapter 37: Assessment and Management of Patients with Allergic Disorders
Unit-opening case studies, Units 1–9

Mary Laudon Thomas, MS, CNS, AOCN
Palo Alto, California

Chapter 32: Assessment of Hematologic Function and Treatment Modalities
Chapter 33: Management of Patients with Nonmalignant Hematologic Disorders
Chapter 34: Management of Patients with Hematologic Neoplasms

Kristin Weitmann, RN, MSN, ACNP
Wauwatosa, Wisconsin

Chapter 27: Management of Patients with Coronary Vascular Disorders
Chapter 29: Management of Patients with Complications from Heart Disease

Marie Wilson, RN, MSN, CCRN, CNRN, CRNP
Philadelphia, Pennsylvania

Chapter 68: Management of Patients with Neurologic Trauma

Reviewers

Julie Baldwin, DNP
Associate Professor
Missouri Western State University
St. Joseph, Missouri

Tamara Baxter, MSN, RN, CNE
Assistant Professor
Northwestern State University
Natchitoches, Louisiana

Rachel Coats, MS, RN, CEN, CNE
Lecturer
Lander University
Greenwood, South Carolina

Debra Connell-Dent, MSN, RN
Assistant Teaching Professor
University of Missouri St. Louis
St. Louis, Missouri

Sarah Darrell, MSN, RN, CNOR
Faculty
Ivy Tech Community College Valparaiso
Valparaiso, Indiana

Amanda Finley, MSN, RN
Assistant Teaching Professor
University of Missouri St. Louis
St. Louis, Missouri

Cassie Flock, MSN, RN
Assistant Professor
Vincennes University
Jasper, Indiana

Belinda Fuller, RN, MSN
Nurse Educator
Gadsden State Community College
Gadsden, Alabama

Melissa Gorton, MS, RN
Assistant Professor of Nursing
Castleton University
Castleton, Vermont

Lori Hailey, RN, MSN, CHSE
Assistant Professor
Arkansas State University
Jonesboro, Arkansas

Carol Heim, MA, RN
Associate Professor
Mount Mercy University
Cedar Rapids, Iowa

Melissa Humfleet, DNP, RN
Assistant Professor of Nursing
Lincoln Memorial University
Harrogate, Tennessee

Elizabeth D. Katrancha, DNP, CCNS, RN, CNE
Assistant Professor
University of Pittsburgh at Johnstown
Johnstown, Pennsylvania

Llynne C. Kiernan, DNP, MSN, RN-BC
Assistant Professor
Norwich University
Northfield, Vermont

Tammy Killen, MSN, RN
Instructor
Jacksonville State University
Jacksonville, Alabama

Tina Marie Kline, MSN, RN, CMSRN, CNE

Associate Professor
Pennsylvania College of Technology
Williamsport, Pennsylvania

Angie Koller, DNP, MSN, RN
Dean and Professor
Ivy Tech Community College
Indianapolis, Indiana

Trudy Kuehn, RN, BSN, MSN
Associate Professor of Nursing
Paul D. Camp Community College
Franklin, Virginia

Dana Law-Ham, PhD, RN, FNP-BC, CNE
Assistant Clinical Professor
University of New England
Portland, Maine

Phyllis Magaletto, MS, RN, BC
Nursing Instructor
Cochran School of Nursing
Yonkers, New York

Julie Page, EdD, MSN, RN
Assistant Professor
University of North Carolina at Chapel Hill
Chapel Hill, North Carolina

Judith Pahlck, MSN-Ed, RN
Dean of Nursing
Jersey College
Teterboro, New Jersey

Annette M. Peacock-Johnson, DNP, RN
Associate Professor of Nursing
Saint Mary's College
Notre Dame, Indiana

Amanda Pribble, MSN, FNP-C
Assistant Professor of Nursing

University of Lynchburg
Lynchburg, Virginia

Karen Robertson, MSN, MBA, PhD/ABD
Associate Professor
Rock Valley College
Rockford, Illinois

Nancy Ross, PhD, RN
Assistant Clinical Professor
University of New England
Portland, Maine

Susan Self, DNP, RN
Assistant Professor in Nursing
Arkansas Tech University
Russellville, Arkansas

Leah Shreves, MSN, RN
Associate Professor of Nursing
Edison State Community College
Piqua, Ohio

Janice A. Sinoski, MSN/Ed, BSN, CCRN, CEN
Assistant Professor of Nursing
University of Lynchburg
Lynchburg, Virginia

Mendy Stanford, DNP, MSN/Ed, CNE
Executive Director of Nursing and Allied Health
Treasure Valley Community College
Ontario, Oregon

Charles Tucker, DNP, RN, CNE
Associate Professor
Mars Hill University
Mars Hill, North Carolina

Heather Vitko, PhD, RN, CCRN, TCRN, CNL
Assistant Professor of Nursing
Saint Francis University

Windber, Pennsylvania

Mina Wayman, APRN, MSN
Associate Professor
Utah Valley University
Orem, Utah

Heather Wierzbinski-Cross, MSN, RN, CNE
Dean for the School of Nursing
Ivy Tech Community College Richmond
Richmond, Indiana

Kennetta Wiggins, MSN, RN
Nursing Instructor and Registered Nurse
Northwest Arkansas Community College
Bentonville, Arkansas

Renee Wright, EdD, RN
Associate Professor
York College, City University of New York
Jamaica, New York

Preface

Since 1964, when Lillian Sholtis Brunner and Doris Smith Suddarth introduced the first edition of the *Textbook of Medical-Surgical Nursing*, the practice of nursing has flexed, changed, evolved, and advanced to meet changing health needs and expectations for health care. With each subsequent edition of this textbook, Lillian and Doris, and their successors, Suzanne Smeltzer and Brenda Bare (and eventually we, the current authors), admirably updated and revised content to reflect changes and challenges that shaped the practice of nursing, considering complex and interconnected influences and maintaining a focus upon salient social, cultural, economic, and environmental factors. Never have we, nor our distinguished and capable predecessors, had to revise and update seminal medical-surgical nursing concepts, principles, and practices during a global pandemic—until now. Most assuredly, this has been a daunting task. Yet, compared to what many of our phenomenally creative, determined, and resilient professional colleagues have had to confront and contend with as a result of this pandemic, our work was much less onerous. We would also like to recognize the long overdue and growing awareness of structural racism within healthcare and the impact of systemic racism on perpetuating stereotypes and health disparities. We encourage nurse educators and students to thoughtfully consider and discuss these issues when exploring epidemiological factors of specific disorders and nursing care throughout the textbook. Now that we have sent this edition to print and have time to reflect upon our work, we find ourselves humbled to call ourselves your peers and so proud of the important and sacred work that you do today and every day. We have decided to break with a long tradition in this textbook that tends to not provide dedications. To YOU our fellow nurses, nursing faculty, and nursing students, we dedicate this book.

Organization

Brunner & Suddarth's Textbook of Medical-Surgical Nursing, 15th Edition, is organized into 16 units. These units mirror those found in previous editions with the incorporation of some changes. Content was

updated throughout all units, with cross-references to specific chapters included as appropriate. Units 1 through 3 cover foundational principles and core concepts related to medical-surgical nursing practice. Units 4 through 15 discuss adult health conditions that are treated medically or surgically. Unit 16 describes community-based challenges that affect medical-surgical nursing practice.

Units 4 through 15 are structured in the following way to better facilitate comprehension:

- The first chapter in the unit covers assessment and includes a review of normal anatomy and physiology of the body system being discussed.
- Subsequent chapters in the unit cover management of specific disorders. Pathophysiology, clinical manifestations, assessment and diagnostic findings, medical management, and nursing management are presented. Nursing Process sections, provided for select conditions, clarify and expand on the nurse's role in caring for patients with these conditions.

There are fewer chapters in this edition than in the past several editions; however, the seminal content within the deleted chapters remains, and is updated and revised. Notably, core content in previous-edition chapters that focused exclusively on *therapeutic modalities* has now been incorporated into chapters focused on health conditions and disorders, where its application dovetails seamlessly into nursing management and the nursing process. Thus, the application of these modalities to medical-surgical nursing practice is readily apparent.

Special Features

When caring for patients, nurses assume many different roles, including practitioner, educator, advocate, and researcher. Many of the features in this textbook have been developed to help nurses fulfill these varied responsibilities. Key updates to practice-oriented features in the 15th edition include new unit-opening Case Studies with QSEN Competency Focus—a feature that highlights a competency from the Quality and Safety Education for Nurses (QSEN) Institute that is applicable to the case study and poses questions for students to consider about relevant knowledge, skills, and attitudes (KSAs). Quality and Safety Nursing Alerts, Genetics in Nursing Practice charts, Ethical Dilemma charts, and Home Care Checklist charts offer updated information.

Plans of Nursing Care, provided for select disorders, illustrate how the nursing process is applied to meet the patient's health care and nursing needs. New to the 15th edition, nursing diagnoses used in the Plans of Nursing Care and throughout the textbook are those devised and validated by the International Council of Nurses in the *International Classification for Nursing Practice (ICNP) Catalogue*. (Please note that because of the global foci of these nursing diagnoses, select terms in these diagnoses are spelled in the British manner.)

A new addition to the textbook this cycle is a chapter focused exclusively on the unique health care needs of persons who identify as lesbian, gay, bisexual, transgender, and/or queer (LGBTQ). As is the case with other chapters of this textbook, the roles of the professional nurse as a practitioner, educator, advocate, and researcher when providing care for persons who are LGBTQ provide the framework for this new chapter.

In addition, two new features in this edition highlight content related to COVID-19 and care of veterans. *COVID-19 Considerations* sections identify evidence-based information at the time this material was written related to the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) or the nursing care of patients with coronavirus disease 2019 (COVID-19). *Veterans Considerations* sections include information applicable to the special care needs of military veterans. Veterans—who may include persons from all age groups, genders, races, and socioeconomic strata—may have unique health risks based upon dates of service and assignment locale.

The textbook also provides pedagogical features developed to help readers engage and learn critical content. Concept Mastery Alerts continue to clarify fundamental nursing concepts to improve the reader's understanding of potentially confusing topics, as identified by Misconception Alerts in Lippincott's Adaptive Learning Powered by PrepU. An enhanced suite of online, interactive multimedia resources is also highlighted with icons placed in text near relevant topics. Unfolding Patient Stories (case study vignettes) based on vSim for Nursing patients are part of this suite of resources.

Read the User's Guide that follows the Preface for a full explanation and visual representation of all special features. See also the "Special Charts in This Book" and "Case Studies in This Book" sections of this front matter for the location of these items in the text.

A Comprehensive Package for Teaching and Learning

To further facilitate teaching and learning, a carefully designed ancillary package has been developed to assist faculty and students.

Instructor Resources

Tools to assist you with teaching your course are available upon adoption of this text on thePoint at http://thepoint.lww.com/Brunner15e.

- An **e-Book** on thePoint gives you access to the book's full text and images online.
- A thoroughly revised and augmented **Test Generator** contains more than 2900 NCLEX-style questions mapped to chapter learning outcomes.
- An extensive collection of materials is provided for each book chapter:
  - **Lesson Plans** outline learning outcomes and identify relevant resources from the robust instructor and student resource packages to help you prepare for your class.
  - **Pre-Lecture Quizzes** (and answers) allow you to check students' reading.
  - **PowerPoint Presentations** provide an easy way to integrate the textbook with your students' classroom experience; multiple-choice and true/false questions are included to promote class participation.
  - **Guided Lecture Notes** are organized by outcome and provide corresponding PowerPoint slide numbers to simplify preparation for lecture.
  - **Discussion Topics** (and suggested answers) can be used in the classroom or in online discussion boards to facilitate interaction with your students.
  - **Assignments** (and suggested answers) include group, written, clinical, and Web assignments to engage students in varied activities and assess their learning.
  - **Case Studies** with related questions (and suggested answers) give students an opportunity to apply their knowledge to a client case similar to one they might encounter in practice.

- Sample **Syllabi** are provided for one- and two-semester courses.
- A **QSEN Competency Map** identifies content and special features in the book related to competencies identified by the QSEN Institute.
- An **Image Bank** lets you use the photographs and illustrations from this textbook in your course materials.
- Access to all **Student Resources** is provided so that you can understand the student experience and use these resources in your course as well.

Student Resources

An exciting set of free learning resources is available on thePoint to help students review and apply vital concepts in medical-surgical nursing. Multimedia engines have been optimized so that students can access many of these resources on mobile devices. Students can access all these resources at http://thepoint.lww.com/Brunner15e using the codes printed in the front of their textbooks.

- **NCLEX-Style Review Questions** for each chapter, totaling more than 1800 questions, help students review important concepts and practice for NCLEX.
- Interactive learning resources appeal to a variety of learning styles. Icons in the text direct readers to relevant resources:
  - **Concepts in Action Animations** bring physiologic and pathophysiologic concepts to life.
  - **Practice & Learn Case Studies** present case scenarios and offer interactive exercises and questions to help students apply what they have learned.
  - **Watch & Learn Video Clips** reinforce skills from the textbook and appeal to visual and auditory learners.
- **Procedural Guidelines charts** review key nursing interventions and rationales for specific patient care situations.
- **Appendix A, Diagnostic Studies and Interpretation**, provides reference ranges and lab values for common laboratory tests.

- **Journal Articles** offer access to current articles relevant to each chapter and available in Wolters Kluwer journals to familiarize students with nursing literature.

Study Guide

A comprehensive study aid for reviewing key concepts, ***Study Guide for Brunner & Suddarth's Textbook of Medical-Surgical Nursing*, 15th Edition**, has been thoroughly revised and presents a variety of exercises, including case studies and practice NCLEX-style questions, to reinforce textbook content and enhance learning.

vSim for Nursing

Available for separate purchase, vSim for Nursing, jointly developed by Laerdal Medical and Wolters Kluwer, offers innovative scenario-based learning modules consisting of Web-based virtual simulations, course learning materials, and curriculum tools designed to develop critical thinking skills and promote clinical confidence and competence. vSim for Nursing | Medical-Surgical includes 10 virtual simulations based on the National League for Nursing Volume I Complex patient scenarios. Students can progress through suggested readings, pre- and postsimulation assessments, documentation assignments, and guided reflection questions, and will receive an individualized feedback log immediately upon completion of the simulation. Throughout the student learning experience, the product offers remediation back to trusted Lippincott resources, including *Brunner & Suddarth's Textbook of Medical-Surgical Nursing,* as well as Lippincott Nursing Advisor and Lippincott Nursing Procedures—two online, evidence-based, clinical information solutions used in health care facilities throughout the United States. This innovative product provides a comprehensive patient-focused solution for learning and integrating simulation into the classroom.

Contact your Wolters Kluwer sales representative or visit http://thepoint.lww.com/vsim for options to enhance your medical-surgical nursing course with vSim for Nursing.

Lippincott DocuCare

Available for separate purchase, Lippincott DocuCare combines Web-based academic EHR simulation software with clinical case scenarios, allowing students to learn how to use an EHR in a safe, true-to-life

setting, while enabling instructors to measure their progress. Lippincott DocuCare's nonlinear solution works well in the classroom, simulation lab, and clinical practice.

Contact your Wolters Kluwer sales representative or visit http://thepoint.lww.com/DocuCare for options to enhance your medical-surgical nursing course with DocuCare.

A Comprehensive, Digital, Integrated Course Solution

Lippincott® CoursePoint+ is an integrated, digital curriculum solution for nursing education that provides a completely interactive experience geared to help students understand, retain, and apply their course knowledge and be prepared for practice. The time-tested, easy-to-use, and trusted solution includes engaging learning tools, evidence-based practice, case studies, and in-depth reporting to meet students where they are in their learning, combined with the most trusted nursing education content on the market to help prepare students for practice. This easy-to-use digital learning solution of *Lippincott® CoursePoint+,* combined with unmatched support, gives instructors and students everything they need for course and curriculum success!

Lippincott® CoursePoint+ includes:

- Leading content provides a variety of learning tools to engage students of all learning styles.
- A personalized learning approach gives students the content and tools they need at the moment they need it, giving them data for more focused remediation and helping to boost their confidence and competence.
- Powerful tools, including varying levels of case studies, interactive learning activities, and adaptive learning powered by PrepU, help students learn the critical thinking and clinical judgment skills to help them become practice-ready nurses.
- Preparation for Practice tools improve student competence, confidence, and success in transitioning to practice.
    - vSim for Nursing: Co-developed by Laerdal Medical and Wolters Kluwer, vSim for Nursing simulates real nursing scenarios and allows students to interact with virtual patients in a safe, online environment.

    - Lippincott Advisor for Education: With over 8500 entries covering the latest evidence-based content and drug information, Lippincott Advisor for Education provides students with the most up-to-date information possible, while giving them valuable experience with the same point-of-care content they will encounter in practice.
- Unparalleled reporting provides in-depth dashboards with several data points to track student progress and help identify strengths and weaknesses.
- Unmatched support includes training coaches, product trainers, and nursing education consultants to help educators and students implement CoursePoint+ with ease.

Janice L. Hinkle, PhD, RN, CNRN
Kerry H. Cheever, PhD, RN
Kristen J. Overbaugh, PhD, RN, ACNS-BC, CHPN

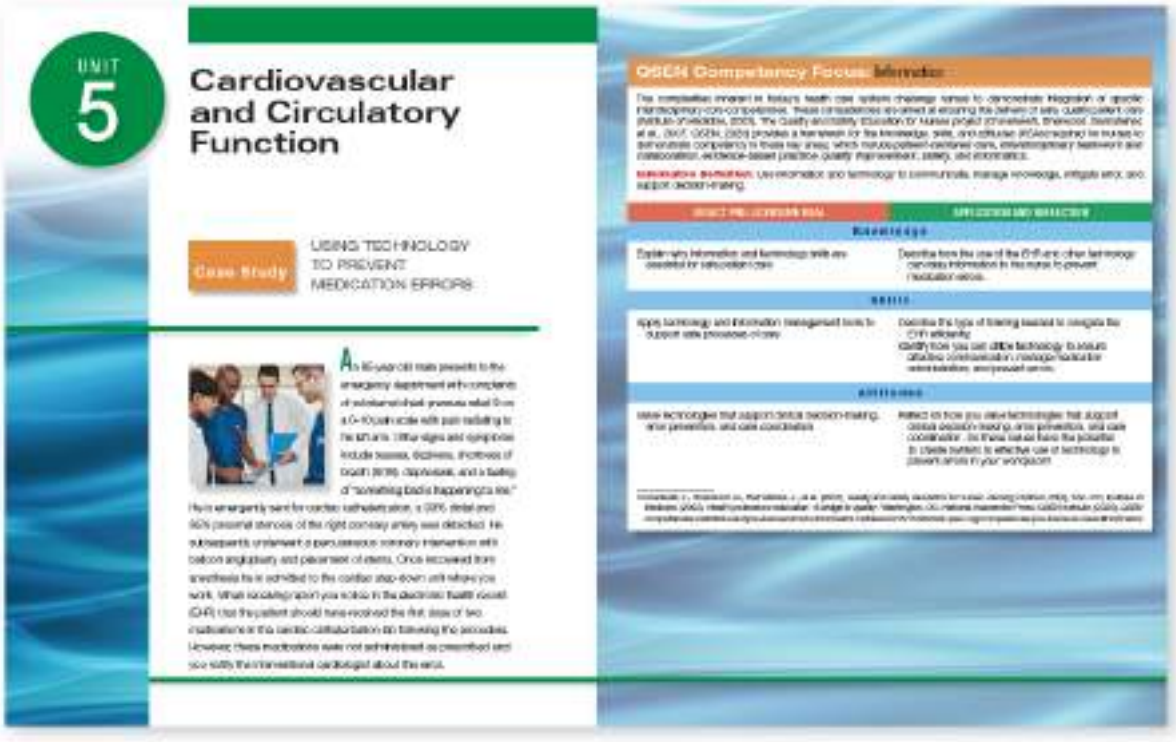
User's Guide

Brunner & Suddarth's Textbook of Medical-Surgical Nursing, 15th Edition, has been revised and updated to reflect the complex nature of nursing practice today. This textbook includes many features to help you gain and apply the knowledge that you need to pass NCLEX and successfully meet the challenges and opportunities of clinical practice. In addition, features have been developed specifically to help you fulfill the varied roles that nurses assume in practice.

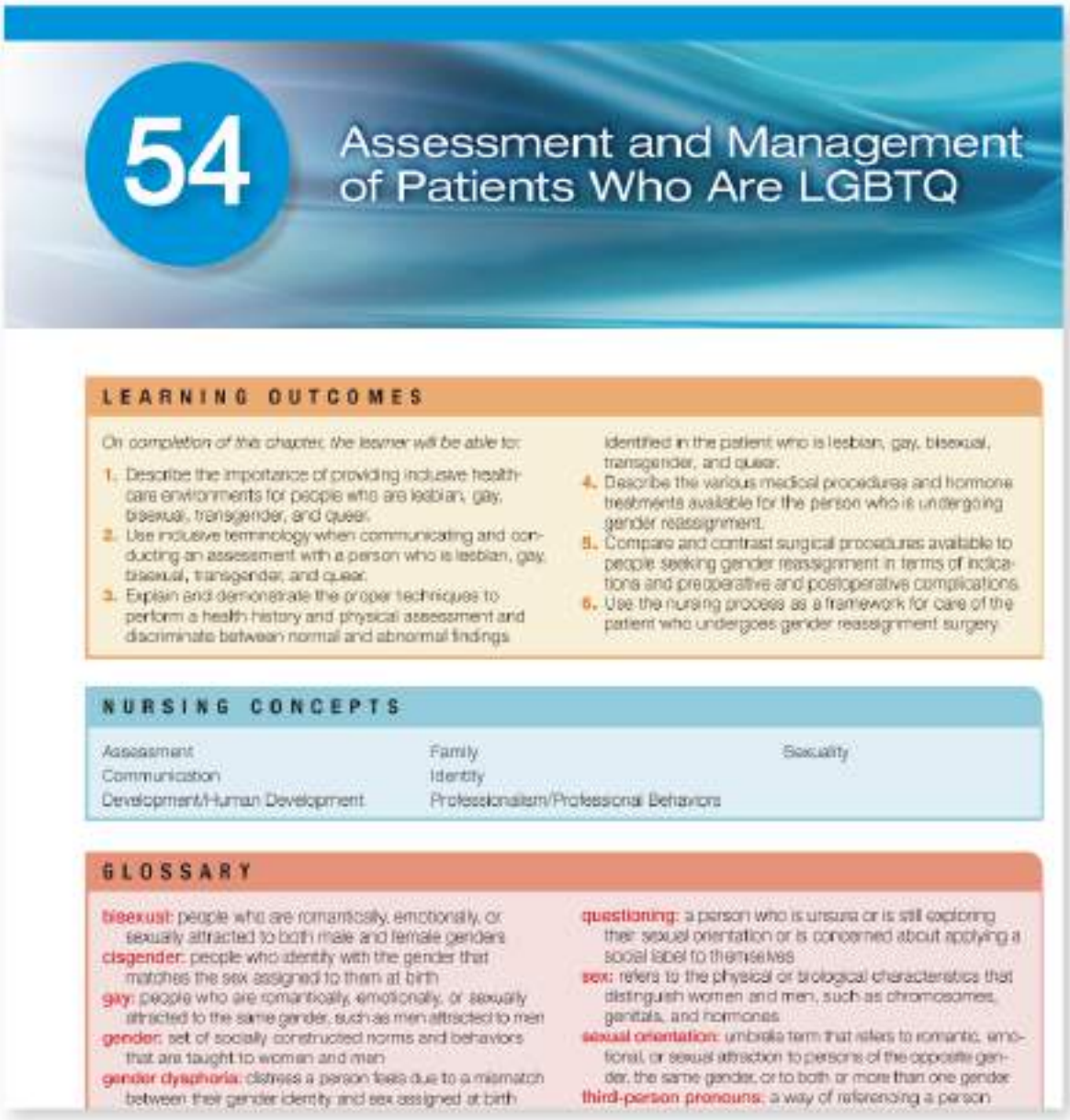
Opening Features That Start with the End in Mind

Unit-opening features put the patient first and highlight competent nursing as well as application of the nursing process.

- **All new! A Case Study with QSEN Competency Focus** opens each unit and provides discussion points focusing on one competency from the QSEN Institute: patient-centered care, interdisciplinary teamwork and collaboration, evidence-based practice, quality improvement, safety, or informatics. This feature helps you consider the KSAs required for the delivery of safe, quality patient care. For your convenience, a list of these case studies, along with their location in the book, appears in the "Case Studies in This Book" section later in this front matter.



- **Learning Outcomes**, succinctly focused and condensed in this edition, provide an overview of each chapter and identify what you will be able to do after completing the material, to help focus reading and studying.
- **NEW! Nursing Concepts** listed at the beginning of each chapter make clear how content applies to Concepts-based curricula.
- A **Glossary** provides a list of key terms and definitions at the beginning of each chapter, providing a review of vocabulary words before reading the material and a useful reference and study tool.



54 Assessment and Management of Patients Who Are LGBTQ

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the importance of providing inclusive health-care environments for people who are lesbian, gay, bisexual, transgender, and queer.
2. Use inclusive terminology when communicating and conducting an assessment with a person who is lesbian, gay, bisexual, transgender, and queer.
3. Explain and demonstrate the proper techniques to perform a health history and physical assessment and discriminate between normal and abnormal findings identified in the patient who is lesbian, gay, bisexual, transgender, and queer.
4. Describe the various medical procedures and hormone treatments available for the person who is undergoing gender reassignment.
5. Compare and contrast surgical procedures available to people seeking gender reassignment in terms of indications and preoperative and postoperative complications.
6. Use the nursing process as a framework for care of the patient who undergoes gender reassignment surgery.

NURSING CONCEPTS

Assessment	Family	Sexuality
Communication	Identity	
Development/Human Development	Professionalism/Professional Behaviors	

GLOSSARY

bisexual: people who are romantically, emotionally, or sexually attracted to both male and female genders
cisgender: people who identify with the gender that matches the sex assigned to them at birth
gay: people who are romantically, emotionally, or sexually attracted to the same gender, such as men attracted to men
gender: set of socially constructed norms and behaviors that are taught to women and men
gender dysphoria: distress a person feels due to a mismatch between their gender identity and sex assigned at birth
questioning: a person who is unsure or is still exploring their sexual orientation or is concerned about applying a social label to themselves
sex: refers to the physical or biological characteristics that distinguish women and men, such as chromosomes, genitals, and hormones
sexual orientation: umbrella term that refers to romantic, emotional, or sexual attraction to persons of the opposite gender, the same gender, or to both or more than one gender
third-person pronouns: a way of referencing a person

Features to Develop the Nurse as Practitioner

One of the central roles of the nurse is to provide holistic care to patients and their families, both independently and through collaboration with other health care professionals. Special features throughout chapters are designed to assist readers with clinical practice.

- **Nursing Process sections** are organized according to the nursing process framework—the basis for all nursing practice—and help clarify the nurse's responsibilities in caring for patients with select disorders.

NURSING PROCESS

The Patient with an Arrhythmia

Assessment

Major areas of assessment include possible causes of the arrhythmia, contributing factors, and the arrhythmia's effect on the heart's ability to pump an adequate blood volume. When cardiac output is reduced, the amount of oxygen reaching the tissues and vital organs is diminished. This diminished oxygenation produces the signs and symptoms associated with arrhythmias. If these signs and symptoms are severe or if they occur frequently, the patient may experience significant distress and disruption of daily life.

- **Plans of Nursing Care**, provided for select disorders, illustrate how the nursing process is applied to meet the patient's health care and nursing needs.

Chart 45-4 **PLAN OF NURSING CARE**

Care of the Patient with Hypothyroidism

NURSING DIAGNOSIS: Impaired breathing associated with depressed ventilation
GOAL: Improved respiratory status and maintenance of normal breathing pattern

Nursing Interventions	Rationale	Expected Outcomes
1. Assess respiratory rate, depth, pattern, pulse oximetry, and arterial blood gases.	1. Identifies patient's baseline to monitor further changes and evaluate effectiveness of interventions.	• Shows improved respiratory status and normal respiratory rate, depth, and pattern • Takes deep breaths, coughs and uses incentive spirometry • Explains rationale for cautious use of medications • Maintains adequate oxygenation
2. Encourage deep breathing, coughing, and the use of incentive spirometry.	2. Prevents atelectasis and promotes adequate ventilation.	
3. Verify with the provider orders to administer any hypnotic and sedative until euthyroid state achieved. If these medications are needed, monitor for adverse side effects.	3. Patients with hypothyroidism are susceptible to respiratory depression with the use of hypnotics and sedatives.	
4. Maintain patient airway through suction and ventilator support if needed (see Chapter 19 for care of patients requiring mechanical ventilation).	4. The use of artificial airway and ventilator support may be necessary.	

- **Assessment charts** focus on data that should be collected as part of the assessment step of the nursing process.

Chart 35-3

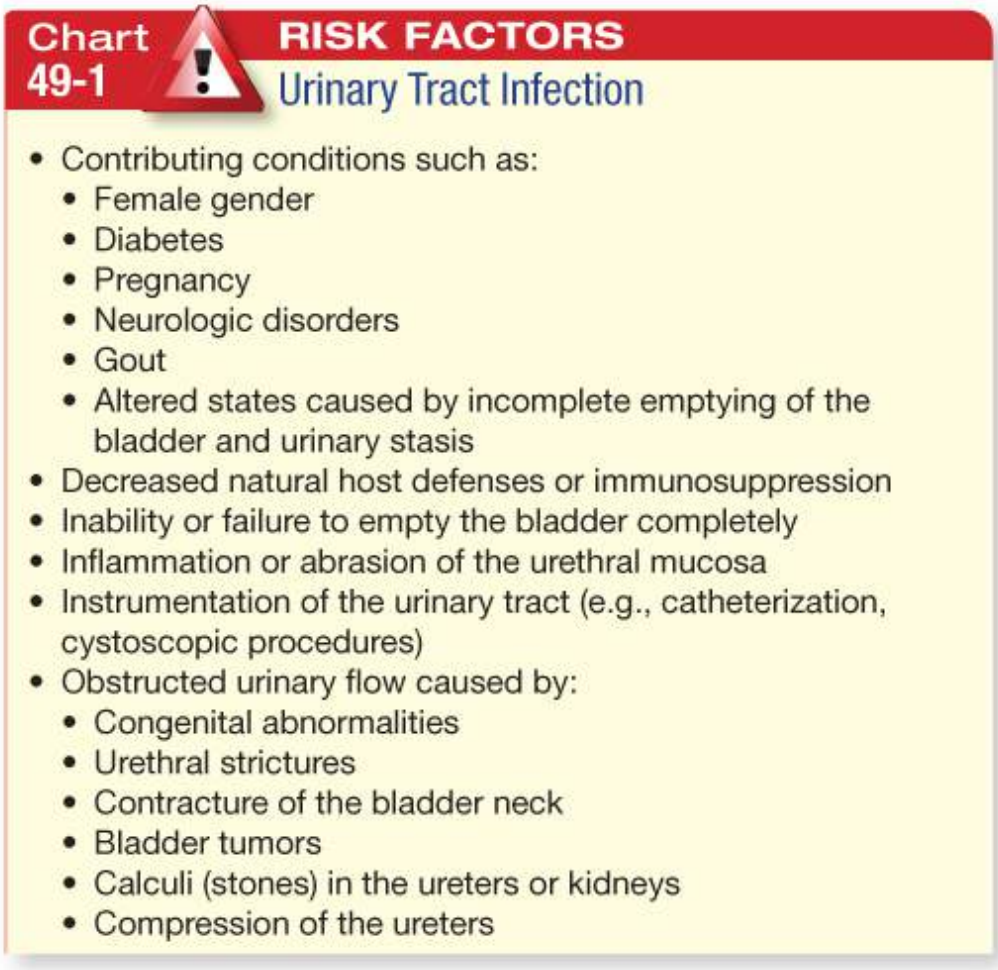
ASSESSMENT

Assessing for Peripheral Nerve Function

Assessment of peripheral nerve function has two key elements: evaluation of sensation and evaluation of motion. The nurse may perform one or all of the following during a musculoskeletal assessment.

Nerve	Test of Sensation	Test of Movement
Peroneal	Prick the skin midway between the great and second toe.	Ask the patient to dorsiflex the foot and extend the toes.

- **Risk Factors charts** outline factors that can impair health and should be considered in the context of social determinants of health and systemic racism.



- **Genetics in Nursing Practice charts** summarize and highlight nursing assessments and management issues related to the role of genetics in select disorders.

Chart 8-1 GENETICS IN NURSING PRACTICE

Genetics Concepts and the Older Adult

Genetic conditions in the older adult may occur from a specific gene mutation or arise as a result of a genetic predisposition combined with other factors (multifactorial). The following are examples of some adult-onset genetic conditions:

- Colon cancer
- Hemochromatosis
- Huntington disease
- Polycystic kidney disease
- Alzheimer's disease

The following are some examples of diseases with multifactorial components, which may include a genetic predisposition, in the older adult:

- Diabetes
- Emphysema
- Heart disease

Nursing Assessments

Refer to Chapter 4, Chart 4-2: Genetics in Nursing Practice: Genetic Aspects of Health Assessment

Family History Assessment Specific to the Older Adult

- Collect and assess family history on both maternal and paternal sides of the family for three generations.
- Determine whether genetic testing has occurred with other family members.
- Assess for individual and family perceptions and beliefs around topics related to genetics.

Patient Assessment Specific to the Older Adult and Genetic Illness

- Assess older adult patient's knowledge and understanding of genetics, genetic testing, and gene-based therapies.
- Assess the patient's understanding of genetic information and decipher health literacy needs.
- Perform cultural, social, and spiritual assessment.
- Assess patient's communication capacities so that communication strategies about genetics are tailored to their needs and abilities.
- Identify patient's support system.

Management Issues Specific to Genetics and the Older Adult

- Refer for further genetic counseling and evaluation as warranted so that family members can discuss inheritance risk to other family members, and availability of genetic testing and gene-based interventions.
- Offer appropriate genetic information and resources that take into consideration older patient's literacy needs.
- Evaluate older patient's understanding before, during, and after the introduction of genetic information and services.
- Take the time to clearly explain the concepts of genetic testing to older patients and provide written information that reinforces the topic of discussion.
- Participate in the management and coordination of care of older patients with genetic conditions and individuals predisposed to develop or pass on a genetic condition.

Genetics Resources

See Chapter 6, Chart 6-7: Components of Genetic Counseling for additional resources.

- **Pharmacology charts and tables** display important considerations related to administering medications and monitoring drug therapy.

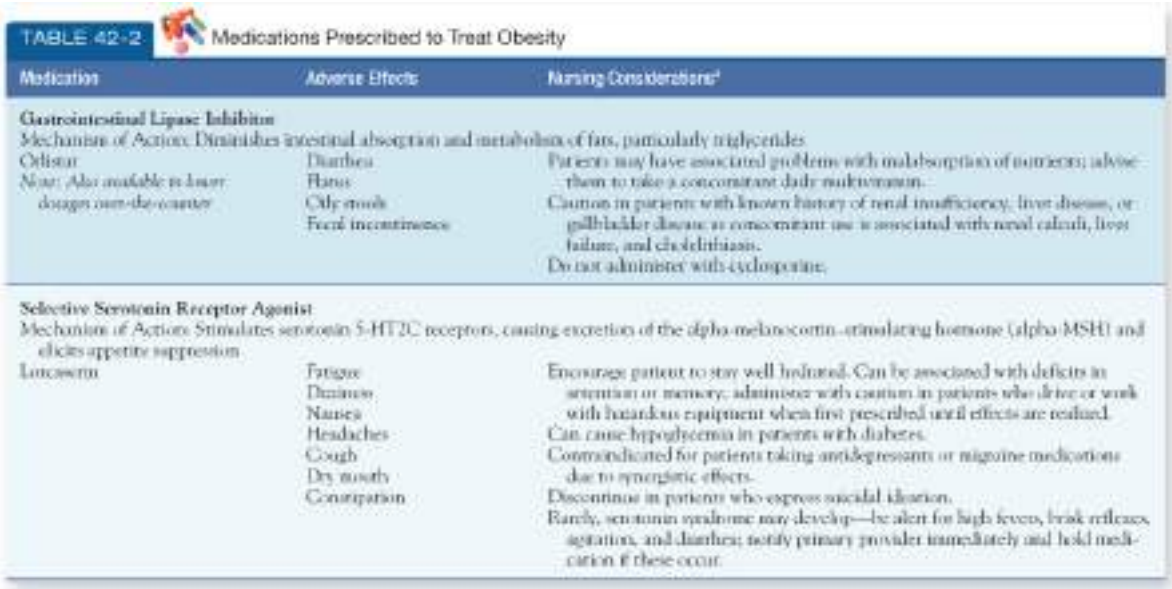


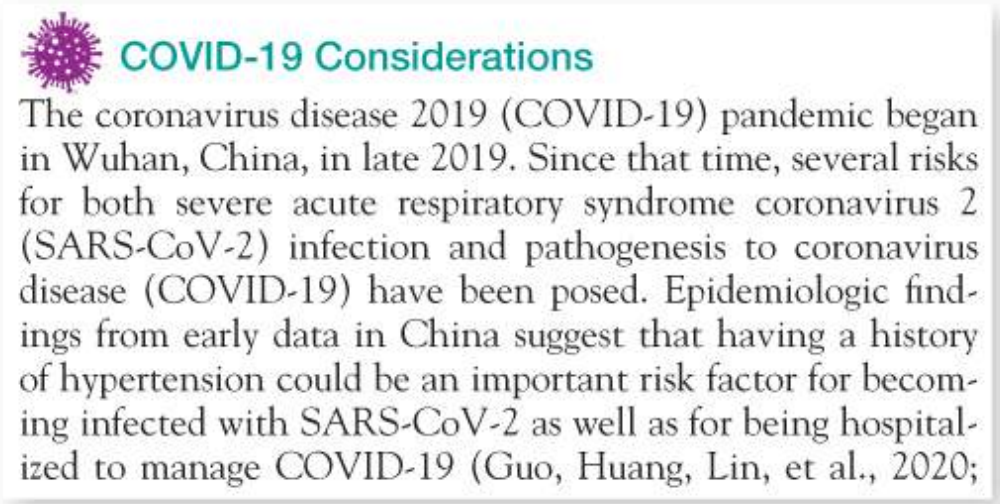
TABLE 42-2 Medications Prescribed to Treat Obesity

Medication	Adverse Effects	Nursing Considerations[a]
Gastrointestinal Lipase Inhibitor		
Mechanism of Action: Diminishes intestinal absorption and metabolism of fats, particularly triglycerides		
Orlistat *Note: Also available in lower dosages over-the-counter*	Diarrhea Flatus Oily stools Fecal incontinence	Patients may have associated problems with malabsorption of nutrients; advise them to take a concomitant daily multivitamin. Caution in patients with known history of renal insufficiency, liver disease, or gallbladder disease as concomitant use is associated with renal calculi, liver failure, and cholelithiasis. Do not administer with cyclosporine.
Selective Serotonin Receptor Agonist		
Mechanism of Action: Stimulates serotonin 5-HT2C receptors, causing excretion of the alpha-melanocortin–stimulating hormone (alpha-MSH) and elicits appetite suppression		
Lorcaserin	Fatigue Dizziness Nausea Headaches Cough Dry mouth Constipation	Encourage patient to stay well hydrated. Can be associated with deficits in attention or memory; administer with caution in patients who drive or work with hazardous equipment when first prescribed until effects are realized. Can cause hypoglycemia in patients with diabetes. Contraindicated for patients taking antidepressants or migraine medications due to synergistic effects. Discontinue in patients who express suicidal ideation. Rarely, serotonin syndrome may develop—be alert for high fevers, brisk reflexes, agitation, and diarrhea; notify primary provider immediately and hold medication if these occur.

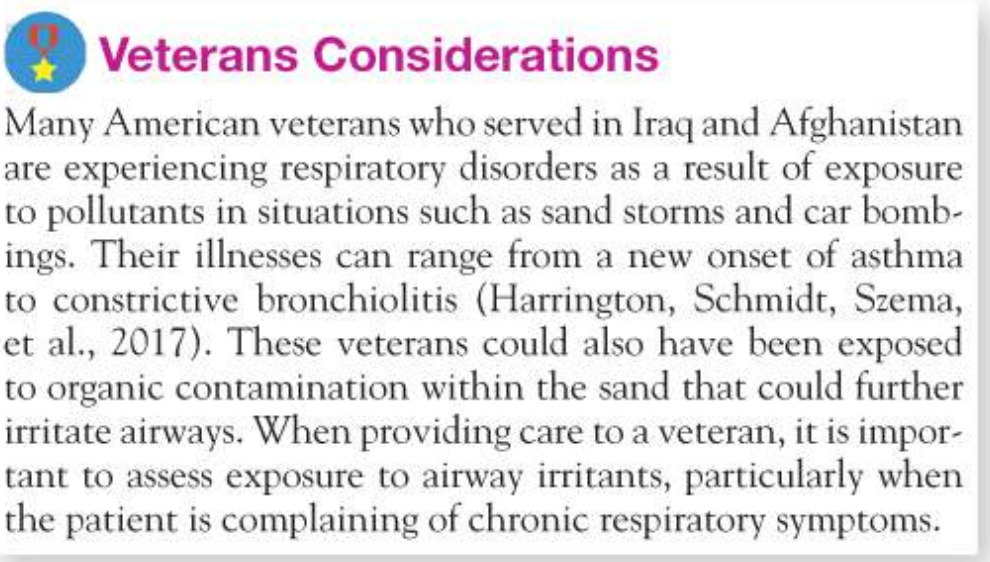
- **Updated! Quality and Safety Nursing Alerts** offer tips for best clinical practice and red-flag safety warnings to help avoid

common mistakes.

- **NEW! COVID-19 Considerations sections** identify evidence-based information at the time this material was written related to the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) or the nursing care of patients with coronavirus disease 2019 (COVID-19).



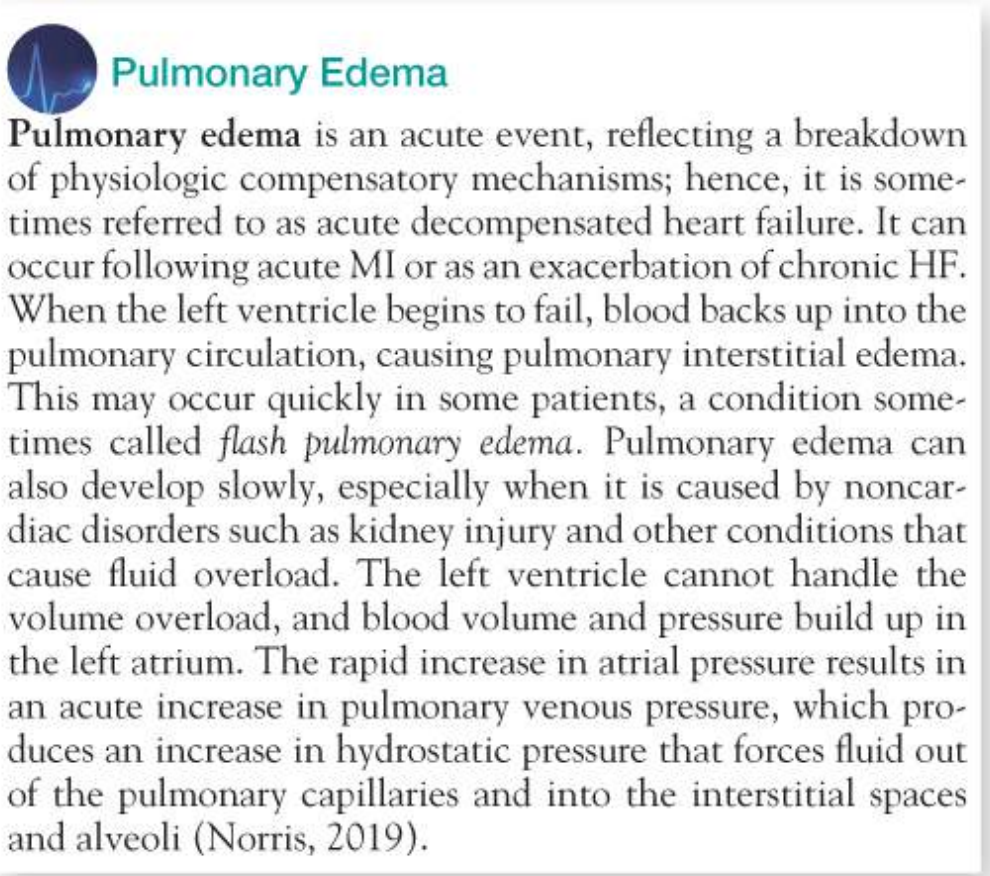
- **NEW! Veterans Considerations sections** highlight information applicable to the special care needs of veterans of the military. Veterans—who may include persons from all age groups, genders, races, and socioeconomic strata—may have unique health risks, based upon dates of service and assignment locale.



Veterans Considerations

Many American veterans who served in Iraq and Afghanistan are experiencing respiratory disorders as a result of exposure to pollutants in situations such as sand storms and car bombings. Their illnesses can range from a new onset of asthma to constrictive bronchiolitis (Harrington, Schmidt, Szema, et al., 2017). These veterans could also have been exposed to organic contamination within the sand that could further irritate airways. When providing care to a veteran, it is important to assess exposure to airway irritants, particularly when the patient is complaining of chronic respiratory symptoms.

- **Critical Care icons** identify nursing considerations for the patient who is critically ill.



Pulmonary Edema

Pulmonary edema is an acute event, reflecting a breakdown of physiologic compensatory mechanisms; hence, it is sometimes referred to as acute decompensated heart failure. It can occur following acute MI or as an exacerbation of chronic HF. When the left ventricle begins to fail, blood backs up into the pulmonary circulation, causing pulmonary interstitial edema. This may occur quickly in some patients, a condition sometimes called *flash pulmonary edema*. Pulmonary edema can also develop slowly, especially when it is caused by noncardiac disorders such as kidney injury and other conditions that cause fluid overload. The left ventricle cannot handle the volume overload, and blood volume and pressure build up in the left atrium. The rapid increase in atrial pressure results in an acute increase in pulmonary venous pressure, which produces an increase in hydrostatic pressure that forces fluid out of the pulmonary capillaries and into the interstitial spaces and alveoli (Norris, 2019).

- **Obesity Considerations icons** identify content related to obesity or to the nursing care of patients with obesity.

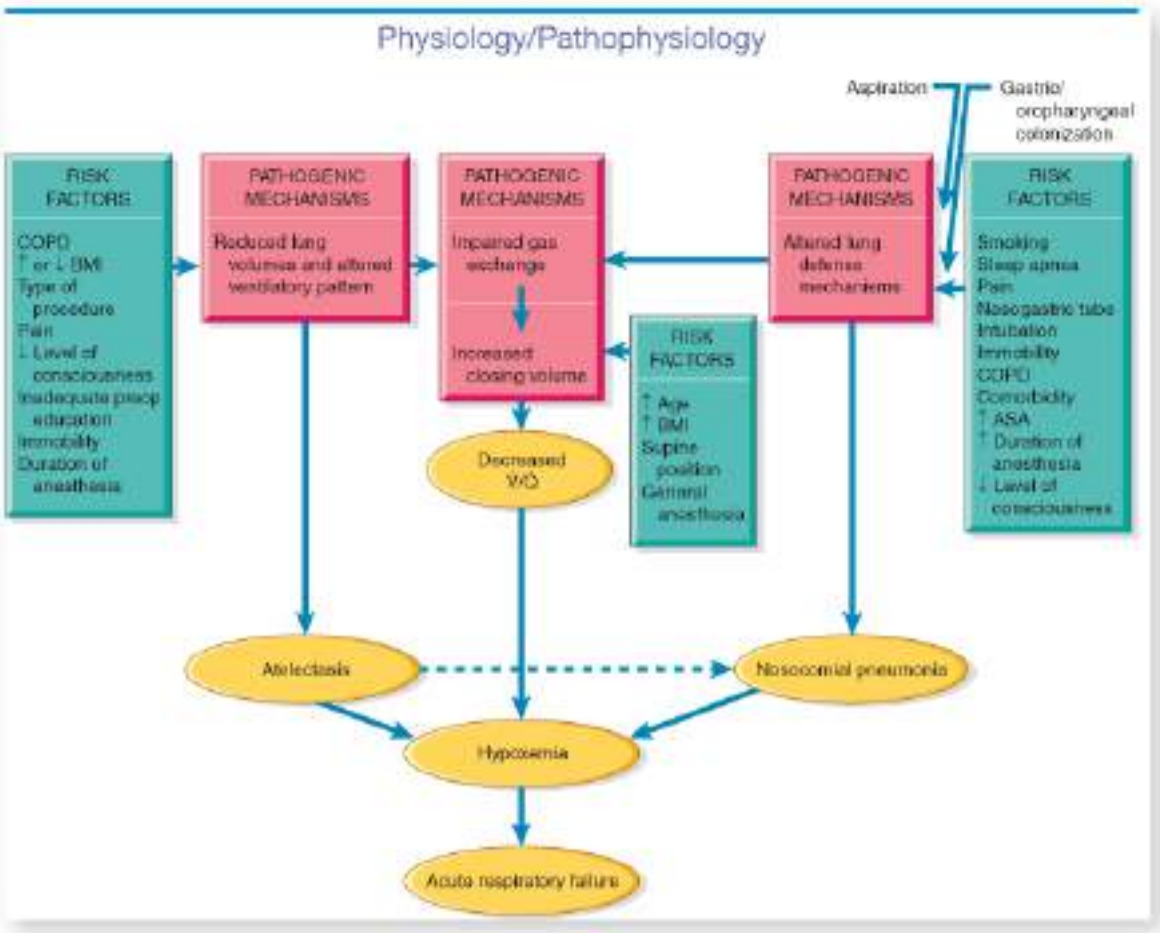
Obesity contributes to back strain by overtaxing the relatively weak back muscles in the absence of abdominal muscle support. Exercises are less effective and more difficult to perform when the patient is overweight. Weight reduction through diet modification is important to minimize recurrence of back pain. A sound nutritional plan that includes a change in eating habits and low-impact activities is vital. Noting achievement of weight reduction and providing positive reinforcement facilitate adherence. Back

- **Gerontologic Considerations icons** highlight information that pertains specifically to the care of the older adult patient. In the United States, older adults comprise the fastest-growing segment of the population.

Gerontologic Considerations

During the normal aging process, the nervous system undergoes many changes and is more vulnerable to illness. Age-related changes in the nervous system vary in degree and must be distinguished from those due to disease. It is important for clinicians not to attribute abnormality or dysfunction to aging without appropriate investigation. For example, although diminished strength and agility are a normal part of aging, localized weakness can only be attributed to disease.

- **Physiology/Pathophysiology figures** include illustrations and algorithms describing normal physiologic and pathophysiologic processes.



Features to Develop the Nurse as Educator

Health education is a primary responsibility of the nursing profession. Nursing care is directed toward promoting, maintaining, and restoring health; preventing illness; and helping patients and families adapt to the residual effects of illness. Patient education and health promotion are central to all of these nursing activities.

- **Patient Education charts and sections** help the nurse prepare the patient and family for procedures, assist them in understanding the patient's condition, and explain to them how to provide self-care.

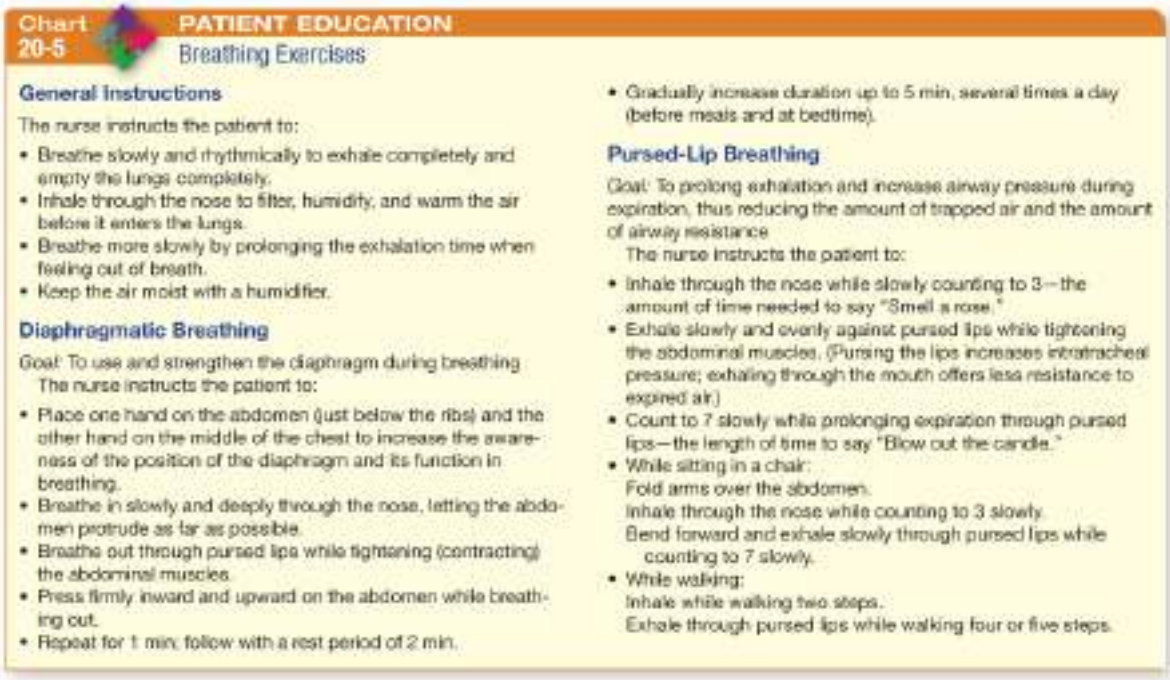


Chart 20-5 PATIENT EDUCATION
Breathing Exercises

General Instructions

The nurse instructs the patient to:

- Breathe slowly and rhythmically to exhale completely and empty the lungs completely.
- Inhale through the nose to filter, humidify, and warm the air before it enters the lungs.
- Breathe more slowly by prolonging the exhalation time when feeling out of breath.
- Keep the air moist with a humidifier.

Diaphragmatic Breathing

Goal: To use and strengthen the diaphragm during breathing
The nurse instructs the patient to:

- Place one hand on the abdomen (just below the ribs) and the other hand on the middle of the chest to increase the awareness of the position of the diaphragm and its function in breathing.
- Breathe in slowly and deeply through the nose, letting the abdomen protrude as far as possible.
- Breathe out through pursed lips while tightening (contracting) the abdominal muscles.
- Press firmly inward and upward on the abdomen while breathing out.
- Repeat for 1 min; follow with a rest period of 2 min.
- Gradually increase duration up to 5 min, several times a day (before meals and at bedtime).

Pursed-Lip Breathing

Goal: To prolong exhalation and increase airway pressure during expiration, thus reducing the amount of trapped air and the amount of airway resistance
The nurse instructs the patient to:

- Inhale through the nose while slowly counting to 3—the amount of time needed to say "Smell a rose."
- Exhale slowly and evenly against pursed lips while tightening the abdominal muscles. (Pursing the lips increases intratracheal pressure; exhaling through the mouth offers less resistance to expired air.)
- Count to 7 slowly while prolonging expiration through pursed lips—the length of time to say "Blow out the candle."
- While sitting in a chair:
  Fold arms over the abdomen.
  Inhale through the nose while counting to 3 slowly.
  Bend forward and exhale slowly through pursed lips while counting to 7 slowly.
- While walking:
  Inhale while walking two steps.
  Exhale through pursed lips while walking four or five steps.

- **Health Promotion charts** review important points that the nurse should discuss with the patient to prevent common health problems from developing.

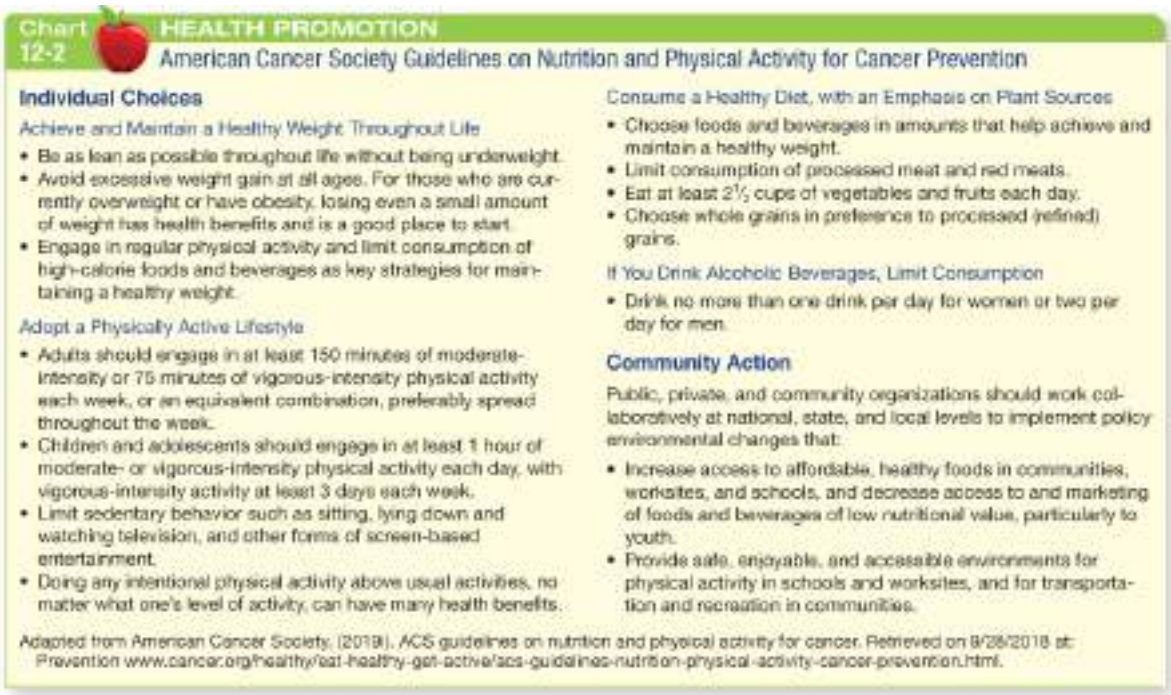


Chart 12-2 HEALTH PROMOTION
American Cancer Society Guidelines on Nutrition and Physical Activity for Cancer Prevention

Individual Choices

Achieve and Maintain a Healthy Weight Throughout Life

- Be as lean as possible throughout life without being underweight.
- Avoid excessive weight gain at all ages. For those who are currently overweight or have obesity, losing even a small amount of weight has health benefits and is a good place to start.
- Engage in regular physical activity and limit consumption of high-calorie foods and beverages as key strategies for maintaining a healthy weight.

Adopt a Physically Active Lifestyle

- Adults should engage in at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity physical activity each week, or an equivalent combination, preferably spread throughout the week.
- Children and adolescents should engage in at least 1 hour of moderate- or vigorous-intensity physical activity each day, with vigorous-intensity activity at least 3 days each week.
- Limit sedentary behavior such as sitting, lying down and watching television, and other forms of screen-based entertainment.
- Doing any intentional physical activity above usual activities, no matter what one's level of activity, can have many health benefits.

Consume a Healthy Diet, with an Emphasis on Plant Sources

- Choose foods and beverages in amounts that help achieve and maintain a healthy weight.
- Limit consumption of processed meat and red meats.
- Eat at least 2½ cups of vegetables and fruits each day.
- Choose whole grains in preference to processed (refined) grains.

If You Drink Alcoholic Beverages, Limit Consumption

- Drink no more than one drink per day for women or two per day for men.

Community Action

Public, private, and community organizations should work collaboratively at national, state, and local levels to implement policy environmental changes that:

- Increase access to affordable, healthy foods in communities, worksites, and schools, and decrease access to and marketing of foods and beverages of low nutritional value, particularly to youth.
- Provide safe, enjoyable, and accessible environments for physical activity in schools and worksites, and for transportation and recreation in communities.

Adapted from American Cancer Society. (2019). ACS guidelines on nutrition and physical activity for cancer. Retrieved on 9/28/2018 at: Prevention www.cancer.org/healthy/eat-healthy-get-active/acs-guidelines-nutrition-physical-activity-cancer-prevention.html.

- **Home Care Checklists** review points that should be covered as part of home care education prior to discharge from the health care facility.

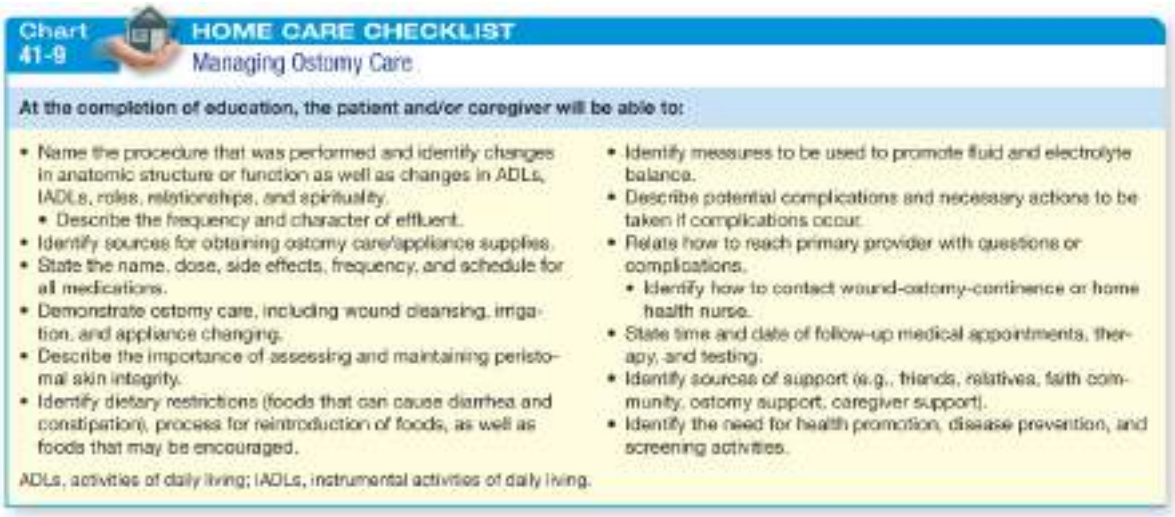


Chart 41-9 HOME CARE CHECKLIST

Managing Ostomy Care

At the completion of education, the patient and/or caregiver will be able to:

- Name the procedure that was performed and identify changes in anatomic structure or function as well as changes in ADLs, IADLs, roles, relationships, and spirituality.
  - Describe the frequency and character of effluent.
- Identify sources for obtaining ostomy care/appliance supplies.
- State the name, dose, side effects, frequency, and schedule for all medications.
- Demonstrate ostomy care, including wound cleansing, irrigation, and appliance changing.
- Describe the importance of assessing and maintaining peristomal skin integrity.
- Identify dietary restrictions (foods that can cause diarrhea and constipation), process for reintroduction of foods, as well as foods that may be encouraged.
- Identify measures to be used to promote fluid and electrolyte balance.
- Describe potential complications and necessary actions to be taken if complications occur.
- Relate how to reach primary provider with questions or complications.
  - Identify how to contact wound-ostomy-continence or home health nurse.
- State time and date of follow-up medical appointments, therapy, and testing.
- Identify sources of support (e.g., friends, relatives, faith community, ostomy support, caregiver support).
- Identify the need for health promotion, disease prevention, and screening activities.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Features to Develop the Nurse as Patient Advocate

Nurses advocate for patients by protecting their rights (including the right to health care) and assisting patients and their families in making informed decisions about health care.

- **All new! Ethical Dilemma charts** provide a clinical scenario, discussion points, and questions to help analyze fundamental ethical principles related to the dilemma.

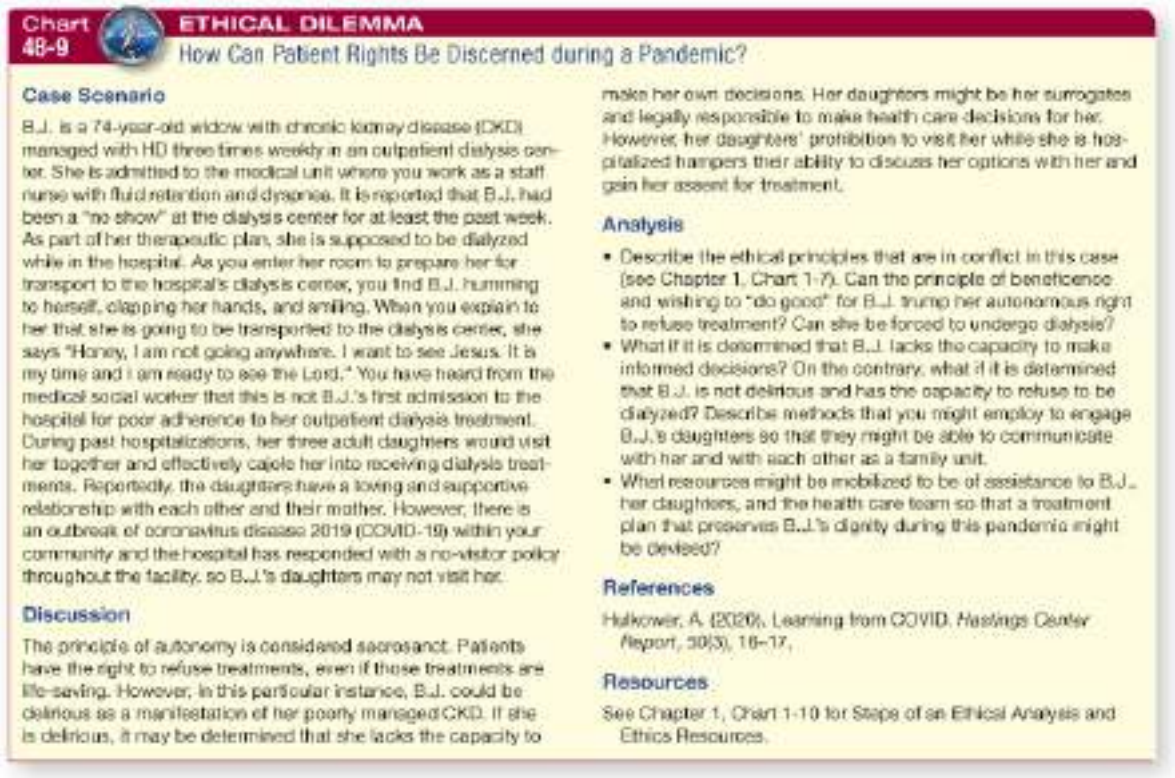


Chart 48-9 ETHICAL DILEMMA

How Can Patient Rights Be Discerned during a Pandemic?

Case Scenario

B.J. is a 74-year-old widow with chronic kidney disease (CKD) managed with HD three times weekly in an outpatient dialysis center. She is admitted to the medical unit where you work as a staff nurse with fluid retention and dyspnea. It is reported that B.J. had been a "no show" at the dialysis center for at least the past week. As part of her therapeutic plan, she is supposed to be dialyzed while in the hospital. As you enter her room to prepare her for transport to the hospital's dialysis center, you find B.J. humming to herself, clapping her hands, and smiling. When you explain to her that she is going to be transported to the dialysis center, she says "Honey, I am not going anywhere. I want to see Jesus. It is my time and I am ready to see the Lord." You have heard from the medical social worker that this is not B.J.'s first admission to the hospital for poor adherence to her outpatient dialysis treatment. During past hospitalizations, her three adult daughters would visit her together and effectively cajole her into receiving dialysis treatments. Reportedly, the daughters have a loving and supportive relationship with each other and their mother. However, there is an outbreak of coronavirus disease 2019 (COVID-19) within your community and the hospital has responded with a no-visitor policy throughout the facility, so B.J.'s daughters may not visit her.

Discussion

The principle of autonomy is considered sacrosanct. Patients have the right to refuse treatments, even if those treatments are life-saving. However, in this particular instance, B.J. could be delirious as a manifestation of her poorly managed CKD. If she is delirious, it may be determined that she lacks the capacity to make her own decisions. Her daughters might be her surrogates and legally responsible to make health care decisions for her. However, her daughters' prohibition to visit her while she is hospitalized hampers their ability to discuss her options with her and gain her assent for treatment.

Analysis

- Describe the ethical principles that are in conflict in this case (see Chapter 1, Chart 1-7). Can the principle of beneficence and wishing to "do good" for B.J. trump her autonomous right to refuse treatment? Can she be forced to undergo dialysis?
- What if it is determined that B.J. lacks the capacity to make informed decisions? On the contrary, what if it is determined that B.J. is not delirious and has the capacity to refuse to be dialyzed? Describe methods that you might employ to engage B.J.'s daughters so that they might be able to communicate with her and with each other as a family unit.
- What resources might be mobilized to be of assistance to B.J., her daughters, and the health care team so that a treatment plan that preserves B.J.'s dignity during this pandemic might be devised?

References

Hulkower, A. (2020). Learning from COVID. *Hastings Center Report, 50*(3), 16–17.

Resources

See Chapter 1, Chart 1-10 for Steps of an Ethical Analysis and Ethics Resources.

Features to Develop the Nurse as Researcher

Nurses identify potential research problems and questions to increase nursing knowledge and improve patient care. The use and evaluation of research findings in nursing practice are essential to further the science of nursing.

- **All new and in every chapter! Nursing Research Profiles** identify the implications and applications of nursing research findings for evidence-based nursing practice.

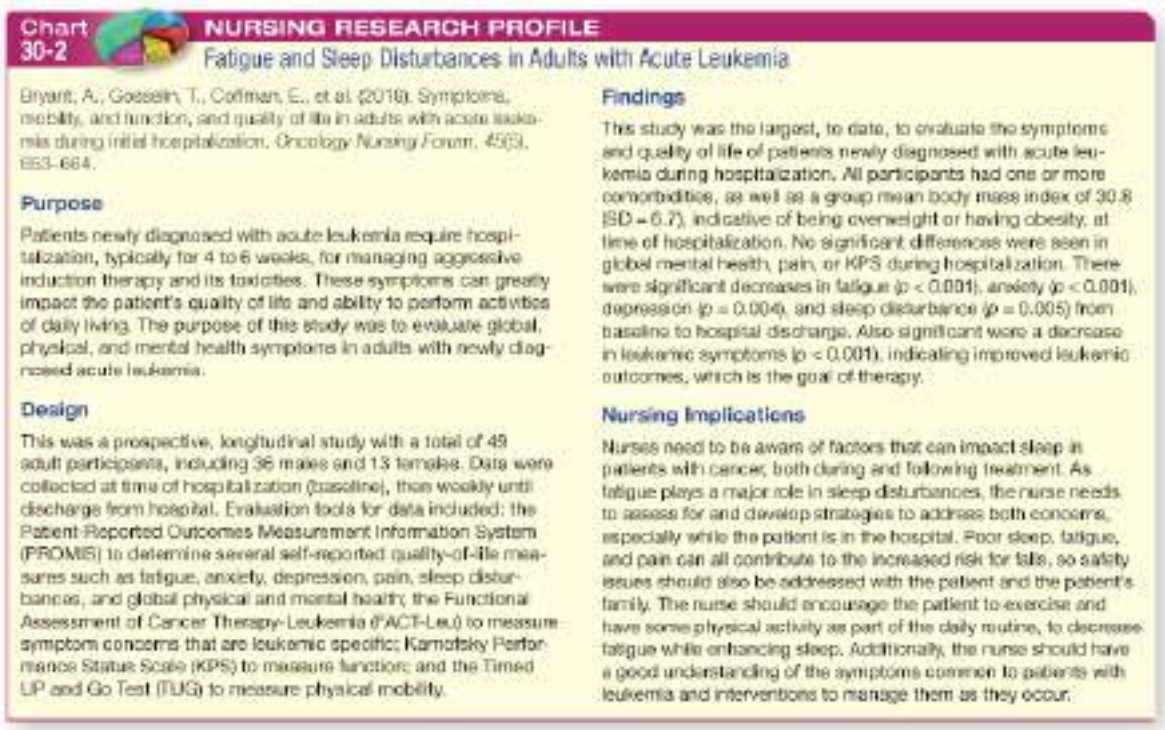


Chart 30-2 NURSING RESEARCH PROFILE

Fatigue and Sleep Disturbances in Adults with Acute Leukemia

Bryant, A., Gosselin, T., Coffman, E., et al. (2016). Symptoms, mobility, and function, and quality of life in adults with acute leukemia during initial hospitalization. *Oncology Nursing Forum, 45*(5), 653-664.

Purpose

Patients newly diagnosed with acute leukemia require hospitalization, typically for 4 to 6 weeks, for managing aggressive induction therapy and its toxicities. These symptoms can greatly impact the patient's quality of life and ability to perform activities of daily living. The purpose of this study was to evaluate global, physical, and mental health symptoms in adults with newly diagnosed acute leukemia.

Design

This was a prospective, longitudinal study with a total of 49 adult participants, including 36 males and 13 females. Data were collected at time of hospitalization (baseline), then weekly until discharge from hospital. Evaluation tools for data included: the Patient-Reported Outcomes Measurement Information System (PROMIS) to determine several self-reported quality-of-life measures such as fatigue, anxiety, depression, pain, sleep disturbances, and global physical and mental health; the Functional Assessment of Cancer Therapy-Leukemia (FACT-Leu) to measure symptom concerns that are leukemic specific; Karnofsky Performance Status Scale (KPS) to measure function; and the Timed UP and Go Test (TUG) to measure physical mobility.

Findings

This study was the largest, to date, to evaluate the symptoms and quality of life of patients newly diagnosed with acute leukemia during hospitalization. All participants had one or more comorbidities, as well as a group mean body mass index of 30.8 (SD = 6.7), indicative of being overweight or having obesity, at time of hospitalization. No significant differences were seen in global mental health, pain, or KPS during hospitalization. There were significant decreases in fatigue ($p < 0.001$), anxiety ($p < 0.001$), depression ($p = 0.004$), and sleep disturbance ($p = 0.005$) from baseline to hospital discharge. Also significant were a decrease in leukemic symptoms ($p < 0.001$), indicating improved leukemic outcomes, which is the goal of therapy.

Nursing Implications

Nurses need to be aware of factors that can impact sleep in patients with cancer, both during and following treatment. As fatigue plays a major role in sleep disturbances, the nurse needs to assess for and develop strategies to address both concerns, especially while the patient is in the hospital. Poor sleep, fatigue, and pain can all contribute to the increased risk for falls, so safety issues should also be addressed with the patient and the patient's family. The nurse should encourage the patient to exercise and have some physical activity as part of the daily routine, to decrease fatigue while enhancing sleep. Additionally, the nurse should have a good understanding of the symptoms common to patients with leukemia and interventions to manage them as they occur.

Features to Facilitate Learning

In addition to practice-oriented features, special features have been developed to help readers learn key information.

- **Concept Mastery Alerts** highlight and clarify fundamental nursing concepts to improve understanding of difficult topics, as identified by Misconception Alerts in Lippincott's Adaptive Learning Powered by PrepU, an adaptive quizzing platform.

Concept Mastery Alert

It is important to remember the different types of cholesterol and the role of each as a risk factor for heart disease. HDL is the "good cholesterol," and higher levels are better; LDL is the "bad cholesterol," and lower levels are better.

- **Unfolding Patient Stories**, written by the National League for Nursing, are an engaging way to begin meaningful conversations in the classroom. These vignettes, which appear throughout the text near related content, feature patients from Wolters Kluwer's vSim for Nursing | Medical-Surgical (co-developed by Laerdal Medical) and DocuCare products; however, each Unfolding Patient Story in the book stands alone, not requiring purchase of these products. For your convenience, a list of these case studies, along with their location in the book, appears in the "Case Studies in This Book" section later in this front matter.

Unfolding Patient Stories: Doris Bowman • Part 2

Recall from Chapter 12 **Doris Bowman**, who is undergoing a total abdominal hysterectomy with bilateral salpingo-oophorectomy. What are potential postoperative complications that the nurse should consider? What assessments and interventions are done by the nurse to monitor for early detection or to prevent these complications? Describe the discharge education provided by the nurse on self-care monitoring required of the patient at home and what should be reported to the health care provider.

Care for Doris and other patients in a realistic virtual environment: ***vSim** for Nursing* (**thepoint.lww.com/vSimMedicalSurgical**). Practice documenting these patients' care in DocuCare (**thepoint.lww.com/DocuCareEHR**).

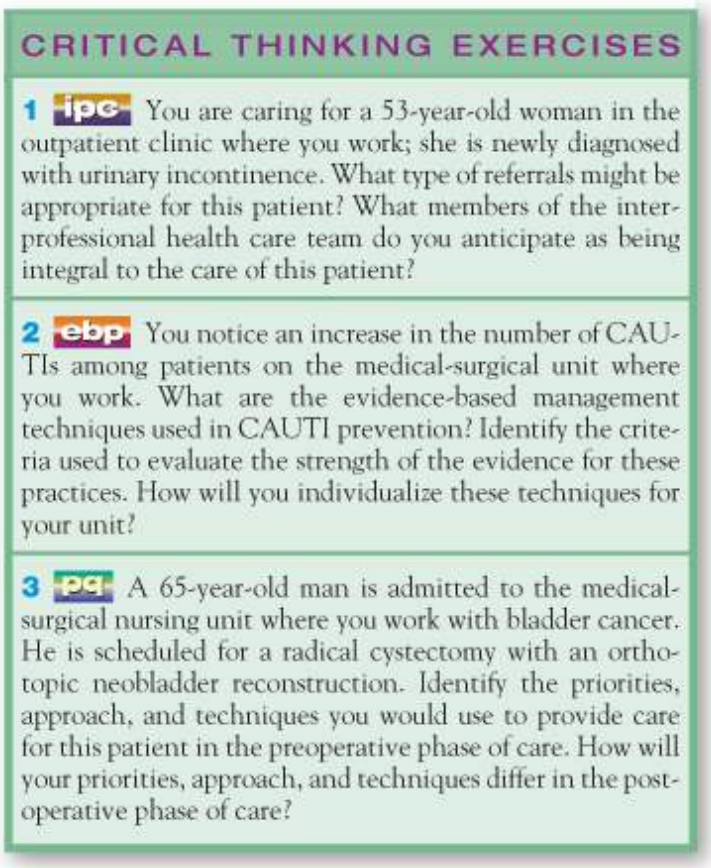
- Interactive learning tools available online enrich learning and are identified with icons in the text:

Concepts in Action Animations bring physiologic and pathophysiologic concepts to life.

Practice & Learn Case Studies present case scenarios and offer interactive exercises and questions to help you apply what you have learned.

Watch & Learn Video Clips reinforce skills from the textbook and appeal to visual and auditory learners.

- **All new! Critical Thinking Exercises** foster critical thinking and challenge you to apply textbook knowledge to clinical scenarios. Evidence-based practice (EBP) questions encourage you to apply best evidence from research findings to nursing interventions. Prioritization (PQ) questions ask you to consider the priorities for nursing care for specific patients and conditions. Interprofessional collaboration (IPC) exercises challenge you to identify the roles and responsibilities of the professional nurse and of interprofessional colleagues in collaboratively delivering quality patient-centered care.



CRITICAL THINKING EXERCISES

1 ipc You are caring for a 53-year-old woman in the outpatient clinic where you work; she is newly diagnosed with urinary incontinence. What type of referrals might be appropriate for this patient? What members of the interprofessional health care team do you anticipate as being integral to the care of this patient?

2 ebp You notice an increase in the number of CAUTIs among patients on the medical-surgical unit where you work. What are the evidence-based management techniques used in CAUTI prevention? Identify the criteria used to evaluate the strength of the evidence for these practices. How will you individualize these techniques for your unit?

3 pq A 65-year-old man is admitted to the medical-surgical nursing unit where you work with bladder cancer. He is scheduled for a radical cystectomy with an orthotopic neobladder reconstruction. Identify the priorities, approach, and techniques you would use to provide care for this patient in the preoperative phase of care. How will your priorities, approach, and techniques differ in the postoperative phase of care?

- **References** cited are listed at the end of each chapter and include updated, current sources.
- **Resources** lists at the end of each chapter include sources of additional information, Web sites, agencies, and patient education materials.

REFERENCES

*Asterisk indicates nursing research.

Books

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Atanelov, Z., & Rebstock, S. E. (2020) Nasopharyngeal airway. *StatPearls [Internet]*. Treasure Island, FL: StatPearls Publishing. Retrieved on 4/6/2020 at: www.ncbi.nlm.nih.gov/books/NBK513220/

Emergency Nurses Association (ENA). (2017). *Emergency nursing scope and standards of practice* (2nd ed.). Des Plaines, IL: Author.

Emergency Nurses Association (ENA). (2020a). *Sheehy's manual of emergency care* (7th ed.). St. Louis, MO: Mosby.

Holleran, R., Wolfe, A., & Frakes, M. (2018). *Patient transport: Principles & practice* (5th ed.). St Louis, MO: Elsevier.

Resources

American Association of Poison Control Centers (AAPCC), www.aapcc.org

American College of Emergency Physicians (ACEP), www.acep.org

American College of Surgeons (ACS), Injury Prevention and Control, www.facs.org/quality-programs/trauma/ipc

American Heart Association, www.heart.org

American Trauma Society (ATS), www.amtrauma.org/default.aspx

American Red Cross, Prepare for Emergencies, www.redcross.org/get-help/prepare-for-emergencies/types-of-emergencies

Divers Alert Network (DAN), www.diversalertnetwork.org

Emergency Nurses Association (ENA), www.ena.org

National Capital Poison, Poison Control Center, poison.org

National Center on Elder Abuse (NCEA), ncea.acl.gov

National Center for Health Statistics (NCHS), cdc.gov/nchs/

National Human Trafficking Hotline, www.humantraffickinghotline.org

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Types of Intravenous Solutions
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Hypotonic Fluids
Hypertonic Fluids
Other Intravenous Therapies
Nursing Management of the Patient Receiving Intravenous Therapy
Managing Systemic Complications
Managing Local Complications
Promoting Home, Community-Based, and Transitional Care
11 Shock, Sepsis, and Multiple Organ Dysfunction Syndrome
Overview of Shock
Normal Cellular Function
Pathophysiology
Stages of Shock
Compensatory Stage
Clinical Manifestations
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Nursing Management
Progressive Stage
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Clinical Manifestations
Medical Management
Nursing Management
Irreversible Stage
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Nursing Management
General Management Strategies in Shock
Fluid Replacement
Vasoactive Medication Therapy
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Hypovolemic Shock
Pathophysiology
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Nursing Management
Cardiogenic Shock
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Distributive Shock
Sepsis and Septic Shock
Pathophysiology
Medical Management
Nursing Management
Neurogenic Shock
Medical Management
Nursing Management
Anaphylactic Shock
Medical Management
Nursing Management
Multiple Organ Dysfunction Syndrome
Pathophysiology
Clinical Manifestations
Medical Management
Nursing Management
Promoting Home, Community-Based, and Transitional Care
Educating Patients About Self-Care
Continuing and Transitional Care

12 Management of Patients with Oncologic Disorders

Epidemiology
Pathophysiology of the Malignant Process
Carcinogenesis
Proliferative Patterns
Role of the Immune System
Detection and Prevention of Cancer
Primary Prevention
Secondary Prevention
Tertiary Prevention
Diagnosis of Cancer
Tumor Staging and Grading

Anatomic Stage Group
Management of Cancer
Surgery
Diagnostic Surgery
Surgery as Primary Treatment
Prophylactic Surgery
Palliative Surgery
Reconstructive Surgery
Nursing Management
Radiation Therapy
Radiation Dosage
Administration of Radiation
Toxicity
Nursing Management
Protecting Caregivers
Chemotherapy
Cell Kill and the Cell Cycle
Classification of Chemotherapeutic Agents
Adjunct Chemotherapeutic Agents
Administration of Chemotherapeutic Agents
Nursing Management
Protecting Caregivers
Hematopoietic Stem Cell Transplantation
Types of Hematopoietic Stem Cell Transplantation
Nursing Management
Immunotherapy and Targeted Therapy
Immunotherapy
Targeted Therapies
Nursing Management
Complementary, Alternative, and Integrative Health Therapies
COVID-19 Considerations
Nursing Care of the Patient with Cancer
Maintaining Tissue Integrity
Promoting Nutrition
Relieving Pain
Decreasing Fatigue
Improving Body Image and Self-Esteem
Addressing Sexuality
Assisting in the Grieving Process
Management of Psychosocial Distress
Monitoring and Managing Potential Complications
Promoting Home, Community-Based, and Transitional Care

Gerontologic Considerations
Cancer Survivorship
Providing Care to the Patient with Advanced Cancer

13 Palliative and End-of-Life Care
Palliative Care and End-of-Life Care
The Evolution of End-of-Life Care
Settings for Palliative Care and End-of-Life Care
Institution-Based Palliative Care
Outpatient-Based Palliative Care
Community-Based Palliative Care
Hospice Care
Communication in Palliative Care
Advanced Care Planning
Symptom Assessment and Management
Expected Physiologic Changes
Time of Death
Providing Psychosocial and Spiritual Support
Hope and Meaning in Illness
Providing Culturally Sensitive Care at the End-of-Life
Spiritual Care
Grief, Mourning, and Bereavement
Special Issues for the Nurse in End-of-Life Care
Medically Administered Nutrition and Hydration
Palliative Sedation at the End-of-Life
Clinicians' Attitudes toward Death
Patient and Family Concerns
Professional Caregiver Issues
Supporting Ourselves

UNIT 3 Perioperative Concepts and Nursing Management

14 Preoperative Nursing Management
Perioperative Nursing
Advances in Surgical and Anesthesia Approaches
Surgical Classifications
Preadmission Testing
Special Considerations during the Perioperative Period
Gerontologic Considerations
Bariatric Patients
Patients with Disability
Patients Undergoing Ambulatory Surgery

Patients Undergoing Emergency Surgery
Required Preoperative Documents
Preoperative Assessment
Nutritional and Fluid Status
Dentition
Drug or Alcohol Use
Respiratory Status
Cardiovascular Status
Hepatic and Renal Function
Endocrine Function
Immune Function
Previous Medication Use
Psychosocial Factors
Spiritual and Cultural Beliefs
Preoperative Nursing Interventions
Providing Patient Education
Providing Psychosocial Interventions
Maintaining Patient Safety
Managing Nutrition and Fluids
Preparing the Bowel
Preparing the Skin
Immediate Preoperative Nursing Interventions
Administering Medication
Maintaining the Preoperative Record
Preoperative Patient Warming
Attending to Family Needs
Expected Patient Outcomes
15 **Intraoperative Nursing Management**
The Surgical Team
The Patient
The Circulating Nurse
The Scrub Role
The Surgeon
The Registered Nurse First Assistant
The Anesthesiologist and CRNA
Safety and Infection Prevention
The Surgical Environment
Prevention of OR Fires
Surgical Attire
Principles of Surgical Asepsis and Sterile Technique
Health Hazards Associated with the Surgical Environment

Robotics
The Surgical Experience
Types of Anesthesia and Sedation
Potential Intraoperative Complications
Anesthesia Awareness
Nausea and Vomiting
Anaphylaxis
Hypoxia and Other Respiratory Complications
Hypothermia
Malignant Hyperthermia
Pathophysiology
Clinical Manifestations
Medical Management
Nursing Management
• *Nursing Process:* The Patient during Surgery

16 **Postoperative Nursing Management**
Care of the Patient in the Postanesthesia Care Unit
Phases of Postanesthesia Care
Admitting the Patient to the Postanesthesia Care Unit
Nursing Management in the Postanesthesia Care Unit
Preparing the Postoperative Patient for Direct Discharge
Care of the Hospitalized Postoperative Patient
Receiving the Patient in the Clinical Unit
Nursing Management After Surgery
• *Nursing Process:* The Hospitalized Patient Recovering from Surgery

UNIT 4 **Gas Exchange and Respiratory Function**

17 **Assessment of Respiratory Function**
Anatomic and Physiologic Overview
Anatomy of the Respiratory System
Function of the Respiratory System
Gerontologic Considerations
Assessment
Health History
Physical Assessment of the Respiratory System
Assessment of Respiratory Function in the Patient Who Is Acutely or Critically Ill
Diagnostic Evaluation
Pulmonary Function Tests
Arterial Blood Gas Studies

Venous Blood Gas Studies
Pulse Oximetry
End-Tidal Carbon Dioxide
Cultures
Sputum Studies
Imaging Studies
Endoscopic Procedures
Biopsy

18 Management of Patients with Upper Respiratory Tract Disorders

Upper Airway Infections

Rhinitis
Pathophysiology
Clinical Manifestations
Medical Management
Nursing Management

Viral Rhinitis (Common Cold)
Clinical Manifestations
Medical Management
Nursing Management

Rhinosinusitis

Acute Rhinosinusitis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Complications
Medical Management
Nursing Management

Chronic Rhinosinusitis and Recurrent Acute Rhinosinusitis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Complications
Medical Management
Nursing Management

Pharyngitis

Acute Pharyngitis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management

Nursing Management
Chronic Pharyngitis
Clinical Manifestations
Medical Management
Nursing Management
Tonsillitis and Adenoiditis
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Peritonsillar Abscess
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Laryngitis
Clinical Manifestations
Medical Management
Nursing Management
• *Nursing Process:* The Patient with Upper Airway Infection
Obstruction and Trauma of the Upper Respiratory Airway
Obstructive Sleep Apnea
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Epistaxis
Medical Management
Nursing Management
Nasal Obstruction
Medical Management
Nursing Management
Fractures of the Nose
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Laryngeal Obstruction
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management

Cancer of the Larynx
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
• *Nursing Process:* The Patient Undergoing Laryngectomy

19 **Management of Patients with Chest and Lower Respiratory Tract Disorders**

Inflammatory and Infectious Pulmonary Disorders

Atelectasis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
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Acute Tracheobronchitis
Pathophysiology
Clinical Manifestations
Medical Management
Nursing Management

Pneumonia
Classification
Pathophysiology
Risk Factors
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
Medical Management
Gerontologic Considerations
COVID-19 Considerations
Complications
• *Nursing Process:* The Patient with Bacterial Pneumonia

Aspiration
Pathophysiology
Prevention

Pulmonary Tuberculosis
Transmission and Risk Factors
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Gerontologic Considerations
Medical Management

Nursing Management
Lung Abscess
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
Medical Management
Nursing Management
Sarcoidosis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Pleural Disorders
Pleurisy
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Pleural Effusion
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Empyema
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Acute Respiratory Failure
Pathophysiology
Clinical Manifestations
Medical Management
Nursing Management
• *Nursing Process:* The Patient Receiving Mechanical Ventilation
Acute Respiratory Distress Syndrome
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings

Medical Management
Nursing Management
COVID-19 Considerations
Pulmonary Vascular Disorders
Pulmonary Edema (Noncardiogenic)
Pulmonary Hypertension
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Pulmonary Heart Disease (Cor Pulmonale)
Pulmonary Embolism
Occupational Lung Disease: Pneumoconioses
Veterans Considerations
Chest Tumors
Lung Cancer (Bronchogenic Carcinoma)
Pathophysiology
Classification and Staging
Risk Factors
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Surgical Management: Thoracotomy
Nursing Management of the Patient Having a Thoracotomy
Radiation Therapy
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Immunotherapy
Palliative Care
Complications
Nursing Management
Gerontologic Considerations
Tumors of the Mediastinum
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Chest Trauma
Blunt Trauma
Pathophysiology
Assessment and Diagnostic Findings
Medical Management
Sternal and Rib Fractures

Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Flail Chest
Pathophysiology
Medical Management
Pulmonary Contusion
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Penetrating Trauma
Medical Management
Pneumothorax
Types of Pneumothorax
Clinical Manifestations
Medical Management
Cardiac Tamponade
Subcutaneous Emphysema
20 Management of Patients with Chronic Pulmonary Disease
Chronic Obstructive Pulmonary Disease
Pathophysiology
Risk Factors
Clinical Manifestations
Assessment and Diagnostic Findings
Complications
Medical Management
Nursing Management
Bronchiectasis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Asthma
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
Complications

Medical Management
Nursing Management
Status Asthmaticus
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Cystic Fibrosis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management

UNIT 5 Cardiovascular and Circulatory Function

21 Assessment of Cardiovascular Function
Anatomic and Physiologic Overview
Anatomy of the Heart
Function of the Heart
Gerontologic Considerations
Gender Considerations
Assessment of the Cardiovascular System
Health History
Physical Assessment
Diagnostic Evaluation
Laboratory Tests
Chest X-Ray and Fluoroscopy
Electrocardiography
Cardiac Stress Testing
Radionuclide Imaging
Additional Imaging
Echocardiography
Cardiac Catheterization
Electrophysiologic Testing
Hemodynamic Monitoring

22 Management of Patients with Arrhythmias and Conduction Problems
Arrhythmias
Normal Electrical Conduction

Influences on Heart Rate and Contractility
The Electrocardiogram
Obtaining an Electrocardiogram
Components of the Electrocardiogram
Analyzing the Electrocardiogram Rhythm Strip
Determining Heart Rate from the Electrocardiogram
Determining Heart Rhythm from the Electrocardiogram
Normal Sinus Rhythm
Types of Arrhythmias
Sinus Node Arrhythmias
Atrial Arrhythmias
Junctional Arrhythmias
Ventricular Arrhythmias
Conduction Abnormalities
• *Nursing Process:* The Patient with an Arrhythmia
Adjunct Modalities and Management
Cardioversion and Defibrillation
Electrical Cardioversion
Defibrillation
Electrophysiology Studies
Pacemaker Therapy
Pacemaker Design and Types
Pacemaker Generator Functions
Complications of Pacemaker Use
Pacemaker Surveillance
Implantable Cardioverter Defibrillator
Nursing Management

23 Management of Patients with Coronary Vascular Disorders

Coronary Artery Disease
Coronary Atherosclerosis
Pathophysiology
Clinical Manifestations
Risk Factors
Prevention
Gender
Angina Pectoris
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management

• *Nursing Process:* The Patient with Angina Pectoris
Acute Coronary Syndrome and Myocardial Infarction
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Cardiac Rehabilitation
• *Nursing Process:* The Patient with Acute Coronary Syndrome
Invasive Coronary Artery Procedures
Percutaneous Coronary Interventions
Percutaneous Transluminal Coronary Angioplasty
Coronary Artery Stent
Complications
Postprocedure Care
Surgical Procedures: Coronary Artery Revascularization
Traditional Coronary Artery Bypass Graft
Alternative Coronary Artery Bypass Graft Techniques
Complications of Coronary Artery Bypass Graft
Nursing Management

24 Management of Patients with Structural, Infectious, and Inflammatory Cardiac Disorders
Valvular Disorders
Mitral Valve Prolapse
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Mitral Regurgitation
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Mitral Stenosis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
Medical Management
Aortic Regurgitation
Pathophysiology

Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
Medical Management
Aortic Stenosis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
Medical Management
Nursing Management: Valvular Heart Disorders
Surgical Management: Valve Repair and Replacement Procedures
Valvuloplasty
Commissurotomy
Annuloplasty
Leaflet Repair
Valve Replacement
Mechanical Valves
Tissue Valves
Nursing Management: Valvuloplasty and Valve Replacement
Cardiomyopathy
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Surgical Management
• *Nursing Process:* The Patient with Cardiomyopathy
Infectious Diseases of the Heart
Rheumatic Endocarditis
Infective Endocarditis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
Medical Management
Surgical Management
Nursing Management
Myocarditis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management

Nursing Management
Pericarditis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
• *Nursing Process:* The Patient with Pericarditis

25 Management of Patients with Complications from Heart Disease

Heart Failure
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Gerontologic Considerations
• *Nursing Process:* The Patient with Heart Failure

Complications from Heart Disease
Cardiogenic Shock
Thromboembolism
Pericardial Effusion and Cardiac Tamponade
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Cardiac Arrest
Clinical Manifestations
Emergency Assessment and Management: Cardiopulmonary Resuscitation

26 Assessment and Management of Patients with Vascular Disorders and Problems of Peripheral Circulation

Anatomic and Physiologic Overview
Anatomy of the Vascular System
Function of the Vascular System
Pathophysiology of the Vascular System
Gerontologic Considerations
Assessment of the Vascular System
Health History
Physical Assessment
Diagnostic Evaluation
Doppler Ultrasound Flow Studies
Exercise Testing

Duplex Ultrasonography
Computed Tomography Scanning
Angiography
Magnetic Resonance Angiography
Contrast Phlebography (Venography)
Lymphoscintigraphy
Arterial Disorders
Arteriosclerosis and Atherosclerosis
Pathophysiology
Risk Factors
Prevention
Clinical Manifestations
Medical Management
Nursing Management
Peripheral Artery Disease
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Nursing Care of the Postoperative Patient
Upper Extremity Arterial Disease
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Aortoiliac Disease
Medical Management
Nursing Management
Aneurysms
Thoracic Aortic Aneurysm
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Abdominal Aortic Aneurysm
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Gerontologic Considerations
Medical Management
Nursing Management
Other Aneurysms
Aortic Dissection

Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Arterial Embolism and Arterial Thrombosis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Raynaud's Phenomenon and Other Acrosyndromes
Clinical Manifestations
Medical Management
Nursing Management
Venous Disorders
Venous Thromboembolism
COVID-19 Considerations
Pathophysiology
Deep Vein Thrombosis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
Medical Management
Nursing Management
Pulmonary Embolism
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Chronic Venous Insufficiency/Postthrombotic Syndrome
Clinical Manifestations
Complications
Management
Leg Ulcers
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
• *Nursing Process:* The Patient with Leg Ulcers

Varicose Veins
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention and Medical Management
Nursing Management
Lymphatic Disorders
Lymphangitis and Lymphadenitis
Lymphedema
Medical Management
Nursing Management
Cellulitis
Pathophysiology
Clinical Manifestations
Medical Management
Nursing Management

27 Assessment and Management of Patients with Hypertension
Hypertension
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
• *Nursing Process:* The Patient with Hypertension
Hypertensive Crises
Hypertensive Emergency
Hypertensive Urgency

UNIT 6 Hematologic Function

28 Assessment of Hematologic Function and Treatment Modalities
Anatomic and Physiologic Overview
Bone Marrow
Blood
Reticuloendothelial System (RES)
Hemostasis
Gerontologic Considerations
Assessment
Health History
Physical Assessment

Diagnostic Evaluation
Hematologic Studies
Bone Marrow Aspiration and Biopsy
Therapeutic Approaches to Hematologic Disorders
Splenectomy
Therapeutic Apheresis
Hematopoietic Stem Cell Transplantation
Therapeutic Phlebotomy
Blood Component Therapy
Procuring Blood and Blood Products
Blood Donation
Directed Donation
Standard Donation
Autologous Donation
Intraoperative Blood Salvage
Hemodilution
Complications of Blood Donation
Blood Processing
Transfusion
Pretransfusion Assessment
Patient Education
Transfusion Procedures
Complications
Nursing Management of Transfusion Reactions
Pharmacologic Alternatives to Blood Transfusions

29 Management of Patients with Nonmalignant Hematologic Disorders

Anemia
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Gerontologic Considerations
• *Nursing Process:* The Patient with Anemia
Hypoproliferative Anemias
Iron Deficiency Anemia
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Anemias in Renal Disease

Anemia of Inflammation
Aplastic Anemia
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Megaloblastic Anemias
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Hemolytic Anemias
Sickle Cell Disease
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
• *Nursing Process:* The Patient with Sickle Cell Crisis
Thalassemias
Glucose-6-Phosphate Dehydrogenase Deficiency
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Immune Hemolytic Anemias
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Hereditary Hemochromatosis
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Polycythemia
Secondary Polycythemia
Management
Neutropenia
Clinical Manifestations
Medical Management
Nursing Management

Lymphopenia
Bleeding Disorders
Clinical Manifestations
Medical Management
Nursing Management
Thrombocytopenia
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Immune Thrombocytopenic Purpura
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Platelet Defects
Clinical Manifestations
Medical Management
Nursing Management
Inherited Bleeding Disorders
Hemophilia
Clinical Manifestations
Medical Management
Nursing Management
Gerontologic Considerations
von Willebrand Disease
Clinical Manifestations
Assessment and Diagnostic Findings
Management
Acquired Bleeding Disorders
Liver Disease
Vitamin K Deficiency
Heparin-Induced Thrombocytopenia
Disseminated Intravascular Coagulation
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Secondary Thrombocytosis
Thrombotic Disorders

Hyperhomocysteinemia
Antithrombin Deficiency
Protein C Deficiency
Protein S Deficiency
Activated Protein C Resistance and Factor V Leiden Mutation
Antiphospholipid Antibody Syndrome
Malignancy
Medical Management
Nursing Management

30 **Management of Patients with Hematologic Neoplasms**

Clonal Stem Cell Disorders

Leukemia

Acute Myeloid Leukemia
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Complications
Nursing Management

Chronic Myeloid Leukemia
Clinical Manifestations
Medical Management
Nursing Management

Acute Lymphocytic Leukemia
Clinical Manifestations
Medical Management
Nursing Management

Chronic Lymphocytic Leukemia
Veterans Considerations
Pathophysiology
Clinical Manifestations
Medical Management
Nursing Management

• *Nursing Process:* The Patient with Acute Leukemia

MYELODYSPLASTIC SYNDROMES (MDSs)

Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management

Myeloproliferative Neoplasms

Polycythemia Vera
Clinical Manifestations

Assessment and Diagnostic Findings
Complications
Medical Management
Nursing Management
Essential Thrombocythemia
Clinical Manifestations
Assessment and Diagnostic Findings
Complications
Medical Management
Nursing Management
Primary Myelofibrosis
Medical Management
Nursing Management
Lymphoma
Hodgkin Lymphoma
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Non-Hodgkin Lymphomas
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
MULTIPLE MYELOMA
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Complications
Gerontologic Considerations
Nursing Management

UNIT 7 Immunologic Function

31 Assessment of Immune Function
Anatomic and Physiologic Overview
Anatomy of the Immune System
Function of the Immune System
Advances in Immunology
Genetic Engineering

Stem Cells
Cancer and Immunotherapy
Assessment of the Immune System
Health History
Physical Assessment
Diagnostic Evaluation
Nursing Management

32 Management of Patients with Immune Deficiency Disorders
PRIMARY IMMUNE DEFICIENCIES DISEASES
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
Medical Management
Nursing Management
Acquired Immune Deficiency
HIV Infection and AIDS
Epidemiology
HIV Transmission
Gerontologic Considerations
Prevention of HIV Infection
Reducing the Risk of Transmission to Health Care Providers
Pathophysiology
Stages of HIV Infection
Assessment and Diagnostic Findings in HIV Infection
Treatment of HIV Infection
Clinical Manifestations
Medical Management
Complementary, Alternative, and Integrative Health Therapies
Supportive Care
• *Nursing Process:* The Patient with HIV Infection
Emotional and Ethical Concerns

33 Assessment and Management of Patients with Allergic Disorders
Physiologic Overview
Function of Immunoglobulins
Function of Antigens
Function of Chemical Mediators
Hypersensitivity
Assessment

Diagnostic Evaluation
Complete Blood Count with Differential
Eosinophil Count
Total Serum Immunoglobulin E Levels
Skin Tests
Provocative Testing
Serum-Specific IgE Test
Allergic Disorders
Anaphylaxis
Pathophysiology
Clinical Manifestations
Prevention
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Nursing Management
Allergic Rhinitis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
• *Nursing Process:* The Patient with Allergic Rhinitis
Contact Dermatitis
Clinical Manifestations
Assessment and Diagnostic Findings
Atopic Dermatitis
Medical Management
Nursing Management
Drug Hypersensitivity
Pseudoallergic Drug Reactions
Urticaria and Angioedema
Hereditary Angioedema
Clinical Manifestations
Medical Management
Cold Urticaria
Clinical Manifestations
Medical Management
Nursing Management
Food Allergy
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management

Latex Allergy
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management

34 Assessment and Management of Patients with Inflammatory Rheumatic Disorders

Rheumatic Diseases
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Gerontologic Considerations

Diffuse Connective Tissue Diseases
Rheumatoid Arthritis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Systemic Lupus Erythematosus
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Primary Sjögren's Syndrome
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Scleroderma
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Polymyositis
Pathophysiology
Clinical Manifestations

Assessment and Diagnostic Findings
Medical Management
Nursing Management
Polymyalgia Rheumatica and Giant Cell Arteritis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Spondyloarthropathies
Ankylosing Spondylitis
Reactive Arthritis (Reiter's Syndrome)
Psoriatic Arthritis
Medical Management
Nursing Management
Metabolic and Endocrine Diseases Associated with Rheumatic Disorders
Gout
Pathophysiology
Clinical Manifestations
Medical Management
Nursing Management
Fibromyalgia
Pathophysiology
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Miscellaneous Disorders

UNIT 8 Musculoskeletal Function

35 Assessment of Musculoskeletal Function
Anatomic and Physiologic Overview
Structure and Function of the Skeletal System
Structure and Function of the Articular System
Structure and Function of the Skeletal Muscle System
Gerontologic Considerations
Assessment
Health History
Physical Assessment
Diagnostic Evaluation
X-Ray Studies

Computed Tomography
Magnetic Resonance Imaging
Arthrography
Bone Densitometry
Bone Scan
Arthroscopy
Arthrocentesis
Electromyography
Biopsy
Laboratory Studies

36 Management of Patients with Musculoskeletal Disorders

Low Back Pain
Gerontologic Considerations
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Common Upper Extremity Disorders
Bursitis and Tendonitis
Loose Bodies
Impingement Syndrome
Carpal Tunnel Syndrome
Ganglion
Dupuytren Disease
Nursing Management of the Patient Undergoing Surgery of the Hand or Wrist
Common Foot Problems
Callus
Corn
Hammer Toe
Onychocryptosis
Pes Cavus
Hallux Valgus
Morton Neuroma
Pes Planus
Plantar Fasciitis
Nursing Management of the Patient Undergoing Foot Surgery
Osteoarthritis (Degenerative Joint Disease)
Pathophysiology
Clinical Manifestations

Assessment and Diagnostic Findings
Medical Management
Nursing Management
The Patient Undergoing Arthroplasty
Preoperative and Intraoperative Nursing Management
Total Hip Arthroplasty
Nursing Management
Total Knee Arthroplasty
Nursing Management
Metabolic Bone Disorders
Osteoporosis
Prevention
COVID-19 Considerations
Gerontologic Considerations
Pathophysiology
Risk Factors
Assessment and Diagnostic Findings
Medical Management
• *Nursing Process:* The Patient with a Spontaneous Vertebral Fracture Related to Osteoporosis
Osteomalacia
Pathophysiology
Gerontologic Considerations
Assessment and Diagnostic Findings
Medical Management
Paget Disease of the Bone
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Gerontologic Considerations
Musculoskeletal Infections
Osteomyelitis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
Medical Management
• *Nursing Process:* The Patient with Osteomyelitis
Septic (Infectious) Arthritis
Clinical Manifestations
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Medical Management
Nursing Management
Bone Tumors
Benign Bone Tumors
Malignant Bone Tumors
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Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
37 Management of Patients with Musculoskeletal Trauma
Contusions, Strains, and Sprains
Management
Joint Dislocations
Medical Management
Nursing Management
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Rotator Cuff Tears
Lateral and Medial Epicondylitis
Lateral and Medial Collateral Ligament Injury
Medical Management
Nursing Management
Cruciate Ligament Injury
Meniscal Injuries
Rupture of the Achilles Tendon
Fractures
Types of Fractures
Clinical Manifestations
Emergency Management
Medical Management
Nursing Management
Fracture Healing and Complications
The Patient with a Cast, Splint, or Brace
Casts
Splints and Braces
Nursing Management
Nursing Management of the Patient with an Immobilized Upper Extremity
Nursing Management of the Patient with an Immobilized Lower Extremity
Nursing Management of the Patient with a Body or Spica Cast

The Patient with an External Fixator
Management
The Patient in Traction
Principles of Effective Traction
Types of Traction
Skin Traction
Skeletal Traction
Nursing Management of the Patient in Traction
Fractures of Specific Sites
Clavicle
Humeral Neck
Humeral Shaft
Elbow
Proximal Radius
Radial and Ulnar Shafts
Wrist
Hand
Pelvis
Acetabulum
Hip
Clinical Manifestations
Gerontologic Considerations
Medical Management
Nursing Management
Femoral Shaft
Assessment and Diagnostic Findings
Management
Tibia and Fibula
Assessment and Diagnostic Findings
Management
Rib
Gerontologic Considerations
Thoracolumbar Spine
Sports-Related Musculoskeletal Injuries
Management
Occupation-Related Musculoskeletal Disorders
Occupation-Related Musculoskeletal Disorders in Nursing Personnel
Amputation
Level of Amputation
Complications
Medical Management
Rehabilitation

• *Nursing Process:* The Patient Undergoing an Amputation

UNIT 9 Digestive and Gastrointestinal Function

38 Assessment of Digestive and Gastrointestinal Function

Anatomic and Physiologic Overview
Function of the Digestive System
Gerontologic Considerations
Assessment of the Gastrointestinal System
Health History
Physical Assessment
Diagnostic Evaluation
Serum Laboratory Studies
Stool Tests
Breath Tests
Abdominal Ultrasonography
Genetic Testing
Imaging Studies
Endoscopic Procedures
Manometry and Electrophysiologic Studies
Gastric Analysis, Gastric Acid Stimulation Test, and pH Monitoring
Laparoscopy (Peritoneoscopy)

39 Management of Patients with Oral and Esophageal Disorders

Disorders of the Oral Cavity
Dental Plaque and Caries
Prevention
Dental Health and Disease
Periapical Abscess
Clinical Manifestations
Medical Management
Nursing Management
Disorders of the Jaw
Temporomandibular Disorders
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Jaw Disorders Requiring Surgical Management
Nursing Management
Disorders of the Salivary Glands
Parotitis

Sialadenitis
Salivary Calculus (Sialolithiasis)
Neoplasms
Cancer of the Oral Cavity and Pharynx
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Human Papillomavirus Prevention
Medical Management
Nursing Management
Nursing Management of the Patient With Disorders of the Oral Cavity
Promoting Mouth Care
Ensuring Adequate Food and Fluid Intake
Supporting a Positive Self-Image
Minimizing Pain and Discomfort
Preventing Infection
Promoting Home, Community-Based, and Transitional Care
Neck Dissection
• *Nursing Process:* The Patient Undergoing a Neck Dissection
Delivering Nutrition Enterally
Nursing Management
Gastrostomy and Jejunostomy
• *Nursing Process:* The Patient with a Gastrostomy or Jejunostomy
Disorders of the Esophagus
Achalasia
Clinical Manifestations
Assessment and Diagnostic Findings
Management
Esophageal Spasm
Clinical Manifestations
Assessment and Diagnostic Findings
Management
Hiatal Hernia
Clinical Manifestations
Assessment and Diagnostic Findings
Management
Diverticulum
Clinical Manifestations
Assessment and Diagnostic Findings
Management
Perforation

Clinical Manifestations
Assessment and Diagnostic Findings
Management
Foreign Bodies
Chemical Burns
Gastroesophageal Reflux Disease
Clinical Manifestations
Assessment and Diagnostic Findings
Management
Barrett Esophagus
Clinical Manifestations
Assessment and Diagnostic Findings
Management
Benign Tumors of the Esophagus
• *Nursing Process:* The Patient with a Noncancerous Disorder of the Esophagus
Cancer of the Esophagus
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management

40 Management of Patients with Gastric and Duodenal Disorders

Gastritis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Peptic Ulcer Disease
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
• *Nursing Process:* The Patient with Peptic Ulcer Disease
Gastric Cancer
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management

Gerontologic Considerations
• *Nursing Process:* The Patient with Gastric Cancer
Tumors of the Small Intestine
Clinical Manifestations
Assessment and Diagnostic Findings
Management

41 **Management of Patients with Intestinal and Rectal Disorders**

Abnormalities of Fecal Elimination
Constipation
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Complications
Gerontologic Considerations
Medical Management
Nursing Management
Diarrhea
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Complications
Gerontologic Considerations
Medical Management
Nursing Management
Fecal Incontinence
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Irritable Bowel Syndrome (IBS)
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Disorders of Malabsorption
Celiac Disease
Pathophysiology
Clinical Manifestations

Assessment and Diagnostic Findings
Medical Management
Nursing Management
Acute Abdomen
Peritonitis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Appendicitis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Complications
Gerontologic Considerations
Medical Management
Nursing Management
Diverticular Disease
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Gerontologic Considerations
Medical Management
Nursing Management
Intestinal Obstruction
Small Bowel Obstruction
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Large Bowel Obstruction
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Inflammatory Bowel Disease
Crohn's Disease (Regional Enteritis)
Pathophysiology
Clinical Manifestations

Assessment and Diagnostic Findings
Complications
Ulcerative Colitis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Complications
Management of Inflammatory Bowel Disease
Medical Management
• *Nursing Process:* Management of the Patient with Inflammatory Bowel Disease
Delivering Nutrition Parenterally
Nursing Management
• *Nursing Process:* The Patient Receiving Parenteral Nutrition
Management of the Patient Requiring an Ostomy
Preoperative Nursing Management
Postoperative Nursing Management
Colorectal Neoplasms
Colorectal Cancer
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Complications
Gerontologic Considerations
Prevention
Medical Management
• *Nursing Process:* The Patient Having Surgery for Colorectal Cancer
Polyps of the Colon and Rectum
Disorders of the Anorectum
Proctitis
Anorectal Abscess
Anal Fistula
Anal Fissure
Hemorrhoids
Pilonidal Sinus or Cyst
Nursing Management of Patients with Anorectal Disorders

UNIT 10 Metabolic and Endocrine Function

42 Assessment and Management of Patients with Obesity
Obesity
Epidemiology of Obesity

Obesity Risks
Pathophysiology
Assessment of Obesity
Diagnostic Evaluation
Medical Management
Gerontologic Considerations
Veterans Considerations
COVID-19 Considerations
Nursing Management
The Patient Undergoing Bariatric Surgery
Surgical Procedures
• *Nursing Process:* The Patient Undergoing Bariatric Surgery

43 Assessment and Management of Patients with Hepatic Disorders

Assessment of the Liver
Anatomic and Physiologic Overview
Anatomy of the Liver
Functions of the Liver
Gerontologic Considerations
Assessment
Health History
Physical Assessment
Diagnostic Evaluation
Liver Function Tests
Liver Biopsy
Other Diagnostic Tests

Manifestations of Hepatic Dysfunction
Jaundice
Hemolytic Jaundice
Hepatocellular Jaundice
Obstructive Jaundice
Hereditary Hyperbilirubinemia
Portal Hypertension
Ascites
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Esophageal Varices
Pathophysiology

Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Surgical Management
Nursing Management
Hepatic Encephalopathy and Coma
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Other Manifestations of Hepatic Dysfunction
Edema and Bleeding
Vitamin Deficiency
Metabolic Abnormalities
Pruritus and Other Skin Changes
Viral Hepatitis
Hepatitis A Virus
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
Medical Management
Nursing Management
Hepatitis B Virus
Gerontologic Considerations
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
Medical Management
Nursing Management
Hepatitis C Virus
Hepatitis D Virus
Hepatitis E Virus
Hepatitis G Virus and GB Virus-C
Nonviral Hepatitis
Toxic Hepatitis
Drug-Induced Hepatitis
Acute Liver Failure
Hepatic Cirrhosis
Pathophysiology
Clinical Manifestations

Assessment and Diagnostic Findings
Medical Management
Nursing Management
Cancer of the Liver
Primary Liver Tumors
Liver Metastases
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Surgical Management
Nursing Management
Liver Transplantation
Surgical Procedure
Complications
Nursing Management
Liver Abscesses
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
44 Management of Patients with Biliary Disorders
Anatomic and Physiologic Overview
The Gallbladder
The Pancreas
The Exocrine Pancreas
The Endocrine Pancreas
Endocrine Control of Carbohydrate Metabolism
Gerontologic Considerations
Disorders of the Gallbladder
Cholecystitis
Cholelithiasis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
• *Nursing Process:* The Patient Undergoing Surgery for Gallbladder Disease
Disorders of the Pancreas
Acute Pancreatitis
Gerontologic Considerations

Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Chronic Pancreatitis
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Pancreatic Cysts
Cancer of the Pancreas
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Tumors of the Head of the Pancreas
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Pancreatic Islet Tumors
Surgical Management
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45 Assessment and Management of Patients with Endocrine Disorders

Assessment of the Endocrine System

Anatomic and Physiologic Overview
Glands of the Endocrine System
Function and Regulation of Hormones
Classification and Action of Hormones
Assessment
Health History
Physical Assessment
Diagnostic Evaluation
Blood Tests
Urine Tests
Additional Diagnostic Studies

The Pituitary Gland

Anatomic and Physiologic Overview

Anterior Pituitary
Posterior Pituitary
Pathophysiology
Anterior Pituitary
Posterior Pituitary
Pituitary Tumors
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Diabetes Insipidus
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Syndrome of Inappropriate Antidiuretic Hormone Secretion
Medical Management
Nursing Management
The Thyroid Gland
Anatomic and Physiologic Overview
Thyroid Hormone
Calcitonin
Pathophysiology
Assessment
Physical Examination
Diagnostic Evaluation
Thyroid Tests
Nursing Implications
Hypothyroidism
Clinical Manifestations
Medical Management
Nursing Management
Gerontologic Considerations
Hyperthyroidism
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Gerontologic Considerations
• *Nursing Process:* The Patient with Hyperthyroidism
Thyroid Tumors
Endemic (Iodine-Deficient) Goiter
Nodular Goiter

Thyroid Cancer
Assessment and Diagnostic Findings
Medical Management
Nursing Management
The Parathyroid Glands
Anatomic and Physiologic Overview
Pathophysiology
Hyperparathyroidism
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Complications: Hypercalcemic Crisis
Hypoparathyroidism
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
The Adrenal Glands
Anatomic and Physiologic Overview
Adrenal Medulla
Adrenal Cortex
Pheochromocytoma
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Adrenocortical Insufficiency (Addison's Disease)
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Cushing's Syndrome
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
• *Nursing Process:* The Patient with Cushing's Syndrome
Primary Aldosteronism
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management

Nursing Management
Corticosteroid Therapy
Side Effects
Therapeutic Uses of Corticosteroids
Dosage
Tapering
Nursing Management

46 Management of Patients with Diabetes
Diabetes
Epidemiology
Classification
COVID-19 Considerations
Pathophysiology
Prevention
Clinical Manifestations
Assessment and Diagnostic Findings
Gerontologic Considerations
Medical Management
Nursing Management
Acute Complications of Diabetes
Hypoglycemia (Insulin Reactions)
Gerontologic Considerations
Clinical Manifestations
Assessment and Diagnostic Findings
Management
Diabetic Ketoacidosis
Pathophysiology
Prevention
Clinical Manifestations
Assessment and Diagnostic Findings
Management
Hyperglycemic Hyperosmolar Syndrome
Clinical Manifestations
Assessment and Diagnostic Findings
Management
• *Nursing Process:* The Patient with Diabetic Ketoacidosis or Hyperglycemic Hyperosmolar Syndrome
Long-Term Complications of Diabetes
Macrovascular Complications
Role of Diabetes in Macrovascular Diseases
Management

Microvascular Complications
Diabetic Retinopathy
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Nephropathy
Clinical Manifestations
Assessment and Diagnostic Findings
Management
Diabetic Neuropathies
Peripheral Neuropathy
Clinical Manifestations
Management
Autonomic Neuropathies
Clinical Manifestations
Management
Foot and Leg Problems
Medical Management
Nursing Management
Special Issues in Diabetes Care
Patients with Diabetes Who Are Undergoing Surgery
Management of Patients with Diabetes Who Are Hospitalized
Self-Care Issues
Hyperglycemia During Hospitalization
Hypoglycemia During Hospitalization
Common Alterations in Diet
Hygiene
Stress
Gerontologic Considerations
Nursing Management

UNIT 11 Kidney and Urinary Tract Function

47 Assessment of Kidney and Urinary Function
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Anatomy of the Kidney and Urinary Systems
Physiology of the Kidney and Urinary Systems
Gerontologic Considerations
Assessment of the Kidney and Urinary Systems
Health History
Physical Assessment

Diagnostic Evaluation
Urinalysis and Urine Culture
Specific Gravity
Osmolality
Renal Function Tests
Diagnostic Imaging
Urologic Endoscopic Procedures
Biopsy

48 Management of Patients with Kidney Disorders
Fluid and Electrolyte Imbalances in Kidney Disorders
Clinical Manifestations
Gerontologic Considerations
Kidney Disorders
Chronic Kidney Disease
Pathophysiology
Stages of Chronic Kidney Disease
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Gerontologic Considerations
Nephrosclerosis
Pathophysiology
Assessment and Diagnostic Findings
Medical Management
Primary Glomerular Diseases
Acute Nephritic Syndrome
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Complications
Medical Management
Nursing Management
Chronic Glomerulonephritis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Nephrotic Syndrome
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings

Complications
Medical Management
Nursing Management
Polycystic Kidney Disease
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Renal Cancer
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Kidney Disease
Acute Kidney Injury
COVID-19 Considerations
Pathophysiology
Classifications of Acute Kidney Injury
Categories of Acute Kidney Injury
Phases of Acute Kidney Injury
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
Gerontologic Considerations
Medical Management
Nursing Management
End-Stage Kidney Disease or Chronic Kidney Disease
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Complications
Medical Management
Nursing Management
Gerontologic Considerations
Renal Replacement Therapy (RRT)
Dialysis
Hemodialysis (HD)
Dialyzers
Vascular Access
Complications
COVID-19 Considerations
Nursing Management

Continuous Renal Replacement Therapy
Continuous Venovenous Hemofiltration
Continuous Venovenous Hemodialysis
Peritoneal Dialysis (PD)
Procedure
Complications
Approaches
Nursing Management
Special Considerations: Nursing Management of the Patient on Dialysis Who Is Hospitalized
Kidney Surgery
Management of Patients Undergoing Kidney Surgery
Preoperative Considerations
Perioperative Concerns
Postoperative Management
Nursing Management
Kidney Transplantation
Preoperative Management
Medical Management
Nursing Management
Postoperative Management
Medical Management
COVID-19 Considerations
Nursing Management
Renal Trauma
Medical Management
Nursing Management
49 Management of Patients with Urinary Disorders
Infections of the Urinary Tract
Lower Urinary Tract Infections
Pathophysiology
Clinical Manifestations
Gerontologic Considerations
Assessment and Diagnostic Findings
Medical Management
• *Nursing Process:* The Patient with a Lower Urinary Tract Infection
Upper Urinary Tract Infections
Acute Pyelonephritis
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Chronic Pyelonephritis

Clinical Manifestations
Assessment and Diagnostic Findings
Complications
Medical Management
Nursing Management
Adult Voiding Dysfunction
Urinary Incontinence
Types of Urinary Incontinence
Gerontologic Considerations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Urinary Retention
Pathophysiology
Assessment and Diagnostic Findings
Complications
Nursing Management
Neurogenic Bladder
Pathophysiology
Assessment and Diagnostic Findings
Complications
Medical Management
Urinary Catheters
Indwelling Catheters
Suprapubic Catheters
Nursing Management
Urolithiasis and Nephrolithiasis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
• *Nursing Process:* The Patient with Renal Calculi
Genitourinary Trauma
Specific Injuries
Ureteral Trauma
Bladder Trauma
Urethral Trauma
Medical Management
Nursing Management
Urinary Tract Cancers
Cancer of the Bladder
Clinical Manifestations

Assessment and Diagnostic Findings
Medical Management
Urinary Diversions
Ileal Conduit
Complications
Nursing Management
Orthotopic Neobladder
Surgical Management
Complications
Nursing Management
Other Continent Urinary Diversion Procedures
• *Nursing Process:* The Patient Undergoing Urinary Diversion Surgery

UNIT 12 Reproductive Function

50 Assessment and Management of Patients with Female Physiologic Processes
CHALLENGES in Women's Health
Assessment of the Female Reproductive System
Anatomic and Physiologic Overview
Anatomy of the Female Reproductive System
Function of the Female Reproductive System
Assessment
Health History
Physical Assessment
Diagnostic Evaluation
Cytologic Test for Cancer (Pap Smear)
Colposcopy and Cervical Biopsy
Cryotherapy and Laser Therapy
Cone Biopsy and Loop Electrosurgical Excision Procedure
Endometrial (Aspiration) Biopsy
Dilation and Curettage
Endoscopic Examinations
Other Diagnostic Procedures
Management of Female Physiologic Processes
Menstruation
Psychosocial Considerations
Cultural Considerations
Menstrual Disorders
Premenstrual Syndrome
Clinical Manifestations
Medical Management

Nursing Management
Dysmenorrhea
Assessment and Diagnostic Findings
Management
Amenorrhea
Abnormal Uterine Bleeding
Dyspareunia
Contraception
Contraindications
Abstinence
Long-Acting Reversible Contraceptive (LARC) Methods
Sterilization
Hormonal Contraception
Mechanical Barriers
Coitus Interruptus or Withdrawal
Fertility Awareness–Based Methods
Emergency Contraception
Nursing Management
Abortion
Spontaneous Abortion
Habitual Abortion
Medical Management
Nursing Management
Induced Abortion
Medical Management
Nursing Management
Infertility
Diagnostic Findings
Medical Management
Nursing Management
Preconception/Periconception Health Care
Ectopic Pregnancy
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
• *Nursing Process:* The Patient with an Ectopic Pregnancy
Perimenopause
Nursing Management
Menopause
Postmenopausal Bleeding
Clinical Manifestations
Psychological Considerations

Medical Management
Nursing Management

51 Management of Patients with Female Reproductive Disorders

Vulvovaginal Infections

Candidiasis
Clinical Manifestations
Medical Management

Bacterial Vaginosis
Clinical Manifestations
Medical Management

Trichomoniasis
Clinical Manifestations
Medical Management

Gerontologic Considerations

• *Nursing Process:* The Patient with a Vulvovaginal Infection

Human Papillomavirus
Pathophysiology
Medical Management
Prevention

Herpes Virus Type 2 Infection (Herpes Genitalis, Herpes Simplex Virus)
Pathophysiology
Clinical Manifestations
Medical Management

• *Nursing Process:* The Patient with a Genital Herpes Infection

Endocervicitis and Cervicitis
Chlamydia and Gonorrhea
Medical Management
Nursing Management

Pelvic Inflammatory Disease
Pathophysiology
Clinical Manifestations
Complications
Medical Management
Nursing Management

Human Immune Deficiency Virus Infection and Acquired Immune Deficiency Syndrome

Structural Disorders

Fistulas of the Vagina
Clinical Manifestations

Assessment and Diagnostic Findings
Medical Management
Pelvic Organ Prolapse: Cystocele, Rectocele, Enterocele
Clinical Manifestations
Medical Management
Uterine Prolapse
Medical Management
Nursing Management
Benign Disorders
Vulvitis and Vulvodynia
Medical Management
Vulvar Cysts
Medical Management
Vulvar Dystrophy
Medical Management
Nursing Management
Ovarian Cysts
Medical Management
Benign Tumors of the Uterus: Fibroids (Leiomyomas, Myomas)
Clinical Manifestations
Medical Management
Endometriosis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Chronic Pelvic Pain
Adenomyosis
Endometrial Hyperplasia
Malignant Conditions
Cancer of the Cervix
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Cancer of the Uterus (Endometrium)
Pathophysiology
Assessment and Diagnostic Findings
Medical Management
Cancer of the Vulva
Clinical Manifestations

Medical Management
Nursing Management
Cancer of the Vagina
Medical Management
Cancer of the Fallopian Tubes
Cancer of the Ovary
Epidemiology
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Hysterectomy
Preoperative Management
Postoperative Management
• *Nursing Process:* The Patient Undergoing a Hysterectomy
Radiation Therapy
Methods of Radiation Therapy
Nursing Considerations for Radiation Safety

52 **Assessment and Management of Patients with Breast Disorders**

Breast Assessment
Anatomic and Physiologic Overview
Assessment
Health History
Physical Assessment: Female Breast
Physical Assessment: Male Breast
Diagnostic Evaluation
Breast Self-Examination
Mammography
Contrast Mammography
Ultrasonography
Magnetic Resonance Imaging
Procedures for Tissue Analysis
Conditions Affecting the Nipple
Nipple Discharge
Fissure
Breast Infections
Mastitis
Lactational Abscess
Benign Conditions of the Breast

Breast Pain
Nursing Management
Cysts
Fibroadenomas
Benign Proliferative Breast Disease
Atypical Hyperplasia
Lobular Carcinoma In Situ
Other Benign Conditions
Malignant Conditions of the Breast
Types of Breast Cancer
Ductal Carcinoma In Situ
Medical Management
Invasive Cancer
Risk Factors
Protective Factors
Breast Cancer Prevention Strategies in the Patient Who Is at High Risk
Clinical Manifestations
Assessment and Diagnostic Findings
Staging
Prognosis
Surgical Management
Nursing Management
• *Nursing Process:* The Patient Undergoing Surgery for Breast Cancer
Radiation Therapy
Side Effects
Nursing Management
Systemic Treatments
Chemotherapy
Side Effects
Nursing Management
Hormonal Therapy
Targeted Therapy
Treatment of Recurrent and Metastatic Breast Cancer
Nursing Management
Reconstructive Procedures After Mastectomy
Tissue Expander Followed by Permanent Implant
Tissue Transfer Procedures
Nipple–Areola Reconstruction
Prosthetics
Special Issues in Breast Cancer Management
Implications of Genetic Testing

Pregnancy and Breast Cancer
Quality of Life and Survivorship
Gerontologic Considerations
Breast Health of Women with Disability
Reconstructive Breast Surgery
Reduction Mammoplasty
Augmentation Mammoplasty
Mastopexy
Diseases of the Male Breast
Gynecomastia
Male Breast Cancer

53 Assessment and Management of Patients with Male Reproductive Disorders
Assessment of the Male Reproductive System
Anatomic and Physiologic Overview
Gerontologic Considerations
Assessment
Health History
Physical Assessment
Diagnostic Evaluation
Prostate-Specific Antigen Test
Ultrasonography
Prostate Fluid or Tissue Analysis
Tests of Male Sexual Function
Disorders of Male Sexual Function
Erectile Dysfunction
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Disorders of Ejaculation
Infections of the Male Genitourinary Tract
Prostatic Disorders
Prostatitis
Clinical Manifestations
Medical Management
Nursing Management
Benign Prostatic Hyperplasia (Enlarged Prostate)
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management

Cancer of the Prostate
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
The Patient Undergoing Prostate Surgery
Surgical Procedures
Complications
• *Nursing Process:* Patient Undergoing Prostatectomy
Disorders Affecting the Testes and Adjacent Structures
Orchitis
Epididymitis
Pathophysiology
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Testicular Torsion
Testicular Cancer
Classification of Testicular Tumors
Risk Factors
Clinical Manifestations
Assessment and Diagnostic Findings
Medical Management
Nursing Management
Hydrocele
Varicocele
Vasectomy
Nursing Management
Vasovasostomy (Sterilization Reversal)
Semen Cryopreservation (Sperm Banking)
Disorders Affecting the Penis
Phimosis
Cancer of the Penis
Clinical Manifestations
Assessment and Diagnostic Findings
Prevention
Medical Management
Priapism
Peyronie Disease
Urethral Stricture
Circumcision

54 Assessment and Management of Patients Who Are LGBTQ
Sexuality and Gender Identity
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UNIT 1 Principles of Nursing Practice

Case Study

EDUCATING OLDER ADULTS TO NAVIGATE THEIR ELECTRONIC HEALTH RECORDS

You are a nurse working in a community health center that provides services for older adults. A recent needs assessment indicates that patrons of the health center are underutilizing electronic resources available to them. Furthermore, these

individuals need education about resources such as their electronic health records (EHRs) including how to access, maintain, and utilize this tool. EHRs enable patients to be more aware and have better control over their health management. You implement a plan for educating older adults in the community on this technology. The main goal of this project is to empower older adults to easily access their own EHRs and manage their appointments, medications, and follow-up visits. An additional goal is that use of this technology will enable patients, families, and communities to have up-to-date information and increased access to health-related resources.

QSEN Competency Focus: **Patient-Centered Care**

The complexities inherent in today's health care system challenge nurses to demonstrate integration of specific interdisciplinary core competencies. These competencies are aimed at ensuring the delivery of safe, quality patient care (Institute of Medicine, 2003). The Quality and Safety Education for Nurses project (Cronenwett, Sherwood, Barnsteiner, et al., 2007; QSEN, 2020) provides a framework for the knowledge, skills, and attitudes (KSAs) required for nurses to demonstrate competency in these key areas, which include ***patient-centered care***, ***interdisciplinary teamwork and collaboration***, ***evidence-based practice***, ***quality improvement***, ***safety,*** and ***informatics.***

Patient-Centered Care Definition: Recognize the patient or designee as the source of control and full partner in providing compassionate and coordinated care based on respect for patient's preferences, values, and needs.

SELECT PRE-LICENSURE KSAs	APPLICATION AND REFLECTION
Knowledge	
Describe strategies to empower patients or families in all aspects of the health care process	How does providing access to patient information empower patients, families, and communities to manage their health? What are the advantages to having immediate access to patient information?
Skills	
Engage patients or designated surrogates in active partnerships that promote health, safety and well-being, and self-care management	What is the responsibility of the nurse in helping patients navigate their EHR? Discuss how you would advocate for patients so they have the resources to access, understand, and utilize their EHR.
Attitudes	
Seek learning opportunities with patients who represent all aspects of human diversity	Think about your own experience and training with patients, families, and communities that have technology barriers. Why is it important for nurses to provide opportunities to patients, families, and communities of diverse backgrounds about the use of technology to access information?

Cronenwett, L., Sherwood, G., Barnsteiner, J., et al. (2007). Quality and safety education for nurses. *Nursing Outlook*, *55*(3), 122–131; Institute of Medicine. (2003). *Health professions education: A bridge to quality*. Washington, DC: National Academies Press; QSEN Institute. (2020). *QSEN competencies: Definitions and pre-licensure KSAs; Patient-centered care*. Retrieved on 8/15/2020 at: qsen.org/competencies/pre-licensure-ksas/#patient-centered_care

1 Professional Nursing Practice

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Define nursing, patient, health, wellness, health promotion, and health care.
2. Describe salient influences on the delivery of health care.
3. Discuss practices that improve quality and safety and ensure the use of evidence-based practices within the health care system.
4. Discuss behavioral competencies and characteristics of professional nursing practice and the nurse's role as a collaborative member of the interprofessional health care team.
5. Define the characteristics of critical thinking, the critical thinking process, and clinical decision making.
6. Describe the components of the nursing process.
7. Identify strategies that can be implemented in ethical decision making.

NURSING CONCEPTS

Accountability
Advocacy
Assessment
Caring
Clinical Decision Making
Collaboration
Critical Thinking
Ethics
Evidence-Based Practice
Health Care Systems
Health Policy
Health Promotion
Informatics
Legal Issues
Nursing Process
Quality Improvement
Safety

GLOSSARY

assessment: the systematic collection of data, through interview, observation, and examination, to determine the patient's health status and any actual or potential problems

bundle: a set of three to five evidence-based practices that, when implemented appropriately, can measurably improve patient outcomes

critical thinking: a cognitive process that utilizes thinking that is purposeful, insightful, reflective, and goal directed to develop conclusions, solutions, and alternatives that are appropriate to the given solution

ethics: the formal, systematic process used to understand, analyze, and evaluate decisions regarding matters of right and wrong as they apply to well-being

evaluation: determination of the patient's response to nursing interventions and the extent to which the outcomes have been achieved

evidence-based practice (EBP): a best practice derived from valid and reliable research studies that also considers the health care setting, patient preferences and values, and clinical judgment

health: according to the World Health Organization (2006), a "state of complete physical, mental, and social well-being and not merely the absence of disease and infirmity" (p. 1)

health informatics: the use of health information technology to improve the quality, efficiency, or delivery of health care

health promotion: focuses on the potential for wellness and targets appropriate alterations in personal habits, lifestyle, and environment in ways that reduce risks and enhance health and well-being

implementation: actualization or carrying out of the nursing plan of care through nursing interventions

interprofessional collaborative practice: employing multiple health professionals to work together with patients, families, and communities to deliver best practices, thus ensuring best patient outcomes

morality: specific beliefs or actions whose outcomes are often examined utilizing the principles of autonomy, beneficence, nonmaleficence, double effect, and distributive justice

moral dilemma: situation in which two or more ethically plausible principles are in opposition to each other and only one may be chosen

moral distress: internal response that occurs when a health care provider believes they inherently know the correct ethical action that is needed but cannot act on that knowledge

moral integrity: virtue composed of veracity, fidelity, benevolence, wisdom, and moral courage

moral problem: competing moral claim or principle; one principle is clearly dominant

moral uncertainty: internal conflict that arises when the person cannot define what the moral situation is or what moral principles apply but has a strong feeling that something is not right

nursing: according to the American Nurses Association (2015b), "the protection, promotion, and optimization of health and abilities, prevention of illness and injury, facilitation of healing, alleviation of suffering through the diagnosis and treatment of human response, and advocacy in the care of individuals, families, groups, communities, and populations" (p. 1)

nursing diagnosis: a clinical judgment concerning a person's, family's, or community's actual or potential health problems, state of health promotion, or potential risk that can be managed by independent nursing interventions

nursing process: a systematic, problem-solving approach for meeting people's health care and nursing needs; components involve assessment, diagnosis, planning, implementation, and evaluation

patient: a traditional term used to identify someone who is a recipient of health care

planning: development of measurable goals and outcomes as well as a plan of care designed to assist the patient in resolving the diagnosed problems and achieving the identified goals and outcomes

precision medicine: using advances in research, technology, and policies to develop individualized plans of care to prevent and treat disease

Quality and Safety Education for Nurses (QSEN): a project whose aim is to develop curricula that prepare future nurses with the knowledge, skills, and attitudes (KSA) required to continuously improve the quality and safety of the health care system through demonstrating competency in patient-centered care, teamwork and collaboration, evidence-based practice, quality improvement, safety, and informatics

telehealth: the use of technology to deliver health care, health information, or health education at a distance

The Joint Commission: a nonprofit organization that accredits hospitals and health care organizations

wellness: the ability to perform well, adjust and adapt to varying situations, and report feeling well and harmoniousa

As American society has undergone changes, so has the nation's health care system. Nursing, as the health care profession with the greatest number of employees and a major contributor to the health care delivery system, has been significantly affected by these changes. Nursing has played an important role in the health care system and will continue to do so. This chapter provides an overview of the practice of nursing in the United States today, as well important factors and issues that will continue to affect its practice into the future.

Nursing

Since the time of Florence Nightingale, who wrote in 1858 that the goal of nursing was "to put the patient in the best condition foar nature to act upon him," nursing scholars and leaders have described nursing as both an art and a science. However, the definition of nursing has evolved over time. In the American Nurses Association (ANA) Scope and Standards of Practice (ANA, 2015b, p. 1), **nursing** is defined as "the protection, promotion, and optimization of health and abilities, prevention of illness and injury, facilitation of healing, alleviation of suffering through the diagnosis and treatment of human response, and advocacy in the care of individuals, families, groups, communities, and populations." Nurses have a responsibility to carry out their role as described in Nursing's Social Policy Statement (ANA, 2010; Fowler, 2015), to comply with the nurse practice act of the state in which they practice, and to comply with the Code of Ethics for Nurses as spelled out by the ANA (2015a) and the International Council of Nurses (ICN, 2012). Advocacy, promotion of a safe environment, research, education, and participation in patient and health systems management as well as shaping health policy are also key nursing roles (ICN, 2012).

The Patient: Consumer of Nursing and Health Care

The term **patient**, derived from a Latin verb meaning "to suffer," has traditionally been used to describe a person who is a recipient of care. The connotation commonly attached to the word is one of dependence. For this reason, many nurses prefer to use the term *client,* which is derived from a Latin verb meaning "to lean," connoting alliance and interdependence. The term *patient* is used purposely throughout this book; it is most commonly used by clinicians, as evidenced by its usage by the Interprofessional Education Collaborative (IPEC, 2016a), whose members include 15 national associations of schools of the health professions, including nursing, allopathic medicine, osteopathic medicine, pharmacy, dentistry, and public health, to name a few (see later discussion of IPEC).

The patient who seeks care for a health problem or problems (increasing numbers of people have multiple health problems or comorbidities) is also an individual person, a member of a family, a member of various social groups, and a citizen of the community. Patients' needs vary depending on problems, associated circumstances, and past experiences. Many patients, who as consumers of health care have become more knowledgeable about health care options, expect a collaborative approach with the nurse in the quest for optimal health (Majid & Gagliardi, 2019). Among the nurse's important functions in health care delivery are identifying the patient's immediate, ongoing, and long-term needs and working together with the patient to address them.

The Patient's Basic Needs: Maslow Hierarchy of Needs

Certain needs are basic to all people. Some of these needs are more important than others. Once an essential need is met, people often experience a need on a higher level of priority. Addressing needs by priority reflects Maslow's Hierarchy of Needs (Fig. 1-1).

Maslow ranked human needs to include physiologic needs, safety and security, sense of belonging and affection, esteem and self-respect, and self-actualization. Self-actualization includes self-fulfillment, desire to know and understand, and aesthetic needs. Lower-level needs always remain; however, a person's ability to pursue higher-level needs indicates movement toward psychological health and well-being (Maslow, 1954). Such a hierarchy of needs is a useful framework that can be applied to many nursing models for assessment of a patient's strengths, limitations, and need for nursing interventions.

Health

How health is perceived depends on how health is defined. The World Health Organization (WHO, 2006) defines **health** in the preamble to its constitution as a "state of complete physical, mental, and social well-being and not merely the absence of disease and infirmity" (p. 1). This definition implies that health and illness are not polar opposites. Theoretically, therefore, it is possible for a patient to have a physical illness and yet strive for and perhaps attain health in another domain (e.g., mental, social). Although commonly cited worldwide, this definition has been criticized for being too utopian—after all, it is not possible for anyone to achieve *complete* physical, mental, and social well-being (Murdaugh, Parsons, & Pender, 2019).

Figure 1-1 • This scheme of Maslow's hierarchy of needs shows how a person moves from fulfillment of basic needs to higher levels of needs, with the ultimate goal being integrated human functioning and health.

Wellness

Wellness has been defined as being equivalent to health. Wellness involves being proactive and being involved in self-care activities aimed toward a state of physical, psychological, social, and spiritual well-being. Wellness is conceptualized as having four components: (1) the capacity to perform to the best of one's ability, (2) the ability to adjust and adapt to varying situations, (3) a reported feeling of well-being, and (4) a feeling that "everything is together" and harmonious (Hood, 2018). With this in mind, nurses must aim to promote positive changes that are directed toward health and well-being. The sense of wellness has a subjective aspect that addresses the importance of recognizing and responding to patient individuality and diversity in health care and nursing.

Health Promotion

Today, increasing emphasis is placed on health, wellness, health promotion, and self-care. Health is seen as resulting from a lifestyle oriented toward wellness. **Health promotion** focuses on the potential for wellness and targets appropriate alterations in personal habits, lifestyle, and environment in ways that reduce risks and enhance health and well-being (see Chapter 3).

People are increasingly knowledgeable about health and take more interest in and responsibility for health and well-being. Organized self-care wellness education programs emphasize health promotion, disease prevention, management of illness, self-care, and collaborative use of the professional health care system. Web sites, chat groups, open forums, and social media support groups promote sharing of experiences and information about self-care with others who have similar conditions, chronic diseases, or disabling conditions. The advent of mobile wireless computer technologies (e.g., Fitbit™) and novel informatics tools (e.g., Carb Manager) have had the effect of tailoring health promotion activities to meet individual preferences (Murdaugh et al., 2019). Researchers have begun to take advantage of these popular technologic advancements by developing population-based registries. The use of mobile health apps has demonstrated a positive impact on health-related behaviors, specifically, physical activity, dietary management, adherence to medication or therapy, and knowledge related to medications and diagnostic testing. Moreover, most mobile health apps seem to promote better clinical health outcomes (Han & Lee, 2018). According to the WHO (2019), "primary health care ensures people receive comprehensive care—ranging from promotion and prevention to treatment, rehabilitation and palliative care—as close as feasible to people's everyday environment" (p. 1). Primary health care includes a lifelong commitment to meeting individuals' health needs across the lifespan; empowerment of individuals to assume accountability for their own health care; and attention to societal needs for health care through social policy and action.

Health Care

Health care describes services that are offered to individuals, families, and communities to help them maintain health and wellness, prevent and manage illness and complications, and provide support through rehabilitation, recovery, and transitions to palliative care. Health care can be provided in inpatient, outpatient, and community settings by a variety of health professionals, including but not limited to nurses, primary providers, pharmacists, dieticians, social workers, psychologists, and physical, occupational, speech and respiratory therapists.

Influences on Health Care Delivery

The health care delivery system is constantly adapting to changes in health care needs and expectations. Shifting population demographics; changing patterns of disease and wellness; advances in technology and genetics; and greater emphasis on health care quality, costs, reform efforts, and interprofessional collaborative practices have impacted health care delivery and the practice of nursing.

Population Demographics

Changes in the population in general are affecting the need for and the delivery of health care. According to the United States (U.S.) Census Bureau (2020), over 329 million people reside in the country. Not only is the population increasing, but its composition is also changing. The decline in birth rate and the increase in lifespan have resulted in proportionately fewer school-age children and more senior citizens, many of whom are women. Much of the population resides in highly congested urban areas, with a steady migration of members of ethnic minorities to urban settings. Poverty is a growing concern. According to the U.S. Department of Housing and Urban Development's (HUD's) 2019 Annual Homeless Assessment Report, on a given night, approximately 568,000 individuals were documented as homeless in the United States. Homelessness increased by 3% from 2018 to 2019, with almost 40% of this population staying on the streets or other unsheltered locations; in addition, a higher percentage of minority populations compared to the total U.S. population are impacted by homelessness today (U.S. Department of Housing and Urban Development, 2020).

Gerontologic Considerations

Both the number and proportion of Americans 65 years of age and older have grown substantially in the past century. In 2017, an estimated 47.8 million older adults resided in the United States; this number continues to climb, with the greatest growth in the Hispanic population (U.S. Census Bureau, 2017).

The health care needs of older adults are complex and demand significant investments, both professional and financial (see Chapter 8 for further discussion). Many older adults suffer from multiple chronic conditions that are exacerbated by acute episodes. In particular, older women are frequently underdiagnosed and undertreated. According to the United Nations' (2017) report on world population aging, globally, the number of people 80 years of age or older is projected to increase more than threefold between 2017 and 2050, rising from 137 to 425 million.

Veterans Considerations

Veterans of the U.S. armed services comprise a unique population with health care needs that vary dependent upon branch of military service, whether service occurred during wartime eras, time and place of service, and individual experiences (Olenick, Flowers, & Diaz, 2015). According to the U.S. Census Bureau (2019), there are currently 18 million veterans, 1.8 million of whom are female. Substance use disorders (SUDs), posttraumatic stress disorder (PTSD), traumatic brain injury (TBI), suicide, depression, hazardous substance exposure, and amputations are common health care problems found among veterans (Olenick et al., 2015) (see Chapter 4). According to a Pew Research Center

(2017) report, the proportion of Americans who served in the U.S. military has been steadily declining since 1980, when 18% of American adults were veterans. In 2016, 7% of Americans were veterans. That proportion is projected to continue to decline, and by 2045 the U.S. Department of Veteran Affairs estimates that there will be approximately 12 million veterans, roughly a 40% decrease from 2016 (Pew Research Center, 2017).

Cultural Diversity

An appreciation for the diverse characteristics and needs of people from varied ethnic and cultural backgrounds is important in health care and nursing. Some projections indicate that by 2030, racial and ethnic minority populations in the United States will triple. The latest U.S. census classified five distinct races as White, Black or African American, Asian, Native American or Alaska Native, and Native Hawaiian/Pacific Islander. The Asian race had the largest growth rate among these five racial groups. The Hispanic population, classified primarily under the White race, was noted to account for more than half of the increased population growth. The non-Hispanic Caucasian population will proportionally decrease so that they will no longer comprise the majority population, and other ethnic and racial minority populations will collectively comprise the majority of all Americans by approximately 2044 (Colby & Ortman, 2015). As the cultural composition of the population changes, it is increasingly important to address cultural considerations in the delivery of health care. Patients from diverse sociocultural groups not only bring various health care beliefs, values, and practices to the health care setting but also have unique risk factors for some disease conditions and unique reactions to treatment. These factors significantly affect a person's responses to health care problems or illnesses, to caregivers, and to the care itself. Unless these factors are assessed, understood, and respected by nurses, the care delivered may be ineffective, and health care outcomes may be negatively affected (see Chapter 4 for additional information on cultural assessment).

Changing Patterns of Disease and Wellness

During the past several decades, the health problems of Americans have changed significantly. Chronic diseases, including cardiovascular disease, cancers, diabetes, and chronic lung diseases account for 7 out of the 10 leading causes of death (Centers for Disease Control and Prevention [CDC], 2019). Nearly half of all adults live with one diagnosed chronic condition; 60 million live with two or more (CDC, 2019). Tobacco use, SUD (e.g., alcohol, illicit drugs), poor physical activity and nutrition habits, and obesity have become major health concerns (CDC, 2019).

As the prevalence of chronic conditions increases, health care broadens from a focus on cure and eradication of disease to include health promotion and the prevention or rapid treatment of exacerbations of chronic conditions. Nursing,

which has always encouraged patients to take control of health and wellness, has a prominent role in the current focus on management of chronic illness and disability (see Chapter 7).

Healthy People 2030

The *Healthy People* initiatives identify important periodic goals that, if reached, could have major impacts on the health and overall well-being of people in the United States (U.S. Department of Health and Human Services [HHS], 2020a). Since their inception over four decades ago, these initiatives have contributed to substantial decreases in cancer and cardiovascular deaths, infant and maternal mortality, and improvements in vaccinations (HHS, 2020a). Leading health indicators (LHIs) or goals outlined in the *Healthy People 2020* initiative aimed to improve access to health services, environmental quality, use of preventive services, nutrition and physical activity, and to address social determinants of health, while decreasing rates of injury and violence, obesity, tobacco use, and substance abuse, among others (HHS, 2020b). This initiative considered social influences that shape health, such as poverty and social injustices, rather than simply focusing on disease states. To date, significant progress has been made in decreasing the number of adults who are smoking and in improving physical activity of adults (HHS, 2020b). The *Healthy People 2030* framework, guided the development of the *Healthy People 2030* initiative and identified the need to collaborate more effectively with a variety of stakeholders across diverse agencies to accomplish its vision of helping all people in the United States optimize their health and well-being across developmental life stages, with a continued emphasis on reducing health disparities and improving health equity and health literacy (HHS, 2020a). The development of *Healthy People 2030* is in progress, data-driven national objectives have been established, and updates can be found by visiting its website. Enacting the goals set by the LHIs and other health care reforms have contributed to continuous change in health care organizations and delivery in the United States.

Advances in Technology and Genetics

Advances in technology and genetics have occurred rapidly during the past several decades. Sophisticated techniques and devices, such as robot assisted technology, have revolutionized treatments making it possible to perform many procedures and tests on an outpatient basis. Increased knowledge and understanding of genetics and genomics have resulted in expanded screening, diagnostic testing, and treatments for a variety of conditions (see Chapter 6 for information on genetics and genomics and nursing practice implications; in addition, note that there are charts that focus upon *Genetics in Nursing Practice* throughout the book, which highlight various relevant genetic disorders).

In January 2015, President Obama announced the launching of the *Precision Medicine Initiative (PMI),* which aimed to leverage advances in research,

technology, and policies to develop individualized plans of care to prevent and treat disease (Genetics Home Reference, 2020). **Precision medicine** is possible because of the recent development of biologic databases (e.g., human genome sequencing), technologic advances that can identify unique characteristics of individual people (e.g., genomics, cellular assay tests), and computer-driven systems that can mine and analyze data sets. The immediate goal of the PMI is to focus on preventing and curing cancers; however, there are long-term implications that hold promise for preventing and treating many other conditions and diseases (Ciupka, 2018).

Health Informatics

The sophisticated communication systems that connect most parts of the world, with the capability of rapid storage, retrieval, and dissemination of information, have stimulated advances in health information technology (HIT). Using HIT to improve the quality, efficiency, or delivery of health care is an interdisciplinary field of study called **health informatics.** Key examples of recent advances in HIT include artificial intelligence, blockchain, cloud technology, disease management technology, and improved operability of electronic health records (EHRs). The *Technology Informatics Guiding Education Reform (TIGER)* initiative, now a subsidiary of the Healthcare Information Management Systems Society (HIMSS), provides expert panel reports and guidelines for incorporating HIT into nursing practice (HIMSS, 2020).

The *International Classification of Diseases (ICD)* (WHO) launched its 10th iteration for use in the United States in 2015. The ICD-10 classifies diseases and conditions into nearly 70,000 codes. In June 2018, WHO released a version of ICD-11, which was presented to the World Health Assembly in 2019 for adoption by countries (WHO, 2018). Currently, the Centers for Medicare & Medicaid Services (CMS, 2015) and most other major health insurance programs require utilization of ICD-10 codes when treatment is rendered for providers to claim reimbursement. This system provides for common nomenclature and tracking of the incidence and prevalence of various diseases and conditions globally. CMS (2020) also requires that clinicians and health care systems use EHRs; its final rule for stage 3 of the *EHR Incentive Program,* now known as the *Promoting Interoperability Program,* required that by 2018 providers use EHRs or face reductions in reimbursement.

In addition to these HIT advancements, **telehealth,** which uses technology to deliver health care, health information, or health education at a distance, is being utilized by both individual clinicians and health care systems more and more frequently. In particular, home health services use telehealth to develop more individualized care plans for patients. One type of telehealth application uses *real-time communication,* characterized by an exchange of information between people at one point in time. For instance, a nurse practitioner in a rural clinic may consult with a specialist on a webcam about a patient's condition. Another type of telehealth application uses *store-and-forward,* characterized by transmission of

digital images that may be retrieved and reviewed at later points in time (HealthIT.gov, 2018).

Quality, Safety, and Evidence-Based Practice

At the turn of the millennium, the Institute of Medicine (IOM, 2000) reported an alarming breakdown in quality control in the American health care system. The IOM report *To Err Is Human: Building a Safer Health System* (2000) noted that nearly 100,000 Americans died annually from preventable errors in hospitals, and many more suffered nonfatal injuries from errors. A subsequent IOM report, *Crossing the Quality Chasm: A New Health System for the 21st Century* (2001), described an inefficient, fragmented, health care system fraught with inequities and inaccessibility. It envisioned a reformed health care system that is evidence-based and systems oriented. Its proposed six aims for improvement included ensuring that patient care is safe, effective, patient centered, timely, efficient, and equitable (IOM, 2001). The following sections describe a series of key practices that are aimed at improving quality and safety and ensuring use of evidence-based practices (EBPs) within the U.S. health care system.

Principles of Evidence-Based Nursing Practice

An **evidence-based practice (EBP)** is a best practice derived from valid and reliable research studies that also considers the health care setting, patient preferences and values, and clinical judgment. The facilitation of EBP involves identifying and evaluating current literature and research findings, and then incorporating these findings into patient care as a means of ensuring quality care (Melnyk & Fineout-Overholt, 2018).

Evidence-Based Practice Bundles

The Institute for Healthcare Improvement (IHI) has developed numerous sets of readily implemented EBP sets for use by hospitals (IHI, 2020). These **bundles** include a set of three to five EBPs that, when implemented appropriately, can measurably improve patients' outcomes. Many of these practices are within the scope of independent nursing practice. For instance, the IHI Ventilator Bundle advocates that the head of the bed should be elevated, and that oral care should be provided using chlorhexidine for all patients on ventilators (IHI, 2012; see Chapter 19).

EBP tools used for planning patient care may include not only bundles but also clinical guidelines, algorithms, care mapping, multidisciplinary action plans (MAPs), and clinical pathways. These tools are used to move patients toward predetermined, measurable outcomes. Algorithms are used more often in acute situations to determine a particular treatment based on patient information or response. Care maps, clinical guidelines, and MAPs (the most detailed of these tools) help to facilitate coordination of care and education throughout hospitalization and after discharge. Nurses who provide direct care have an

important role in the development and use of these tools through participation in researching the literature and then developing, piloting, implementing, and revising the tools as needed.

Quality and Safety Education for Nurses

The **Quality and Safety Education for Nurses (QSEN)** project was initially funded by the nonprofit Robert Wood Johnson Foundation (RWJF) to develop curricula that prepare future nurses with the knowledge, skills, and attitudes (KSA) required to continuously improve the quality and safety of the health care system. In particular, nurses educated under QSEN concepts demonstrate the KSA consonant with competency in patient-centered care, teamwork and collaboration, EBP, quality improvement, safety, and informatics (QSEN, 2020). Each of the Unit Openers in this book highlights a case study that demonstrates the application of QSEN competencies germane to pre-licensure nursing practice. Table 1-1 highlights the QSEN definition of teamwork and collaboration and its associated KSA.

Interprofessional Collaborative Practice

The IOM report, *Health Professions Education: A Bridge to Quality* (IOM, 2003), challenged health professions education programs to integrate interdisciplinary core competencies into respective curricula to include patient-centered care, interdisciplinary teamwork and collaboration, EBP, quality improvement, safety, and informatics. In response to this report, the Interprofessional Education Collaborative Expert Panel (IPEC) published *Core Competencies for Interprofessional Collaborative Practice* (IPEC, 2011) with the goal to "prepare all health professions students for deliberately working together with the common goal of building a safer and better patient-centered and community/population-oriented US health care system" (p. 3). **Interprofessional collaborative practice** involves employing multiple health professionals to work together with patients, families, and communities to deliver best practices, thus assuring best patient outcomes. In 2016, the IPEC updated this document by organizing the four original competencies under the essential domain of interprofessional collaboration; topics within this central domain, as displayed in Figure 1-2**,** include values/ethics for interprofessional practice, roles and responsibilities for collaborative practice, interprofessional communication practices, and interprofessional teamwork and team-based practice (IPEC, 2016b). In addition, updates aimed to standardize language used among health care professionals to better facilitate interprofessional education, improve assessment and evaluation of outcomes, and more effectively meet contemporary health care goals, with a greater focus on population health. However, the updated guidelines maintain the IPEC's original vision "that interprofessional collaborative practice is key to the safe, high-quality, patient-centered care desired by all" (IPEC, 2016b, p. 4). Many of the end-of-chapter Critical Thinking

Exercises that are presented throughout this book highlight the role of the nurse as a member of the interprofessional collaborative team.

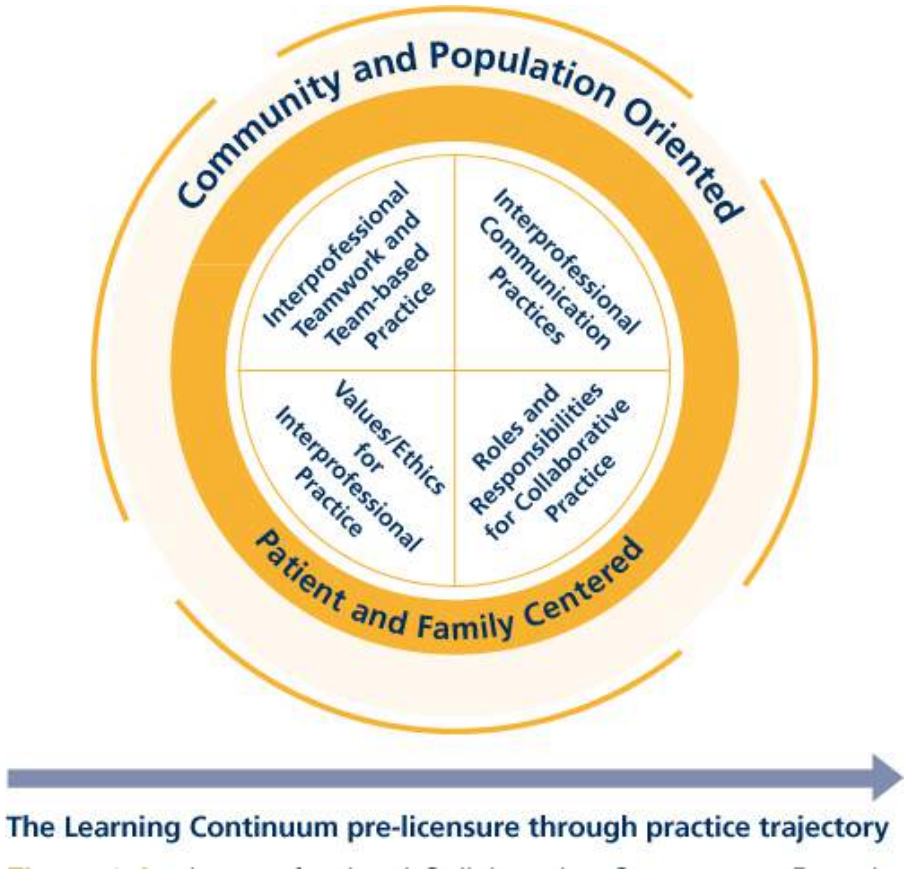


Figure 1-2 • Interprofessional Collaboration Competency Domain. Interprofessional Education Collaborative. (2016b). *Core competencies for interprofessional collaborative practice: 2016 update*. Washington, DC: Author. All rights reserved. Reproduced with permission.

TABLE 1-1 Quality and Safety Education for Nurses (QSEN) Definition of Safety and Knowledge, Skills, and Attitudes (KSA) for Pre-Licensure Nursing Students

Teamwork and Collaboration

Definition: Function effectively within nursing and inter-professional teams, fostering open communication, mutual respect, and shared decision making to achieve quality patient care.

Knowledge	Skills	Attitudes
Describe own strengths, limitations, and values in functioning as a member of a team	Demonstrate awareness of own strengths and limitations as a team member Initiate plan for self-development as a team member Act with integrity, consistency and respect for differing views	Acknowledge own potential to contribute to effective team functioning Appreciate importance of intra- and inter-professional collaboration
Describe scopes of practice and roles of health care team members Describe strategies for identifying and managing overlaps in team member roles and accountabilities Recognize contributions of other individuals and groups in helping patient/family achieve health goals	Function competently within own scope of practice as a member of the health care team Assume role of team member or leader based on the situation Initiate requests for help when appropriate to situation Clarify roles and accountabilities under conditions of potential overlap in team member functioning Integrate the contributions of others who play a role in helping patient/family achieve health goals	Value the perspectives and expertise of all health team members Respect the centrality of the patient/family as core members of any health care team Respect the unique attributes that members bring to a team, including variations in professional orientations and accountabilities
Analyze differences in communication style preferences among patients and families, nurses and other members of the health team Describe impact of own communication style on others Discuss effective strategies for communicating and resolving conflict	Communicate with team members, adapting own style of communicating to needs of the team and situation Demonstrate commitment to team goals Solicit input from other team members to improve individual, as well as team, performance Initiate actions to resolve conflict	Value teamwork and the relationships upon which it is based Value different styles of communication used by patients, families and health care providers Contribute to resolution of conflict and disagreement
Describe examples of the impact of team functioning on safety and quality of care	Follow communication practices that minimize risks associated with	Appreciate the risks associated with handoffs

Explain how authority gradients influence teamwork and patient safety	handoffs among providers and across transitions in care Assert own position/perspective in discussions about patient care Choose communication styles that diminish the risks associated with authority gradients among team members	among providers and across transitions in care
Identify system barriers and facilitators of effective team functioning	Participate in designing systems that support effective teamwork	Value the influence of system solutions in achieving effective team functioning

Reprinted with permission from Cronenwett, L., Sherwood, G., Barnsteiner, J., et al. (2007). Quality and safety education for nurses. *Nursing Outlook*, *55*(3), 122–131; QSEN Institute & Frances Payne Bolton School of Nursing, Case Western Reserve University (2020). Competencies: Prelicensure KSAs. Retrieved on 2/26/20 at: qsen.org/competencies/pre-licensure-ksas/#safety

The Practice of Nursing

As scientific advances in health care technology continue to evolve, nurses face increasingly complex issues and situations. Greater acuity of patients in both hospital and community settings, an aging population, complex disease processes, and end-of-life concerns, as well as ethical issues and cultural factors must be considered. The decision making component of nurses' problem-solving activities has become increasingly multifaceted and requires critical thinking based upon sound ethical principles.

Critical Thinking

Critical thinking is a cognitive process that utilizes thinking that is purposeful, insightful, reflective, and goal directed in order to develop conclusions, solutions, and alternatives that are appropriate for the given situation. Critical thinking, which includes reasoning and judgment, is based upon a body of knowledge and includes analysis of all information and ideas. Critical thinking leads to the formulation of conclusions and alternatives that are the most appropriate for the situation and is used to plan patient-centered care. Critical thinking has been identified as an essential core competency for nurses by the National League for Nursing (NLN) and the American Association of Colleges of Nursing (AACN, 2008; NLN, 2012). This cognitive process is critical to effective use of the nursing process and clinical reasoning (Flanders, Gunn, Wheeler, et al., 2017).

Critical thinking includes metacognition—the examination of one's own reasoning or thought processes—to help refine thinking skills. Independent

nursing judgments and decisions evolve from a sound knowledge base and the ability to synthesize information within the context in which it is presented. Nursing practice in today's society requires the use of high-level critical thinking skills. Critical thinking enhances clinical decision making, helping to identify patient needs and the best nursing actions that will assist patients in meeting those needs. Because critical thinking is a deliberate, outcome-oriented activity, it is logical, organized, and iterative. "In nursing, critical thinking is the ability to think systematically and reflect on the reasoning process used to ensure safe nursing practice" (Zarifsanaiey, Amini, & Saadat, 2016, p. 2). The process of critical thinking gives nurses the tools to make sound decisions and implement quality nursing care.

Critical thinkers are inquisitive truth seekers who are open to the alternative solutions that might surface. Critical thinking is influenced by "habits of the mind including: confidence, perseverance, inquisitiveness, intuition, flexibility, creativity, intellectual integrity, contextual perspective, open-mindedness and reflection" (Griffits, Hines, Maloney, et al., 2017, p. 2832). Clinical reasoning is a thought process that is a specific method of critical thinking. The process of clinical reasoning results in clinical judgment, which is nursing actions. Clinical reasoning is the core of the nursing process (see later discussion) (Alfaro-LeFevre, 2017).

The following factors are identified as critical components of clinical reasoning: communication and relationships, educational level, knowledge and ability to use critical thinking, familiarity with the environment and the context of care, experience and exposure to a variety of situations, as well as professionalism (Griffits et al., 2017). The skills involved in critical thinking are developed over time through effort, practice, and experience.

Rationality and Insight

Skills needed in critical thinking include interpretation, analysis, inference, explanation, evaluation, self-reflection, and self-regulation. Critical thinking requires strong background knowledge and knowledge of key concepts as well as logical thinking. Nurses use this disciplined process to validate the accuracy of data and the reliability of any assumptions they have made, and they then carefully evaluate the effectiveness of what they have identified as the necessary actions to take. Nurses also evaluate the reliability of sources, being mindful of and questioning inconsistencies. Nurses use interpretation to determine the significance of data that are gathered, analysis to identify patient problems suggested by the data, and inference to draw conclusions. Explanation is the justification of actions or interventions used to address patient problems and to help patients move toward desired outcomes. Evaluation is the process of determining whether outcomes have been or are being met. Self-regulation is the process of examining the care provided and adjusting the interventions as needed. All processes are iterative.

Critical thinking is also reflective, involving metacognition, active evaluation, and refinement of the thinking process. Metacognition involves reflective thinking as well as awareness of the nursing skills needed for patient-centered care (Alfaro-LeFevre, 2017). Nurses engaged in critical thinking consider the possibility of cultural differences and personal bias when interpreting data and determining appropriate actions (see Chapter 4 for further discussion). Critical thinkers must be insightful and have a sense of fairness and integrity; the courage to question personal ethics; and the perseverance to strive continuously to minimize the effects of egocentricity, ethnocentricity, and other biases on the decision making process (Alfaro-LeFevre, 2017).

Components of Critical Thinking

Certain cognitive or mental activities are key components of critical thinking as it relates to nurses. Critical thinkers (Alfaro-LeFevre, 2017):

- Identify the priorities that will determine the nurse's plan of patient-centered care.
- Gather pertinent data from the patient's chart and assessments to determine why certain developments have occurred and to determine if additional data are needed to address the situation accurately.
- Validate the information presented to make sure that it is accurate and compare it with any preexisting data. Information should be evidence based.
- Analyze the information to determine its significance and to identify the formation of clusters or patterns that point to certain conclusions.
- Utilize logical thinking, past clinical experiences, theoretical knowledge, and intuitive thinking to assess the status of the patient's condition. Anticipate the patient's needs and outcomes while acknowledging personal bias and cultural influences.
- Maintain a flexible attitude that facilitates thinking and inquiry and consider all possibilities.
- Utilize inductive and deductive reasoning to identify available options and analyze each in terms of its advantages and disadvantages.
- Formulate decisions that reflect creativity and independent decision making.
- Demonstrate personal humility in terms of one's knowledge deficits and willingly seek additional information to assist with decision making.
- Exhibit the courage to seek new, innovative approaches to patient-centered care. Detach their personal viewpoints from situations and look at things objectively, a process called *bracketing*.

Critical thinking requires going beyond basic problem solving into a realm of inquisitive exploration, looking for all relevant factors that affect the issue, and being an "out-of-the-box" thinker. Nurses' ongoing quest for "best practice" clearly demonstrates intellectual integrity, a component of critical thinking.

Critical Thinking and Clinical Reasoning in Nursing Practice

Critical thinking and decision making are thought to be associated with improved clinical expertise. Critical thinking is the foundation of the process of clinical reasoning and clinical judgment (Alfaro-LeFevre, 2017). Using critical thinking to develop a plan of nursing care requires considering the human factors that might influence the plan. Nurses interact with patients, families, and other health care providers in the process of providing appropriate, individualized nursing care.

Nurses must use critical thinking skills in all practice settings—acute care, ambulatory care, extended care, and the home and community—and must view each patient situation as unique and dynamic. The unique factors that patients and nurses bring to the health care situation are considered, studied, analyzed, interpreted, and evaluated. Interpretation of the information then allows nurses to focus on those factors that are most relevant and most significant to the clinical situation. Decisions about a nursing plan, priority of actions, and measurable outcomes are developed into an action plan.

In decision making related to the nursing process, nurses use cognitive and metacognitive skills as well as logical reasoning to set priorities. These skills include systematic and comprehensive assessment, recognition of assumptions, inconsistencies and biases, verification of reliability and accuracy, identification of missing information, distinguishing relevant from irrelevant information, support of the evidence with facts and conclusions, priority setting with timely decision making, determination of patient-specific outcomes, and reassessment of responses and outcomes (Alfaro-LeFevre, 2017). All of these data are examined within the context of a solid knowledge base. For example, Goodrich, Wagner-Johnston, and Delibovi (2017) describe how oncology nurses use critical thinking, clinical reasoning, and decision making skills in identifying and managing complications of novel and complex therapies for cancer treatment when they:

- Develop greater knowledge of potential adverse events by examining evidence-based guidelines.
- Partner with the patient and family to better understand how treatments impact activities of daily living, quality of life, and overall symptom burden.
- Distinguish potential complications from expected manifestations associated with the underlying cancer diagnosis.
- Collaborate with interprofessional team members to modify treatment plans based on assessment data.

Because developing the skill of critical thinking involves experiential learning and practice, critical thinking exercises are offered at the end of each chapter as a means of honing the reader's ability to think critically. Some exercises include questions that stimulate the reader to seek information about EBP relative to the clinical situation described, others challenge the reader to identify priority assessments and interventions, while others challenge the reader to describe the

role of the nurse as a member of the interprofessional collaborative team, as noted previously. Additional exercises may be found in the study guide that accompanies the text. The questions listed in Chart 1-1 can serve as a guide in working through the exercises. It is important to remember that each clinical situation is unique and calls for an individualized approach that fits its unique set of circumstances. As critical thinking may require consideration of ethical principles and cultural contexts, these concepts are discussed in this chapter and in Chapter 4.

The Nursing Process

The **nursing process** is a deliberate problem-solving approach for meeting people's health care and nursing needs. Although the steps of the nursing process have been stated in various ways by different writers, the common components cited are assessment, diagnosis, planning, implementation, and evaluation (Carpenito, 2017). The ANA's *Scope and Standards of Practice* (ANA, 2015b) includes an additional component entitled outcome identification, defined as identification of expected outcomes for a plan that is tailored to the patient's needs. The sequence of steps in this process is assessment, diagnosis, outcome identification, planning, implementation, and evaluation. For the purposes of this text, the nursing process is based on the traditional five steps and delineates two components in the diagnosis step: nursing diagnoses and collaborative problems. After the diagnoses or problems have been determined, the desired outcomes are often evident. The traditional steps are defined as follows:

1. ***Assessment:*** The systematic collection of data through interview, observation, and examination to determine the patient's health status as well as any actual or potential health problems. (Analysis of data is included as part of the assessment. Analysis may also be identified as a separate step of the nursing process.)
2. ***Diagnosis:*** Identification of the following two types of patient problems:
   - ***Nursing diagnoses:*** According to Carpenito (2017), "Are clinical judgments about individual, family, or community responses to actual or potential health problems/life processes" that can be managed by independent nursing interventions (p. 9).
   - ***Collaborative problems:*** According to Carpenito (2017), "Certain physiologic complications that nurses monitor to detect onset or changes in status. Nurses manage collaborative problems using physician- and nurse-prescribed interventions to minimize the complications of the events" (p. 9).
3. ***Planning:*** Development of measurable goals and outcomes as well as a plan of care designed to assist the patient in resolving the diagnosed problems and achieving the identified goals and desired outcomes.

Chart 1-1

The Inquiring Mind: Critical Thinking in Action

Throughout the critical thinking process, a continuous flow of questions evolves in the thinker's mind. It is not sufficient to rely solely on the acquisition of knowledge or a set of problem-solving skills; rather, it is the combination of one's application of knowledge, analysis of the situation, synthesis, and evaluation that promotes effective critical thinking inquiry. Although posing questions will vary according to the particular clinical situation, certain general inquiries can serve as a basis for reaching conclusions and determining a course of action.

When faced with a patient situation, seeking answers to some or all of the following questions may help to determine those actions that are most appropriate:

- What relevant assessment information do I need, and how do I interpret this information? What is the most effective way to gather this information? What does this information tell me? What contextual factors must be considered when gathering this information? What are the priority assessments?
- Have I identified the most important assessments and findings? Does the information I have gathered point to any other problems that I should consider?
- Have I gathered all of the necessary information (signs and symptoms, laboratory values, medication history, emotional factors, mental status)? Is anything missing?
- Is there anything that needs to be reported immediately? Do I need to seek additional assistance?
- What risks factors are specific to this patient? Which risk factors are of the highest priority? What must I do to minimize these risks?
- What possible complications must I anticipate?
- What are the most important problems in this situation? Do the patient and the patient's family recognize the same problems?
- What are the desired outcomes for this patient? Which have the highest priority? Do the patient and I agree on these points?
- What is going to be my first action in this situation? Why is this action a priority?
- How can I construct a plan of care to achieve the goals?
- Are there any age-related factors involved, and will they require some special approach? Will I need to make some change in the plan of care to take these factors into account?
- How do the family dynamics affect this situation, and will they affect my actions or the plan of care?
- Are there cultural factors that I must address and consider?
- Am I dealing with an ethical issue here? If so, how am I going to resolve it?
- Has any nursing research been conducted on this subject? What are the nursing implications of this research for care of this patient? What is the strength of the evidence found from research?

Adapted from Alfaro-LeFevre, R. (2017). *Critical thinking and clinical judgment: A practical approach* (6th ed.). Philadelphia, PA: Elsevier; Alfaro-LeFevre, R. (2019). Promoting critical thinking in frontline nurses. Retrieved on 2/29/2020 at: www.alfaroteachsmart.com

4. ***Implementation:*** Actualization or carrying out of the plan of care through nursing interventions.
5. ***Evaluation:*** Determination of the patient's responses to the nursing interventions and the extent to which the outcomes have been achieved.

Dividing the nursing process into distinct steps serves to emphasize the essential nursing actions that must be taken to address the patient's nursing diagnoses and manage any collaborative problems or complications. However, dividing the process into separate steps is artificial: The process functions as an integrated whole, with the steps being interrelated, interdependent, and recurrent (Fig. 1-3). Chart 1-2 presents an overview of the nursing activities involved in applying the nursing process. Note that the use of the nursing process requires critical thinking and consideration of common ethical principles to ensure that a truly comprehensive plan of care is developed.

Assessment

According to Carpenito (2017), the initial or baseline assessment is a systematic process of collecting predetermined data during the first contact with the patient. Data are gathered through the health history and the physical assessment. In addition, ongoing assessment and monitoring are crucial to remain aware of changing patient needs and the effectiveness of nursing care.

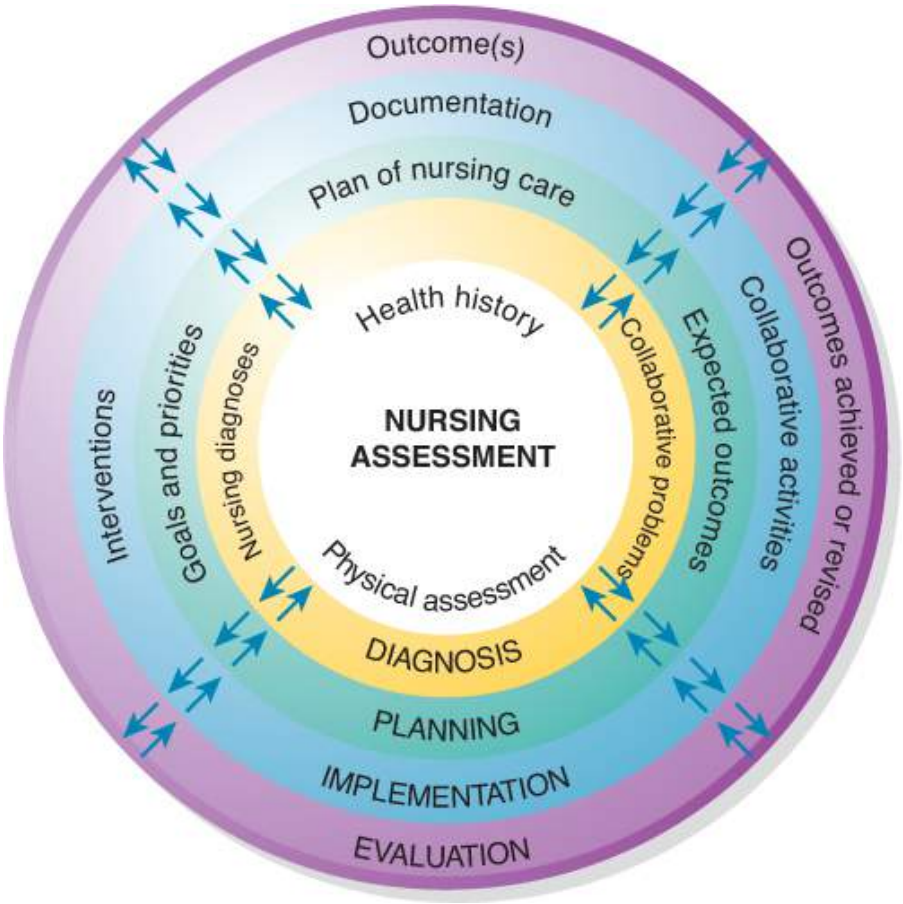


Figure 1-3 • The nursing process is depicted schematically in this circle. Starting from the innermost circle, nursing assessment, the process moves outward through the formulation of nursing diagnoses and collaborative problems; planning, with setting of goals and priorities in the nursing plan of care; implementation and documentation; and, finally, the ongoing process of evaluation and outcomes.

Chart 1-2

Steps of the Nursing Process

Assessment

1. Conduct the health history.
2. Perform the physical assessment.
3. Interview the patient's family or significant others.
4. Study the health record.
5. Organize, analyze, synthesize, and summarize the collected data.

Diagnosis

Nursing Diagnoses

1. Identify the patient's nursing problems or potential problems.
2. Identify the defining characteristics of the nursing problems.
3. Identify the etiology of the nursing problems.
4. State nursing diagnoses concisely and precisely.

Collaborative Problems

1. Identify potential problems or complications that require collaborative interventions.
2. Identify health care members with whom collaboration is essential.

Planning

1. Assign priority to the nursing diagnoses.
2. Specify the goals.
   a. Develop immediate, intermediate, and long-term goals.
   b. State the goals in realistic and measurable terms.
3. Identify nursing interventions appropriate for goal attainment.
4. Establish expected outcomes.
   a. Make sure that the outcomes are realistic and measurable.
   b. Identify critical times for the attainment of outcomes.
5. Develop the written plan of nursing care.
   a. Include nursing diagnoses, goals, nursing interventions, expected outcomes, and critical times.
   b. Write all entries precisely, concisely, and systematically.
   c. Keep the plan current and flexible to meet the patient's changing problems and needs.
6. Involve the patient, family or significant others, nursing team members, and other health care team members in all aspects of planning.

Implementation

Put the plan of nursing care into action.

1. Coordinate the activities of the patient, family or significant others, nursing team members, and other health care team members.
2. Record the patient's responses to the nursing actions.

Evaluation

1. Collect data.
2. Compare the patient's actual outcomes with the expected outcomes. Determine the extent to which the expected outcomes were achieved.
3. Include the patient, family or significant others, nursing team members, and other health care team members in the evaluation.
4. Identify alterations that need to be made in the nursing diagnoses, collaborative problems, goals, nursing interventions, and expected outcomes.
5. Continue all steps of the nursing process: assessment, diagnosis, planning, implementation, and evaluation.

Health History

The health history is conducted to determine a person's state of wellness or illness and is best accomplished as part of a planned interview. The interview is a personal dialogue between a patient and a nurse that is conducted to obtain information. The nurse's approach to the patient largely determines the amount and quality of the information received. To achieve a relationship of mutual trust and respect, the nurse must communicate a sincere interest in the patient. Examples of therapeutic communication techniques are found in Table 1-2**.**

A health history guide may help in obtaining pertinent information and directing the course of the interview. Various health history formats designed to guide the interview are available; however, they must be adapted to the responses, health problems, and needs of the person (see Chapter 4 for more information about the health history).

Physical Assessment

A physical assessment may be carried out before, during, or after the health history, depending on a patient's physical and emotional status and the immediate priorities of the situation. The purpose of the physical assessment is to identify those aspects of a patient's physical, psychological, and emotional state that indicate a need for nursing care. It requires the use of sight, hearing, touch, and smell as well as appropriate interview skills and techniques. Physical examination techniques, as well as techniques and strategies for assessing behaviors and role changes, are presented in Chapter 4 and in the first chapter of each unit of this book, beginning with Unit 4 and continuing through Unit 15.

Other Components of the Assessment

Additional relevant information should be obtained from the patient's family or significant others, from other members of the health care team, and from the patient's EHR. Depending on the patient's immediate needs, this information may have been completed before the health history and the physical assessment were obtained. A review of a past medical history or records from previous admissions may provide important information for consideration. Whatever the sequence of

events, the nurse should use all available sources of pertinent data to complete the nursing assessment.

Recording the Data

After the health history and physical assessment are completed, the information obtained is recorded in the patient's permanent record. These records are more commonly becoming electronic (i.e., EHRs). The ANA (2009) advocates that when EHRs are used, "patients should receive written, easily understood notification of how their health records are used and when their individually identifiable health information is disclosed to third parties" (p. 1). It is imperative that the patient's right to privacy and confidentiality are not violated through the use of EHRs. Regardless of whether the record is in a traditional paper format or an EHR, it must provide a means of communication among members of the health care team and facilitate coordinated planning and continuity of care (Räsänen & Günther, 2019). The record fulfills other functions as well:

TABLE 1-2 Select Therapeutic Communication Techniques

Technique	Definition	Therapeutic Value
Listening	Active process of receiving information and examining one's reactions to the messages received	Nonverbally communicates nurse's interest in the patient
Silence	Periods of no verbal communication among participants for therapeutic reasons	Gives patient time to think and gain insights, slows the pace of the interaction, and encourages the patient to initiate conversation while conveying the nurse's support, understanding, and acceptance
Restating	Repeating to the patient what the nurse believes is the main thought or idea expressed	Demonstrates that the nurse is listening and validates, reinforces, or calls attention to something important that has been said
Reflection	Directing back to the patient their feelings, ideas, questions, or content	Validates the nurse's understanding of what the patient is saying and signifies empathy, interest, and respect for the patient
Clarification	Asking the patient to explain what they mean or attempting to verbalize vague ideas or unclear thoughts of the patient to enhance the nurse's understanding	Helps to clarify the patient's feelings, ideas, and perceptions and to provide an explicit correlation between them and the patient's actions
Focusing	Questions or statements to help the patient develop, explore, or expand an idea or verbalize feelings	Allows the patient to discuss central issues and keeps communication goal directed
Broad openings	Encouraging the patient to select topics for discussion	Indicates acceptance by the nurse and the value of the patient's initiative
Humor	Discharge of energy through the comic enjoyment of the imperfect	Promotes insight by bringing repressed material to consciousness, resolving paradoxes, tempering aggression, and revealing new options; a socially acceptable form of sublimation
Informing	Providing information	Helpful in health teaching or patient education about relevant aspects of the patient's well-being and self-care
Sharing perceptions	Asking the patient to verify the nurse's understanding of what the patient is thinking or feeling	Conveys the nurse's understanding to the patient and has the potential to clarify confusing communication; may promote additional reflection
Theme identification	Underlying issues or problems experienced by the patient that emerge repeatedly during	Allows the nurse to best promote the patient's exploration and understanding of important problems

	the course of the nurse–patient relationship	
Suggesting	Presentation of alternative ideas for the patient's consideration relative to problem solving	Increases the patient's perceived options or choices

Adapted from Stuart, G. W. (2012). *Principles and practice of psychiatric nursing* (10th ed.). St. Louis, MO: CV Mosby.

- Serves as the legal and business record for a health care agency and for the professional staff members who are responsible for the patient's care. Various systems are used for documenting patient care, and each health care agency selects the system that best meets its needs.
- Serves as a basis for evaluating the quality and appropriateness of care and for reviewing the effective use of patient care services.
- Provides data that are useful in research, education, and short- and long-range planning.

Diagnosis

The assessment component of the nursing process serves as the basis for identifying nursing diagnoses and collaborative problems. Soon after the completion of the health history and the physical assessment, nurses organize, analyze, synthesize, and summarize the data collected and determine the patient's need for nursing care.

Nursing Diagnoses

Nursing diagnoses, the first taxonomy created in nursing, have fostered autonomy and accountability in nursing and have helped to delineate the scope of practice. Many state nurse practice acts include nursing diagnosis as a nursing function, and nursing diagnosis is included in the ANA's *Scope and Standards of Practice* (2015b) and the standards of nursing specialty organizations. Nursing diagnoses are routinely validated, refined, and updated to reflect current clinical practice and research.

NANDA International (NANDA-I; formerly known as the North American Nursing Diagnosis Association) was the first official organization responsible for developing the taxonomy of nursing diagnoses. In 2000, the International Classification for Nursing Practice (ICNP®) was established as an alternative system to support nursing care and standardization in documentation for practicing nurses at the point of care and across specialties (Coenen, 2003; International Council of Nurses [ICN], 2019). ICNP offers nursing diagnoses, intervention statements, and outcome statements designed to assist nurses within each step of the nursing process and all phases of care and was most recently updated in 2019. The nursing diagnoses used throughout this book are ICNP diagnoses. Because ICNP is proprietary to ICN, which has a global health focus, ICNP terms are spelled using the British method.

Choosing a Nursing Diagnosis

When identifying a nursing diagnosis for a particular patient, nurses must first identify the commonalities among the assessment data collected. These common features lead to the categorization of related data that reveal the existence of a problem and the need for nursing intervention. The identified problems are then defined as specific nursing diagnoses. Nursing diagnoses represent actual or potential health problems, state of health promotion, or potential risks that can be managed by independent nursing actions.

It is important to remember that nursing diagnoses are not medical diagnoses; they are not medical treatments prescribed by the primary provider, and they are not diagnostic studies. Rather, they are succinct statements of specific patient problems that guide nurses in the development of the plan of nursing care.

To give additional meaning to the nursing diagnosis, the characteristics and etiology of the problem are identified and included as part of the diagnosis. For example, the nursing diagnoses and their defining characteristics and etiology for a patient who has anemia may include the following:

- Activity intolerance associated with imbalance between supply and demand of oxygen
- Impaired peripheral tissue perfusion associated with decreased hemoglobin
- Impaired nutritional status associated with fatigue and inadequate intake of essential nutrients

Collaborative Problems

In addition to nursing diagnoses and their related nursing interventions, nursing practice involves certain situations and interventions that do not fall within the definition of nursing diagnoses. These activities pertain to potential problems or complications that are medical in origin and require collaborative interventions with the primary provider and other members of the health care team. The term *collaborative problem* is used to identify these situations.

Collaborative problems are certain physiologic complications that nurses monitor to detect changes in the status or onset of complications. Nurses manage collaborative problems using primary provider- and nurse-prescribed interventions to minimize complications (Carpenito, 2017). When treating collaborative problems, the primary nursing focus is monitoring patients for the onset of complications or changes in the status of existing complications. The complications are usually related to the disease process, treatments, medications, or diagnostic studies. The nurse recommends nursing interventions that are appropriate for managing the complications and implements the treatments prescribed by the patient's primary provider. According to Carpenito (2017), collaborative problems do not have patient goals; therefore, the approach to evaluation is different from a nursing diagnosis. The algorithm in Figure 1-4 depicts the differences between nursing diagnoses and collaborative problems.

After the nursing diagnoses and collaborative problems have been identified, they are recorded on the plan of nursing care.

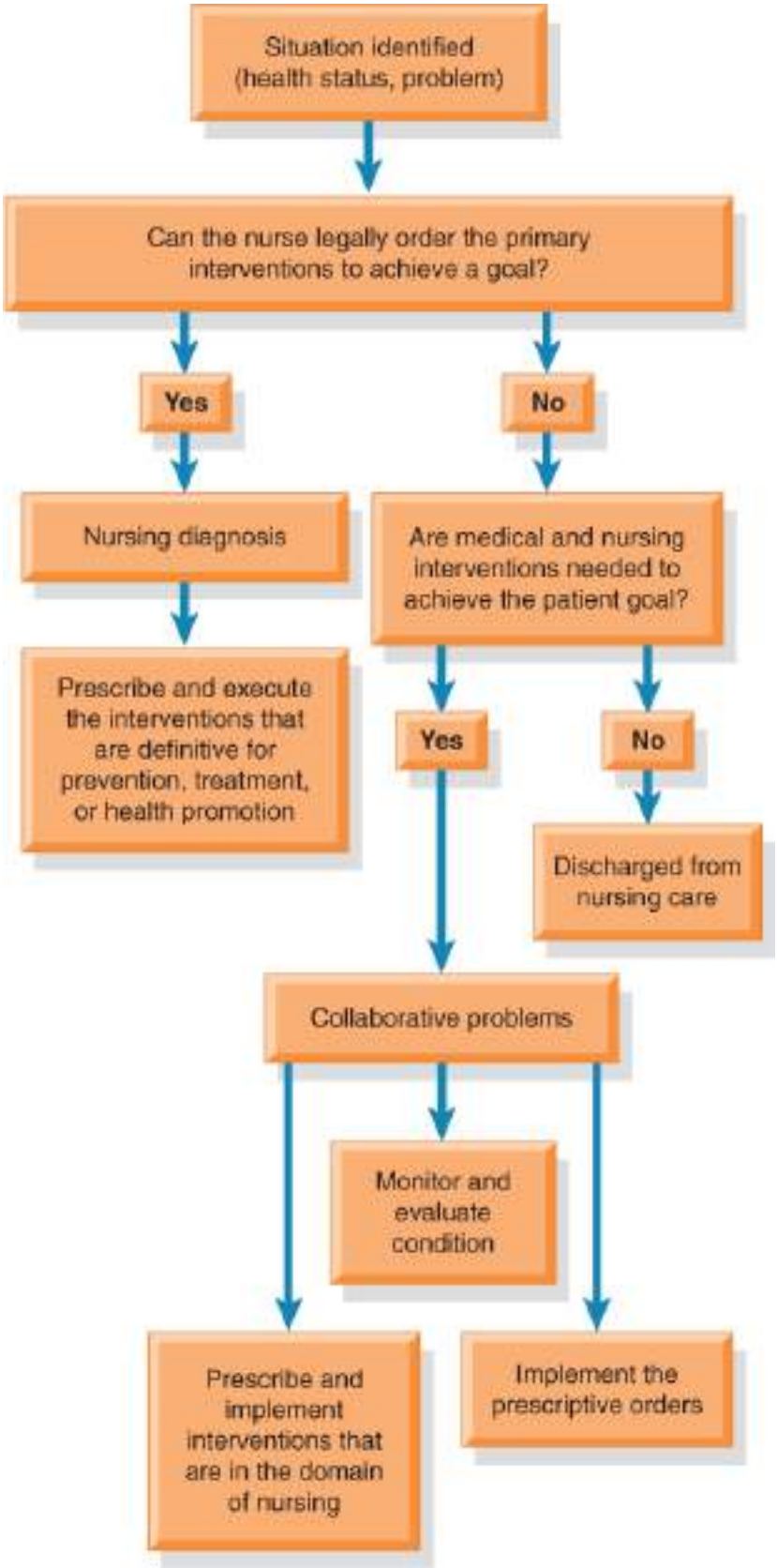


Figure 1-4 • Differentiating nursing diagnoses and collaborative problems. Redrawn with permission from Carpenito, L. J. (2017). *Nursing diagnosis: Application to clinical practice* (15th ed., p. 25). Philadelphia, PA: Lippincott Williams & Wilkins.

Planning

Once the nursing diagnoses have been identified, the planning component of the nursing process begins. This phase involves the following steps:

1. Assigning priorities to the nursing diagnoses and collaborative problems
2. Specifying realistic and measurable expected outcomes
3. Specifying the immediate, intermediate, and long-term goals of nursing action
4. Identifying specific nursing interventions appropriate for attaining the outcomes
5. Identifying interdependent interventions
6. Documenting the nursing diagnoses, collaborative problems, expected outcomes, nursing goals, and nursing interventions on the plan of nursing care
7. Communicating to appropriate personnel any assessment data that point to health care needs that can best be met by other members of the health care team

Setting Priorities

Assigning priorities to the nursing diagnoses and collaborative problems is a joint effort by the nurse and the patient or family members. Any disagreement about priorities is resolved in a way that is mutually acceptable. Consideration must be given to the urgency of the problems, with the most critical problems receiving the highest priority. Maslow Hierarchy of Needs provides one framework to prioritize problems (see previous discussion).

Establishing Expected Outcomes

Expected outcomes of the nursing interventions, identified either as long term or short term, are written in terms of the patient's behaviors and the time period in which the outcomes are to be met. The outcomes must be attainable and quantifiable (Carpenito, 2017). Resources for identifying appropriate expected outcomes include the ICNP and the standard outcome criteria developed by the Nursing Outcomes Classification (NOC) (Moorhead, Swanson, Johnson, et al., 2018) (Chart 1-3) and by health care agencies for people with specific health problems. These outcomes can be associated with nursing diagnoses and interventions and can be used when appropriate. However, the NOC may need to be adapted to establish realistic criteria for the specific patient involved.

The expected outcomes that define the patient's desired behavior are used to measure the progress made toward resolving the problem. The expected outcomes also serve as the basis for evaluating the effectiveness of the nursing interventions and for deciding whether additional nursing care is needed or whether the plan of care needs to be revised.

Establishing Goals

After the priorities of the nursing diagnoses and expected outcomes have been established, goals (immediate, intermediate, and long term) and the nursing actions appropriate for attaining the goals are identified. The patient and family are included in establishing goals for the nursing actions. Immediate goals are those that can be attained within a short time frame. Intermediate and long-term goals require a longer time frame to be achieved and usually involve preventing complications and other health problems and promoting self-care and rehabilitation. For example, goals for a patient with a nursing diagnosis of impaired mobility associated with pain and edema following total knee replacement may be stated as follows:

- Immediate goal: Stands at bedside for 5 minutes 6 to 12 hours after surgery
- Intermediate goal: Ambulates 15 to 20 minutes with walker or crutches in hospital and home
- Long-term goal: Ambulates independently 1 to 2 miles each day

Determining Nursing Actions

In planning appropriate nursing actions to achieve the desired goals and outcomes, the nurse, with input from the patient and significant others, identifies individualized interventions based on the patient's circumstances and preferences that address each outcome. Interventions should identify the activities needed, who will implement them, as well as the frequency. Determination of interdisciplinary activities is made in collaboration with other health care providers as needed. The patient's medications and other prescribed treatments should be integrated into the plan of care to assist the nurse in determining how all interventions contribute to resolution of the identified problems.

The nurse identifies and plans patient education as needed to assist the patient in learning certain self-care activities. Planned interventions should be ethical and appropriate to the patient's culture, age, developmental level, and gender. Standardized interventions, such as those found on standardized care plans, the ICNP, or in the Nursing Interventions Classification (NIC) (Butcher, Bulechek, Dochterman, et al., 2018) can be used. Chart 1-4 describes the NIC system and provides an example of an NIC system intervention. It is important to individualize prewritten interventions to promote optimal effectiveness for each patient. Actions of nurses should be based on established standards.

Implementation

The implementation phase of the nursing process involves carrying out the proposed plan of nursing care. The nurse assumes responsibility for implementation and coordinates the activities of all those involved in implementation, including the patient and family, and other members of the health care team so that the schedule of activities facilitates the patient's recovery. The plan of nursing care serves as the basis for implementation as such:

- The immediate, intermediate, and long-term goals are used as a focus for the implementation of the designated nursing interventions.
- While implementing nursing care, the nurse continually assesses the patient and the patient's individual response to the nursing care.
- Revisions are made in the plan of care as the patient's condition, problems, and responses change and when reordering of priorities is required.

Implementation includes direct or indirect execution of the planned interventions. It is focused on resolving the patient's nursing diagnoses and collaborative problems and achieving expected outcomes, thus meeting the patient's health needs. The following are examples of nursing interventions:

- Supervise the patient performing active range-of-motion exercises three times a day.

Chart 1-3

Nursing Outcomes Classification

The Nursing Outcomes Classification (NOC) is a classification of patient outcomes that are sensitive to nursing interventions. Each outcome is a neutral statement about a variable patient condition, behavior, or perception, coupled with a rating scale. The outcome statement and scale can be used to identify baseline functioning, expected outcomes, and actual outcomes for individual patients. The following table is an example of a nursing-sensitive outcome.

Cardiac Pump Effectiveness (0400)

Definition: Adequacy of blood volume ejected from the left ventricle to support systemic perfusion pressure.

Outcome Target Rating ***Maintain at*** _____ ***Increase to*** _____

Cardiac Pump Effectiveness Overall Rating		Severe Deviation From Normal Range 1	Substantial Deviation From Normal Range 2	Moderate Deviation From Normal Range 3	Mild Deviation From Normal Range 4	No Deviation From Normal Range 5	
Indicators							
040001	Systolic blood pressure	1	2	3	4	5	NA
040019	Diastolic blood pressure	1	2	3	4	5	NA
040002	Apical heart rate	1	2	3	4	5	NA
040003	Cardiac index	1	2	3	4	5	NA
040004	Ejection fraction	1	2	3	4	5	NA
040006	Peripheral pulses	1	2	3	4	5	NA
040007	Heart size	1	2	3	4	5	NA
040020	Urine output	1	2	3	4	5	NA
040022	24-hour intake and output balance	1	2	3	4	5	NA
040025	Central venous pressure	1	2	3	4	5	NA
		Severe	**Substantial**	**Moderate**	**Mild**	**None**	
040009	Neck vein distention	1	2	3	4	5	NA
040010	Dysrhythmia	1	2	3	4	5	NA
040011	Abnormal heart sounds	1	2	3	4	5	NA
040012	Angina	1	2	3	4	5	NA
040013	Peripheral edema	1	2	3	4	5	NA
040014	Pulmonary edema	1	2	3	4	5	NA
040015	Diaphoresis	1	2	3	4	5	NA
040016	Nausea	1	2	3	4	5	NA
040017	Fatigue	1	2	3	4	5	NA
040023	Dyspnea at rest	1	2	3	4	5	NA
040026	Dyspnea with mild exertion	1	2	3	4	5	NA
040024	Weight gain	1	2	3	4	5	NA
040027	Ascites	1	2	3	4	5	NA
040028	Hepatomegaly	1	2	3	4	5	NA
040029	Impaired cognition	1	2	3	4	5	NA
040030	Activity intolerance	1	2	3	4	5	NA
040031	Pallor	1	2	3	4	5	NA
040032	Cyanosis	1	2	3	4	5	NA
040033	Flushed	1	2	3	4	5	NA

Used with permission from Moorhead, S., Swanson, E., Johnson, M., et al. (Eds.). (2018). *Nursing outcomes classification (NOC)* (6th ed.). St. Louis, MO: Mosby-Elsevier.

- Teach the patient who is postoperative to use an incentive spirometer 10 times every hour while awake.
- Monitor the patient for adverse effects of opioid analgesic medications, including sedation and respiratory depression.
- Assist the patient in developing a plan to reduce dietary sodium and increase daily activity.
- Administer sublingual nitroglycerin as prescribed to the patient who complains of angina.

- Assess electrolyte levels prior to administering scheduled intravenous diuretics.

Chart 1-4

Nursing Interventions Classification

The Nursing Interventions Classification (NIC) is an in-depth, evidence-based taxonomy of interventions that includes independent and collaborative interventions. These interventions are performed in a variety of health care settings. Intervention labels are terms such as *bleeding precautions, medication administration,* or *pain management: acute.* Listed under each intervention are multiple discrete nursing actions that together constitute a comprehensive approach to the treatment of a particular condition. Not all actions are applicable to every patient; nursing judgment and critical thinking will determine which actions to implement. The following is an example of a nursing intervention:

Fluid Resuscitation

Definition

Administering prescribed intravenous (IV) fluids rapidly

Activities

Obtain and maintain a large-bore IV.
Collaborate with primary providers to ensure administration of both crystalloids (e.g., normal saline and lactated Ringer's) and colloids (e.g., Hesban, and Plasmanate), as appropriate.
Administer IV fluids, as prescribed.
Obtain blood specimens for crossmatching, as appropriate.
Administer blood products, as prescribed.
Monitor hemodynamic response.
Monitor oxygen status.
Monitor for fluid overload.
Monitor output of various body fluids (e.g., urine, nasogastric drainage, and chest tube).
Monitor BUN, creatinine, total protein, and albumin levels.
Monitor for pulmonary edema and third spacing.

Used with permission from Butcher, H. K., Bulecheck, G. M., Dochterman, J. M., et al. (Eds.). (2018). *Nursing interventions classification (NIC)* (7th ed.). St. Louis, MO: Elsevier.

- Check gastric residuals in the patient receiving tube feedings before each feeding.

Clinical judgment, critical thinking, and good decision-making skills are essential in the selection of appropriate evidence-based and ethical nursing interventions. All nursing interventions are patient centered and outcome directed

and are implemented with compassion, skill, confidence, and a willingness to accept and understand the patient's responses.

Concept Mastery Alert

Implementation is nursing action. Therefore, statements involving implementation always start with a verb.

Although many nursing actions are independent, others are interdependent, such as carrying out prescribed treatments, administering medications and therapies, and collaborating with other health care team members to accomplish specific expected outcomes and to monitor and manage potential complications. Such interdependent functioning is just that—interdependent. Requests or prescriptions from other health care team members should not be followed blindly but must be assessed critically and questioned when necessary. The implementation phase of the nursing process ends when the nursing interventions have been completed.

Evaluation

Evaluation, the final step of the nursing process, allows the nurse to determine the patient's response to the nursing interventions and the extent to which the objectives have been achieved. The plan of nursing care is the basis for evaluation. The nursing diagnoses, collaborative problems, priorities, nursing interventions, and expected outcomes provide the specific guidelines that dictate the focus of the evaluation. Through evaluation, the nurse can answer the following questions:

- Were the nursing diagnoses and collaborative problems accurate?
- Did the patient achieve the expected outcomes within the critical time periods?
- Have the patient's nursing diagnoses been resolved?
- Have the collaborative problems been resolved?
- Do priorities need to be reordered?
- Have the patient's nursing needs been met?
- Should the nursing interventions be continued, revised, or discontinued?
- Have new problems evolved for which nursing interventions have not been planned or implemented?
- What factors influenced the achievement or lack of achievement of the objectives?
- Should changes be made to the expected outcomes and outcome criteria?

Objective data that provide answers to these questions are collected from all available sources (e.g., patients, families, significant others, health care team

members). These data are included in patients' records and must be substantiated by direct patient observation before the outcomes are documented.

Documentation of Outcomes and Revision of the Plan

Outcomes are documented concisely and objectively. Documentation should relate outcomes to the nursing diagnoses and collaborative problems, describe the patient's responses to the interventions, indicate whether the outcomes were met, and include any additional pertinent data. As noted previously, the nurse individualizes a plan of care for each patient's particular circumstances. Chart 1-5 gives an example of a plan of nursing care that has been developed for a 22-year-old woman admitted to a postoperative surgical unit after having an emergent laparoscopic appendectomy.

The plan of care is subject to change as a patient's needs change, as the priorities of needs shift, as needs are resolved, and as additional information about a patient's state of health is collected. As the nursing interventions are implemented, the patient's responses are evaluated and documented, and the plan of care is revised accordingly. A well-developed, continuously updated plan of care is the greatest assurance that the patient's nursing diagnoses, and collaborative problems are addressed, and their basic needs are met.

Chart 1-5 **PLAN OF NURSING CARE**

Example of a Plan of Nursing Care for a Patient Post Laparoscopic Appendectomy

NURSING DIAGNOSIS: Acute pain
GOAL: Relief of pain and discomfort

Nursing Interventions	Rationale	Expected Outcomes
1. When taking vital signs, use pain scale to assess pain and discomfort characteristics: location, quality, frequency, durations, etc., at baseline and on an ongoing basis.	1. Provides baseline data.	• Reports decreased level of pain and discomfort on pain scale.
2. Assure the patient that you know that pain is real and will assist in reducing it.	2. Fear that pain will not be considered real increases anxiety and reduces pain tolerance.	• Reports less disruption in activity and quality of life from pain and discomfort.
3. Assess other factors contributing to patient's pain: fear; fatigue; other symptoms; psychosocial and/or spiritual distress, etc.	3. Provides data about factors that decrease patient's ability to tolerate pain and increase pain level.	• Reports decrease in other symptoms and psychosocial distress.
4. Administer prescribed analgesic regimen, and provide education to patient and family regarding regimen.	4. Analgesics tend to be more effective when given early in pain cycle, around the clock at regular intervals, or when given in long-acting forms; breaks the pain cycle; premedication with analgesics is used for activities that cause increased pain or breakthrough pain.	• Adheres to analgesic regimen as prescribed. • Barriers to adequately addressing pain do not interfere with strategies for managing pain.
5. Address myths or misconceptions and lack of knowledge about use of opioid analgesics.	5. Barriers to adequate pain management involve patients' fear of side effects, fatalism about the possibility of achieving pain control, fear of distracting providers from treating the postoperative pain, belief that pain is	• Takes an active role in administration of analgesia. • Identifies additional effective pain relief strategies. • Uses previously employed successful pain relief strategies appropriately.
6. Collaborate with patient, primary provider/surgeon, and other health care team members when changes in pain management are necessary.		• Reports effective use of nonpharmacologic pain relief

7. Encourage strategies of pain relief that patient has used successfully in previous pain experience. 8. Offer nonpharmacologic strategies to relieve pain and discomfort: distraction, guided imagery, relaxation, cutaneous stimulation, therapeutic touch, Reiki, etc.	indicative of progressive disease, and fears about addiction. Professional health providers also have demonstrated limited knowledge about pain management, potential analgesic side effects, and management and risk of addiction. 6. New methods of administering analgesia must be acceptable to the patient, primary provider/surgeon, and health care team to be effective; patient's participation decreases sense of powerlessness. 7. Encourages success of pain relief strategies accepted by patient and family. 8. Increases options and strategies available to patient that serve as adjuncts to pharmacologic interventions.	strategies and a decrease in pain. • Reports that decreased level of pain permits early ambulation postoperatively.

NURSING DIAGNOSIS: Risk for infection (i.e., wound infection, pneumonia, urinary tract infection [UTI])
GOAL: No evidence of infection

Nursing Interventions	Rationale	Expected Outcomes
1. Assess wound site for signs of infection	1. Some manifestations of	• No drainage, increased

or increased inflammation:

a. If there is a dressing or bandage present, verify whether and when it will be changed by the primary provider/surgeon.
b. Note the color, consistency, and amount of drainage, if present; if so, also note if any odor is present; notify the primary provider/surgeon as indicated.
c. Note any changes in appearance of wound over time, particularly if it becomes increasingly edematous or erythematous.

2. Monitor vital signs, temperature, and laboratory results (if available) for signs of infection.

3. Monitor for manifestations of atelectasis or pneumonia.

a. Assess for adventitious lung sounds (e.g., rales, wheezes) or for decreased air movement.

inflammation are to be expected (e.g., wound tenderness, slight erythema, and edema); however, this should decrease over time and there should be no evidence of an infection at the wound site.

a. The primary provider/surgeon may wish to remove the first dressing or bandage, to assess the status of the wound and presence of drainage firsthand.
b. Drainage may indicate an infectious process, particularly if it is malodorous.
c. Increased wound edema or erythema may indicate an infection.

2. Changes in vital signs, particularly temperature, may suggest an infection; if these changes are marked, they may suggest sepsis (see Chapter 11 for further discussion of the clinical manifestations of

erythema, or edema at the laparoscopic wound site.
- Temperature within normal limits (i.e., between 36.1°C [97°F] and 38.0°C [100.4°F]).
- Lung sounds clear to auscultation; no cough.
- Voids clear yellow urine without complaints of burning on micturition or feelings of bladder fullness.
- Laboratory results, if assessed, are within normal limits.

b. Encourage early movement (e.g., demonstrate and encourage use of incentive spirometer, encourage early ambulation).

c. Preemptively treat postoperative pain, as described above.

4. Monitor micturition status; note when patient first voids, the amount, and if there are any complaints of burning or bladder fullness; notify the primary provider/surgeon as indicated; monitor laboratory results, including the CBC and urinalysis as indicated.

sepsis); laboratory results, particularly the presence of leukocytosis with a shift to the left on the differential of the white blood cell count (WBC) on the complete blood count (CBC), may suggest an infection is present. Postoperatively, most patients will have a slightly elevated temperature (up to 38.0°C [100.4°F]), which is consistent with the inflammatory process. A temperature higher than this in a previously healthy adult suggests some type of underlying infectious process.

3. Atelectasis and pneumonia are prevalent postoperative pulmonary complications (see Chapter 16, Table 16-4).

a. Lung sounds should be clear to auscultation bilaterally; the presence of adventitious sounds may suggest the development of atelectasis or pneumonia; diminished lung

sounds may suggest poor air movement from splinting respirations, which can lead to respiratory compromise.

b. Movement mobilizes respiratory secretions and respiratory effort.

c. Pain interferes with the ability to move; pain results in splinting of respiratory effort.

4. Urinary retention and urinary tract infections are prevalent postoperative complications (see Chapter 16, Table 16-4); CBC results may reveal leukocytosis with a shift to the left on the WBC differential; urinalysis results may reveal the presence of blood cells (e.g., red blood cells [RBCs], WBCs) that may suggest a urinary tract infection.

NURSING DIAGNOSIS: Impaired nutritional status associated with perioperative *nil per os* (NPO) status
GOAL: Will consume typical diet by discharge

Nursing Interventions	Rationale	Expected Outcomes
1. Assess for return of gastrointestinal function postoperatively. a. Auscultate for the presence of bowel sounds. b. Ask the patient if they have passed flatus. c. Encourage early ambulation as this will assist with return of gastrointestinal function.	1. Gastrointestinal motility is diminished post surgery; peristalsis should return within hours and is evidenced by return of bowel sounds and passing of flatus.	• Will advance diet, as tolerated. • No complaints of nausea.
2. Advance diet as tolerated and prescribed by primary provider/surgeon. a. Assess for complaints of nausea. If present, may give antiemetic medications as prescribed (e.g., ondansetron) and delay advancement of diet.	2. Patient will need to demonstrate ability to tolerate fluids and food prior to discharge. a. Complaints of nausea are prevalent post laparoscopic surgery; if patient vomits, that may delay recovery (e.g., disrupt wound, delay intake of nutrients); administering antiemetic medications may preempt complications.	

NURSING DIAGNOSIS: Activity intolerance associated with fatigue post surgery
GOAL: Participation in activities of daily living within tolerance

Nursing Interventions	Rationale	Expected Outcomes
1. Assess factors contributing to activity intolerance and fatigue. 2. Promote atmosphere conducive to physical and mental rest: a. Encourage alternation of rest and activity. b. Encourage limitation of visitors and stress-producing interactions.	1. Indicates factors contributing to severity of fatigue 2. Promotes rest, activity tolerance, and decreased overall stress	• Identifies factors contributing to fatigue • Alternates periods of rest and activity • Limits visitors to ensure adequate rest periods
NURSING DIAGNOSIS: Lack of knowledge regarding methods to ensure postoperative recovery **GOAL:** Increased knowledge about expected postoperative recovery and transition back to preoperative baseline functional status		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Educate patient on expectations for recovery, discharge, and transition to home. a. Demonstrate wound care to patient, as prescribed by primary provider/surgeon; ask patient to return demonstrate wound care. b. Educate patient on use of prescribed analgesic medications	1. Inpatient recovery time after a laparoscopic appendectomy is short (e.g., 1 day, assuming there are no complications [see Chapter 16, Table 16-4]); therefore, preparing patient for discharge must commence expeditiously.	• Demonstrates appropriate care of wound. • Verbalizes understanding of continued analgesic regimen, including when to take prescriptive analgesic medications (e.g., oxycodone), and whether there are any activity restrictions associated with their use (e.g., no driving).

(e.g., oxycodone), including actions, indications, side effects, and when to take them (e.g., prior to ambulation). c. Educate patient on activity restrictions (e.g., bathing, lifting, return to work or school) as prescribed by primary provider/surgeon. d. Educate patient on when to follow up with primary provider/surgeon postoperatively, for scheduled postoperative appointment and as needed.	• Verbalizes understanding of activity restrictions, including bathing, lifting, return to work/school, as prescribed by primary provider/surgeon. • Verbalizes adherence to scheduled postoperative appointment.

Frameworks for a Common Approach to Nursing

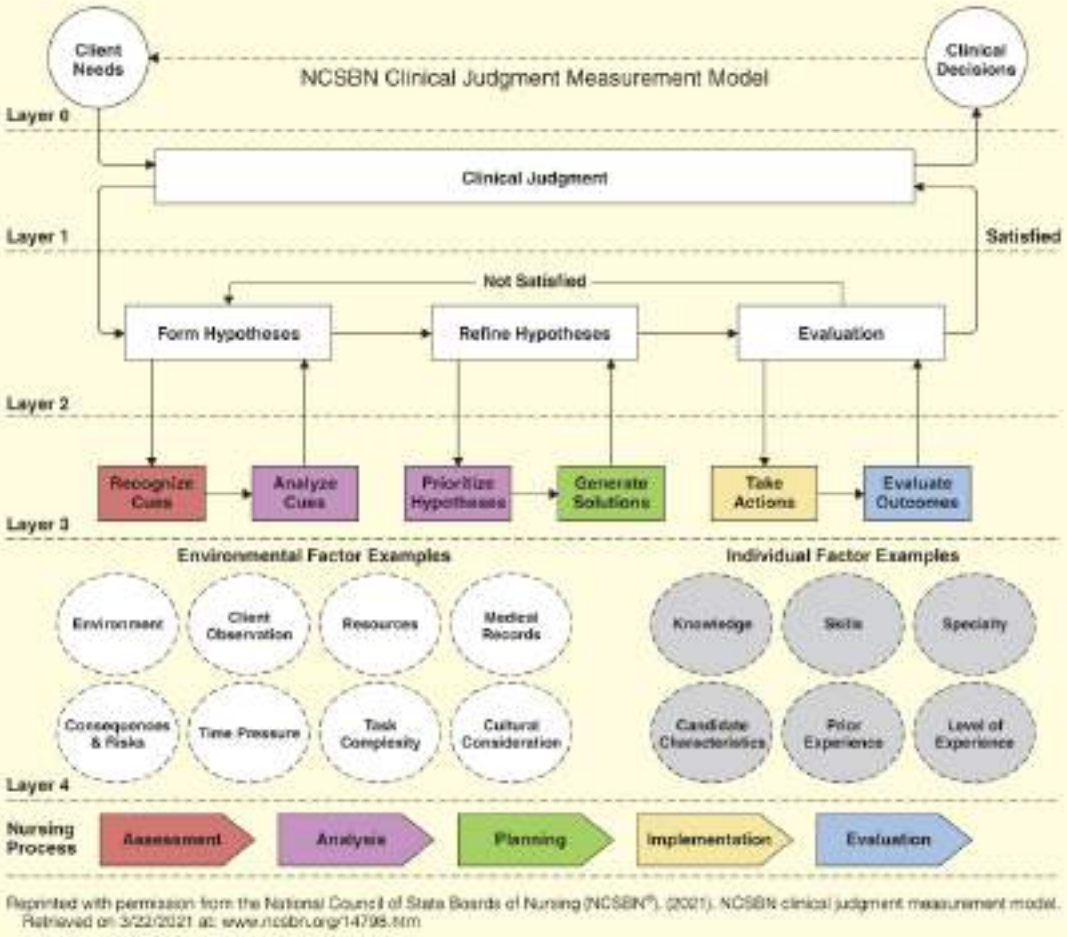
Various frameworks or taxonomies can be used for determining nursing diagnoses, establishing outcomes, designing interventions, and guiding clinical decision making. Ultimately, a framework that uses a language common to all aspects of nursing, regardless of the classification system, is desirable. In 2001, a taxonomy of nursing practice was developed for the harmonization of NANDA-I, NIC, and NOC. This three-part combination links nursing diagnoses, accompanying interventions, and outcomes, organizing them in the same way. Similarly, the ICNP has developed catalogues that align nursing diagnoses, outcome statements, and intervention statements. Such organization of concepts in a common language or taxonomy may facilitate the process of clinical judgment and critical thinking, because interventions and outcomes are more accurately matched with appropriately developed nursing diagnoses (Carpenito, 2017). More recently, the National Council of State Boards of Nursing (NCSBN®) developed the NCSBN Clinical Judgment Measurement Model, which offers a framework to measure clinical decision making and clinical judgment in the context of the National Council Licensure Examination (NCLEX-RN® examination; see Chart 1-6). Figure 1-5 illustrates the application of this model to the nursing process.

Ethical Nursing Care

In the complex health care world, nurses are faced with numerous ethical issues. Consequently, there has been a heightened interest in the field of ethics in an attempt to gain a better understanding of how these issues can be addressed. Specifically, the focus on ethics in health care has intensified in response to controversial developments, including advanced technology, genomics, medical futility, scarcity of resources, and end-of-life issues, to name a few.

Chart 1-6

The NCSBN Clinical Judgment Measurement Model



Reprinted with permission from the National Council of State Boards of Nursing (NCSBN®). (2021). NCSBN clinical judgment measurement model. Retrieved on 3/22/2021 at: www.ncsbn.org/14798.htm

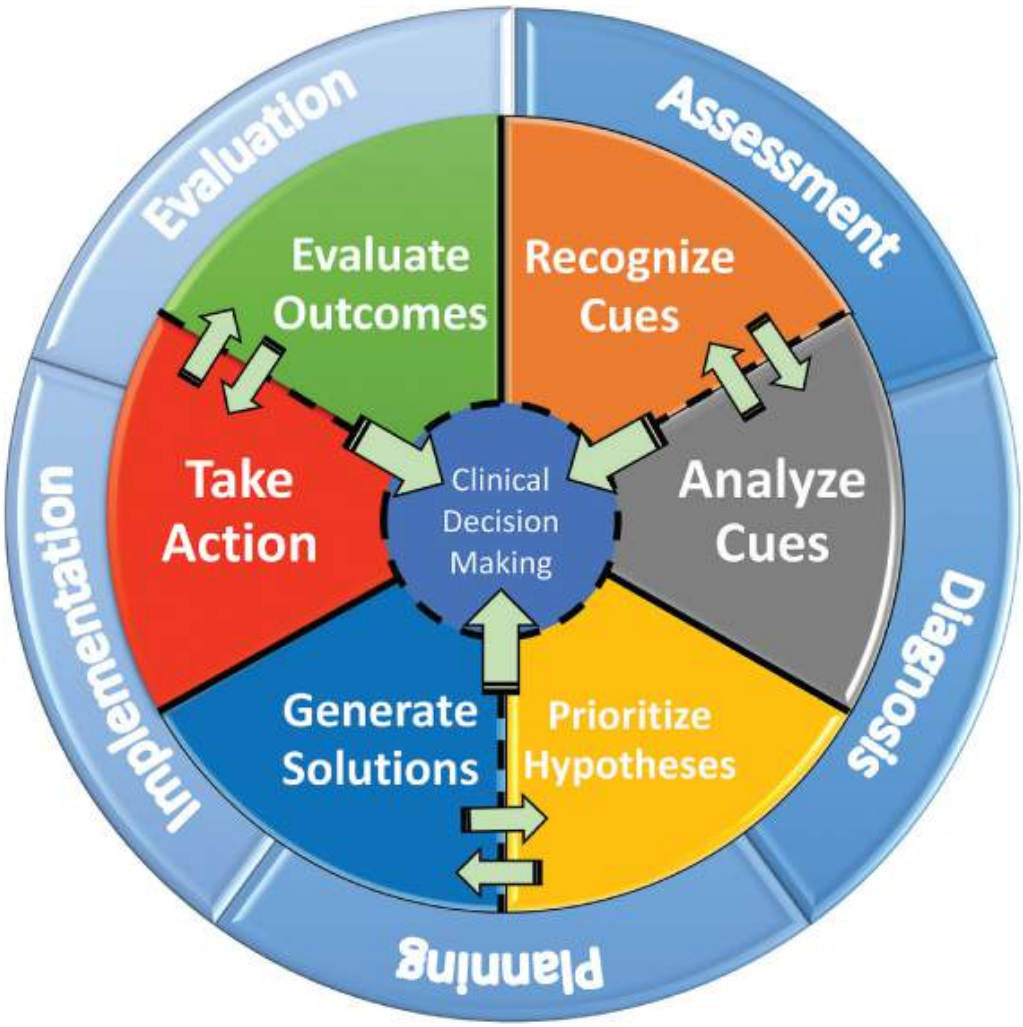


Figure 1-5 • Clinical judgment domains. Reprinted with permission from Brenton, A. & Petersen, E. K. (2019). *Next generation NCLEX® (NGN) Educator Webinar Part I*. Chicago, IL: National Council of State Boards of Nursing (NCSBN®).

Today, sophisticated technology can prolong life well beyond the time when death would have occurred in the past. Expensive experimental procedures, clinical trials, complex equipment and treatments are available to prolong life, even when such attempts may not provide quality of life. The development of technologic support has influenced the quality and delivery of nursing care at all stages of life and also has contributed to an increase in average life expectancy. For example, robotic technology is helping older adults living in the community to better manage chronic health problems (Bakas, Sampsel, Israel, et al., 2018). Adults with end-stage heart failure who are not candidates for cardiac transplantation can live longer with the support of newer generation left ventricular assist devices (LVADs), which require less invasive surgery and are associated with less complications than older model LVADs (Kubrusly, 2019). Advances in immunotherapy have increased life expectancies for patients diagnosed with advanced stage melanomas and nonsquamous cell lung cancers

(Munro, 2019). Patients who would have died of organ failure are living longer because of organ transplantation and stem cell transplant.

These advances in technology have been a mixed blessing. Questions have been raised about whether it is appropriate to use such technology and, if so, under what circumstances. Although many patients do achieve a good quality of life, others face extended suffering as a result of efforts to prolong life, usually at great expense both emotionally and financially. Ethical issues also surround those practices or policies that seem to allocate health care resources unjustly on the basis of age, race, gender, disability, or social mores. Older adults may be at risk for being denied health care because of their advanced age and the bias known as ageism (see Chapter 8 for a further discussion of ageism).

Ethical dilemmas that nurses may encounter in the medical-surgical nursing arena are diverse and occur in all settings. An awareness of underlying concepts helps nurses use reason to work through these dilemmas. Basic concepts related to moral philosophy, such as ethics and its principles, theories, and approaches, are included in this chapter. Understanding the role of the professional nurse in ethical decision making not only helps nurses articulate their ethical positions and develop the skills needed to make ethical decisions, but also helps them use the nursing process to develop plans of care from an ethical perspective.

Ethics versus Morals

The terms *ethics* and *morality* are used to describe beliefs about right and wrong and to suggest appropriate guidelines for action. In essence, **ethics** is the formal, systematic study of moral beliefs to understand, analyze, and evaluate matters of right and wrong; whereas, **morality** includes specific values, characters, or actions whose outcomes are often examined through systematic ethical analysis. Because the distinction between ethics and morality is slight, the terms are often used interchangeably.

Ethics Theories

One classic theory in ethics is teleologic theory or consequentialism, which focuses on the ends or consequences of actions. The best-known form of this theory, utilitarianism, is based on the concept of "the greatest good for the greatest number." The choice of action is clear under this theory, because the action that maximizes good over bad is the correct one. The theory poses difficulty when one must judge intrinsic values and determine whose good is the greatest. In addition, it is important to ask whether good consequences can justify any amoral actions that might be used to achieve them.

Chart 1-7 **ETHICAL DILEMMA**

Common Ethical Principles

The following common ethical principles may be used to validate moral claims.

Autonomy

This word *autonomy* is derived from the Greek words *autos* ("self") and *nomos* ("rule" or "law") and therefore refers to self-determination. The principle of autonomy entails the right of patients to receive adequate and accurate information so that they have the ability to make a choice free from external constraints. It is synonymous with self-determination.

Beneficence and Nonmaleficence

Beneficence is the duty to perform acts that can be of benefit others. It also entails taking positive action to prevent patients from harming themselves or others, including society as a whole. There is also an implied commitment to help people with disability.

Nonmaleficence is the duty to not inflict harm. The only time when it is considered morally permissible to exercise power over a competent person against their will is when by doing so, harm to others is prevented.

Double Effect

The double effect is a principle that may morally justify some actions that produce both good and evil effects.

All four of the following criteria must be fulfilled:

1. The action itself is good or morally neutral.
2. The agent sincerely intends the good and not the evil effect (the evil effect may be foreseen but is not intended).
3. The good effect is not achieved by means of the evil effect.
4. There is proportionate or favorable balance of good over evil.

Distributive Justice

From a broad perspective, justice states that like cases should be treated alike. More specifically, distributive justice is an ethical principle commonly applicable to clinical situations. This principle is upheld when benefits and burdens are distributed equitably and fairly without consideration of age, gender, socioeconomic status, religion, ethnicity, or sexual orientation. Simply stated, there is an ethical obligation to distribute or allocate resources fairly.

Adapted from Beauchamp, T. L., & Childress, J. F. (2019). *Principles of biomedical ethics* (8th ed.). New York: Oxford University Press.

Another theory in ethics is the deontologic or formalist theory, which argues that ethical standards or principles exist independently of the ends or consequences. In a given situation, nurses have a "sense of duty" to act based on the one relevant principle, or the most relevant of several ethical principles. Their actions must be independent of the ends or consequences. Problems arise with

this theory when personal and cultural biases influence the choice of the most primary ethical principle.

Approaches to Ethics

Two approaches to ethics are meta-ethics and applied ethics. An example of meta-ethics (understanding the concepts and linguistic terminology used in ethics) in the health care environment is analysis of the concept of informed consent. Nurses are aware that patients must give consent before surgery; however, sometimes a question arises as to whether a patient is truly informed and mentally competent. Delving more deeply into the concept of informed consent would be a meta-ethical inquiry (see Chapter 14 for more information about informed consent before surgery).

Applied ethics refers to identification of ethical problems relevant to a specific discipline and that discipline's practice. It addresses the implications of actions or practices in terms of their moral permissibility. Various disciplines use the frameworks of general ethical theories and principles and apply them to specific problems within their domain. Nursing ethics may be considered a form of applied ethics because it addresses moral situations that are specific to the nursing profession and patient care. Common ethical principles that can be used to validate moral claims in clinical practice include autonomy, beneficence and nonmaleficence, double effect, and distributive justice. Brief definitions of these important principles can be found in Chart 1-7**.**

Moral Situations

Many situations exist in which ethical analysis is needed. Some are **moral dilemmas,** or situations in which a clear conflict exists between two or more moral principles or competing moral claims, and nurses must choose the lesser of two evils. Other situations represent **moral problems,** in which there may be competing moral claims or principles, although one claim or principle is clearly dominant. Some situations result in **moral uncertainty,** when one cannot accurately define what the moral situation is or what moral principles apply but has a strong feeling that something is not right. Still other situations may result in **moral distress,** in which one is aware of the correct course of action, but institutional constraints stand in the way of pursuing the correct action. Altaker, Howie-Esquivel, and Cataldo (2018) found that moral distress in critical-care nurses was related to perceptions of a poor ethical climate and poor personal empowerment (see Nursing Research Profile in Chart 1-8).

Many scenarios may occur in clinical practice that require an ethical analysis. For example, an older adult patient with a history of advanced dementia and heart failure is admitted to the hospital with shortness of breath and diagnosed with aspiration pneumonia. This is the patient's third hospitalization in the last year for aspiration pneumonia. The patient fails a swallow evaluation and the speech-language pathologist recommends that the patient remain NPO (nothing by mouth). The primary provider coordinates a family meeting to discuss options for

nutrition which include inserting a percutaneous feeding tube or carefully hand feeding the patient to promote comfort. The team learns that the patient never completed a living will or assigned a health care representative. The patient's son recalls his mother telling him once on a trip to Italy that "eating was one of her greatest pleasures." However, the patient's daughter is adamant that her mother receives a feeding tube, despite learning that feeding tubes do not increase survival and are associated with complications in patients with significant cognitive deficits. Both the son and daughter have a close relationship with their mother, but neither have had a formal discussion with her about her end-of-life wishes. They do not have any other siblings and their father died several years ago suddenly from a cerebral aneurysm. The son is reluctant to go against his sister's wishes. The nurse has worked with other patients and families in similar situations and knows that his role is to advocate for his patient. He is familiar with current literature which suggests enteral feedings do not improve nutritional or functional status in this population and feels strongly that a feeding tube will not enhance the patient's quality of life. The primary provider is concerned that the daughter will create "problems" for the hospital if a feeding tube is not inserted and states that "he does not have time to deal with her" so schedules the patient for the procedure. The nurse feels strongly that this is the wrong decision and that the daughter would benefit from more education and time to process this complex decision. However, the nurse does not feel empowered to voice his concerns to the primary provider and is left feeling a sense of moral distress; he knows the right course of action, but institutional factors, including existing power hierarchies among nurses and primary providers and lack of time and additional supportive services, prevent him from acting. The nurse wishes that he had had more time to discuss this case with his charge nurse or nurse manager, or to consult the palliative care team which is not in the hospital on the weekends, and today is a Saturday.

Chart 1-8 NURSING RESEARCH PROFILE

Moral Distress in Critical-Care Nurses

Altaker, K. W., Howie-Esquivel, J., & Cataldo, J. K. (2018). Relationships among palliative care, ethical climate, empowerment, and moral distress in intensive care unit nurses. *American Journal of Critical Care*, *27*(4), 295–302.

Purpose

Between 10% and 29% of patients admitted to intensive care units (ICUs) die. Difficulty delivering adequate end-of-life comfort care can cause moral distress among nurses who work in ICUs. Delivering quality comfort care can be predicated upon the ability of the critical-care nurses to appropriately access palliative care services. Moral distress may also be affected by the overall ethical climate in the ICU, as well as by the personal sense of empowerment by the individual critical-care nurse. Therefore, the purpose of this study was to evaluate relationships between critical-care nurses' moral distress, palliative care service access, ICU ethical climate, and personal empowerment.

Design

A Web-based survey was sent to a nationally representative sample of critical-care nurses who belonged to the American Association of Critical-Care Nurses. In order to be eligible for the study, participants had to be currently working as a direct provider of nursing care in an adult ICU and had to have provided care to at least one dying patient within the past 6 months. Of those who agreed to participate, 235 completed all survey items. Items included in the survey were derived from psychometrically validated instruments including the Moral Distress Scale-Revised, the Hospital Ethical Climate Survey, and the Psychological Empowerment Instrument. In addition, survey items that assessed participants' perceptions of access to, use of, and barriers to palliative care in the ICU were developed and included in the survey.

Findings

Moral distress was negatively associated with feelings of empowerment ($r = -0.145$; $p = 0.02$) and with the ICU ethical climate ($r = -0.354$; $p < 0.001$). Multiple regression analysis found that the factors that contributed to variance in moral distress included the ICU ethical climate, access to palliative care services, size of the ICU, and personal characteristics of the nurse, such as ethnicity and educational level. The factor that contributed the most to moral distress was the ICU ethical climate, with a positive ICU ethical climate correlating with lower levels of moral distress.

Nursing Implications

Findings from this study suggest that critical-care nurses who feel less empowered also feel greater moral distress; however, this relationship was not clear when the variable of ICU ethical climate was analyzed. It seems that personal characteristics of the critical-care nurse, including feelings of empowerment, as well as the ethical climate within the ICU, have roles in determining whether the critical-care nurse experiences moral distress. An unexpected finding was that critical-care nurses who reported access to

palliative care services reported greater moral distress. The quality of the interprofessional relationships between critical-care nurses and interdisciplinary members of palliative care teams must be explored. Further studies must be conducted to better discern the causes of moral distress among critical-care nurses so that appropriate interventions may be targeted to mitigate moral distress, which can cause nurse burnout and patient care avoidance.

It is essential that nurses freely engage in dialogue concerning moral situations, even though such dialogue is difficult for everyone involved. Improved interdisciplinary collaboration is supported when all members of the health care team can voice their concerns and come to an understanding of the moral situation. Consultation with an ethics committee could be helpful to assist the health care team, patient, and family to identify the moral dilemma and possible approaches to the dilemma (see the Ethics Committees section). Nurses should be familiar with agency policy supporting patient self-determination and resolution of ethical issues.

Types of Ethical Problems in Nursing

As a profession, nursing is accountable to society. Nursing has identified its standards of accountability through formal codes of ethics that explicitly state the profession's values and goals. The ICN has endorsed a globally applicable *Code of Ethics for Nurses* (ICN, 2012). Likewise, the ANA established a *Code of Ethics for Nurses* that includes ethical standards, each with its own interpretive statements (ANA, 2015a). The interpretive statements provide guidance to address and resolve ethical dilemmas by incorporating universal moral principles. In addition, the ANA sponsors a Center for Ethics and Human Rights that contains a repository of position statements that can be used to guide nursing practice (Chart 1-9).

Ethical issues have always affected the role of professional nurses. The accepted definition of professional nursing not only supports the advocacy role for nurses, but also the claim that nurses must be actively involved in the decision making process regarding ethical concerns surrounding health care and human responses. Nurses are morally obligated to present ethical conflicts within a logical, systematic framework. Health care settings in which nurses are valued members of the team promote interdisciplinary communication and may enhance patient care. The nurse presented in the case study in the previous section is morally obligated to address his concerns constructively. He should carve out the time to discuss his concerns within his chain of command, through notifying his charge nurse of his concerns for the patient. To practice effectively in these settings, nurses must be aware of ethical issues and serve as patient advocates to assist patients in asserting their autonomy in decision making.

Chart 1-9

Position Statements from the American Nurses Association Center for Ethics and Human Rights

Position Statement	Latest Approval/Revision Date
Addressing Nurse Fatigue to Promote Safety and Health	Revised 9/10/14
Capital Punishment and Nurses' Participation in Capital Punishment	Revised 2016
Euthanasia, Assisted Suicide, and Aid in Dying	Revised 4/24/19
Nurse's Role in Providing Ethically and Developmentally Appropriate Care to People with Intellectual and Developmental Disabilities	Approved 10/10/19
Nursing Advocacy for LGBTQ+ Populations	Approved 4/19/18
Nursing Care and Do Not Resuscitate (DNR) and Allow Natural Death (AND)	Approved 3/12/12
Nutrition and Hydration at the End of Life	Revised 6/7/17
Privacy and Confidentiality	Revised 6/2015
Reduction of Patient Restraint and Seclusion in Health Care Settings	Approved 3/12/12
Registered Nurses' Role and Responsibilities in Providing Expert Care and Counseling at End of Life	Revised 2016
Risk and Responsibility in Providing Nursing Care	Approved 6/2015
Stem Cell Research	Approved 1/10/07
The Nurses' Role in Ethics and Human Rights: Protecting and Promoting Individual Worth, Dignity, and Human Rights in Practice Setting	Approved 2/2016
Therapeutic Use of Marijuana and Related Cannabinoids	Revised 2016

Nursing theories that incorporate the biopsychosocial–spiritual dimensions emphasize a holistic viewpoint, with humanism or caring at the core. Caring and compassion are often cited as virtues inherent within the moral foundation for professional nursing practice. For nurses to embrace this professional ethos, they must be aware not only of major ethical dilemmas but also of those daily interactions with health care consumers that frequently give rise to less easily identifiable ethical challenges. Although technologic advances and diminished resources have been instrumental in raising numerous ethical questions and controversies, including life-and-death issues, nurses should not ignore the many routine situations that involve ethical considerations. Some of the most common issues faced by nurses today include confidentiality, the use of restraints, truth-telling, refusing to provide care, and end-of-life decisions and palliative care.

Confidentiality

All nurses should be aware of the confidential nature of information obtained in daily practice. Confidentiality acknowledges and respects each person's privacy. If information is not pertinent, nurses should question whether it is prudent to document it in a patient's record. In the practice setting, discussion of patients

with other members of the health care team is often necessary. However, these discussions should occur in a private area where it is unlikely that the conversation will be overheard. Nurses should also be aware that the use of family members or hospital ancillary personnel as interpreters for patients who are not fluent in English language or who are deaf violates patients' rights of confidentiality. Translation services should be provided for non–English-speaking patients, and interpreters should be provided for those who use sign language by the hospital or institution.

Another threat to confidentiality is the widespread use of computer-based technologies, particularly EHRs, and people's easy access to them. The growing demand for telehealth innovations and the increasing use of this method can result in unchecked access to health information. In addition, personal and health information is often made available to numerous individuals and corporate stakeholders, which may increase the potential for misuse of health care information. Because of these possibilities of maleficence, sensitivity to the principle of confidentiality is essential. The ANA (2015) published a position statement that addresses patients' rights to privacy and confidentiality of their health information.

Federal legislation has been developed to protect the right of confidentiality. According to the Health Insurance Portability and Accountability Act (HIPAA) (HHS, 2003), efforts must be made to protect each patient's private health information (PHI), whether it is transmitted by verbal, written, or electronic means of communication. Communication should be confined to the appropriate settings and with appropriate individuals and should occur for the appropriate purposes of facilitating patient care. Violations of protection of any patient's privacy could result in criminal or civil litigation (HHS, 2003).

Restraints

The use of restraints (including physical and pharmacologic measures) and patient seclusion are additional issues with ethical overtones because of the limits on a person's autonomy and human dignity when these measures are used. Nurses must weigh carefully the risks of limiting autonomy and increasing the risks of injury by using restraints against the risks of injury if not using restraints, which have been documented as resulting in physical harm and death. The ANA (2012) advocates that in situations where restraints and seclusion must be used, all staff must be educated on safety measures. In addition, there must be adequate staff that are vigilant in monitoring their use. These interventions may be utilized only when there is no other viable option available. **The Joint Commission,** a nonprofit organization that accredits hospitals and health care organizations, and CMS have designated standards for the use of restraints (see The Joint Commission and CMS Web sites listed in the Resources section).

Trust Issues

Truth-telling or veracity is one of the basic principles in the nurse–patient relationship. Truth-telling is based upon the principle of autonomy; it requires that the nurse understands and supports patient self-determination (Beauchamp & Childress, 2019). For example, failure to disclose a diagnosis to a patient deprives the person of the right to make informed decisions. Three ethical dilemmas in clinical practice that can directly conflict with this principle are the use of placebos (nonactive substances used for treatment), not revealing a diagnosis to a patient, and revealing a diagnosis to people other than the patient with the diagnosis. All involve the issue of trust, which is an essential element in the nurse–patient relationship.

Placebos may be used in experimental research, in which a patient is involved in the decision making process and is aware that placebos are being used in the treatment regimen. However, the use of a placebo as a substitute for an active drug to show that a patient does not have actual symptoms of a disease is deceptive, has both ethical and legal implications, and severely undermines the nurse–patient relationship.

Informing a patient of his or her diagnosis when the family and primary provider have chosen to delay full disclosure of pertinent information is an ethical dilemma that can occur in nursing practice. The nurse may experience moral distress when asked by the patient for a truthful diagnosis. The nurse may use evasive comments with the patient in these situations. This area is indeed complex, because it challenges a nurse's **moral integrity.** Nurses could consider the following strategies:

- Avoid lying to the patient.
- Provide all information related to nursing procedures and diagnoses.
- Act as a patient advocate and communicate the patient's requests for information to the family and primary provider. The family is often unaware of the patient's repeated questions to the nurse. With a better understanding of the situation, the family members may change their perspective.
- Make a referral to the institution's ethics committee.

Although providing the information may be the morally appropriate behavior, the manner in which the patient is told is important. Nurses must be compassionate and caring when informing patients; disclosure of information merely for the sake of patient autonomy does not convey respect for others and in some circumstances may result in emotional distress. Family support or the support of a spiritual advisor (e.g., chaplain) may be needed to reduce the impact of distressing information or a poor prognosis.

Disclosing the patient's diagnosis to others without the patient's consent is a HIPAA violation and therefore is not only unethical but also illegal. Failure to protect the patient's right to privacy and a breach of confidentiality is unethical.

Refusing to Provide Care

Any nurse who feels morally obliged to refuse to provide care for a particular type of patient faces an ethical dilemma. Reasons for refusal range from a conflict of personal values to a fear that the nurse would place either the patient or self in jeopardy. Feelings related to care of people of different ethnicities or sexual orientation also surface as societal changes emerge. The ethical obligation to care for all patients is clearly identified in the *Code of Ethics for Nurses* (ANA, 2015a). Accordingly, the nurse must give patient-centered care to all patients, regardless of their socioeconomic status, sexual orientation, gender expression, ethnicity, or proximity to death. In particular, patients facing end-of-life decisions must receive supportive care, which must be extended to their family and surrogate decision makers (ANA, 2015a).

End-of-Life Issues

Dilemmas that center on death and dying are prevalent in medical-surgical nursing practice. With the availability of increasingly sophisticated and advanced technology, it may be difficult to accept that nothing more can be done to prolong life or that technology may prolong life but at the expense of the patient's comfort and quality of life. When providing end-of-life care, nurses serve as the patient's advocate and manage pain and suffering. Nurses have the moral obligation to facilitate a patient's right to self-determination. Furthermore, nurses should facilitate end-of-life discussions between the patient and the family in order to prevent suffering and preserve the patient's dignity (ANA, 2015a).

Many people who are terminally ill seek legal options for a peaceful and dignified death. Nurses who deliver palliative care must understand that their actions are targeted at relieving pain and suffering and not hastening death. According to Provision 1.4 of the *Code of Ethics for Nurses,* "The nurse should provide interventions to relieve pain and other symptoms in the dying patient consistent with palliative care practice standards and may not act with the sole intent to end life (2015a, p. 3)," even if the intent to end life is motivated by compassion or respect for patient autonomy.

End-of-life issues shift the focus from curative care to palliative and end-of-life care. Focusing on the caring as well as the curing role may help nurses deal with these difficult moral situations. Needs of patients and families require holistic and interdisciplinary approaches. End-of-life issues that often involve ethical dilemmas include pain control, "do not resuscitate" (DNR) orders, life support measures, and administration of food and fluids. These issues are discussed in detail in Chapter 13.

Preventive Ethics

When a nurse is faced with two conflicting alternatives, it is the nurse's moral responsibility to choose the lesser of the two evils. These situations often result in feelings of moral distress in the nurse who is obliged to make a choice.

Patient Self-Determination

Frequently, dilemmas occur when health care practitioners are unsure of the patient's wishes because the patient is unconscious or mentally incompetent and cannot communicate. The Patient Self-Determination Act, enacted in December 1991, encourages people to prepare advance directives in which they indicate their wishes concerning the degree of supportive care they wish if they become incapacitated. This legislation requires that patients be informed about advance directives by the staff of the health care facility.

Advance directives are legal documents that specify a person's wishes before hospitalization and provide valuable information that may assist health care providers in decision making. A living will is one type of advance directive. Typically, living wills are limited to situations in which the patient's medical condition is deemed terminal. Because it is difficult to define *terminal* accurately, living wills are not always honored. Another potential drawback is that living wills are frequently written while people are in good health. It is not unusual for people to change their minds as an illness progresses; therefore, patients retain the option to nullify these documents.

Identifying a health care representative, in which one person identifies another person to make health care decisions on his or her behalf, is another type of advance directive. It is the responsibility of the health care representative to act as the patient stated in the advance directive. For example, patients may have clarified their wishes concerning various medical situations. If there is no advance directive, the health care representative must act in good faith and make decisions that they believe the patient would make if mentally competent. Laws concerning advance directives vary among state jurisdictions. However, even in states where these documents are not legally binding, they provide helpful information to determine the patient's prior expressed wishes in situations in which this information can no longer be obtained.

Advance directives are limited in scope to hospital and long-term care facility environments. Emergency medical system (EMS) personnel (e.g., paramedics) therefore cannot legally follow advance directives. Yet, there are many patients with debilitating long-term chronic and eventually fatal illnesses who reside at home. Some of these patients may not wish to have invasive, life-sustaining emergency interventions should their status rapidly deteriorate. To protect the wishes of these patients to forego life-sustaining treatments, a document titled Physician Orders for Life-Sustaining Treatment (POLST) has been legally endorsed by many states. POLST gives EMS personnel the ability to rapidly determine whether a patient wishes to have cardiopulmonary resuscitation (CPR) or receive any type of emergency interventions that may sustain life in the event when the patient suddenly becomes incapacitated (National POLST Paradigm, 2019).

Ethics Committees

Institutional ethics committees exist in many hospitals to assist clinicians with ethical dilemmas. The purpose of these multidisciplinary committees varies among institutions. In some hospitals, the committees exist solely for the purpose

of developing policies; whereas in others, they may have a strong educational or consultation focus. Consultations can be conducted on the nursing unit, at the patient's bedside, or in a designated conference room. These committees usually are composed of people with some advanced training in ethics and are important resources for the health care team, patient, and family. Nurses with a particular interest or expertise in the area of ethics can serve as members of these committees, which are valuable resources for staff nurses. In addition, primary providers, social workers, and hospital chaplains are often members of the team.

Ethical Decision Making

Ethical dilemmas are common and diverse in nursing practice. Situations vary, and experience indicates that there are no clear solutions to these dilemmas (Beauchamp & Childress, 2019). However, the fundamental philosophical principles are the same, and the process of moral reflection helps nurses justify their actions. The systematic approach to ethical decision making can follow the steps of the nursing process. Ethics charts contained in all units within this text present case scenarios that challenge the reader to identify the ethical principles involved that may or may not be in conflict (Chart 1-10). Chart 1-10 outlines the steps of an ethical analysis that may be used to resolve the moral dilemmas presented in these charts.

Chart 1-10 ETHICAL DILEMMA

Steps of an Ethical Analysis

The following guidelines reflect an active process in decision making, similar to the nursing process detailed in this chapter. Nurses can use these guidelines to engage in ethical decision making. Key resources that may assist in ethical decision making are also included.

Assessment

1. Once the ethical issue has been identified, assess the ethical/moral situations of the problem. This step entails recognition of the ethical, legal, and professional dimensions involved.
   - **a.** Does the situation entail substantive moral problems (conflicts among ethical principles or professional obligations)? Examine the ethical issue using the principles of autonomy, beneficence, justice, and nonmaleficence.
   - **b.** Are there procedural conflicts? (e.g., Who should make the decisions? Any conflicts among the patient, health care providers, family, and guardians?)
   - **c.** Identify the significant people involved and those affected by the decision.
   - **d.** Identify agency or hospital policy or protocol to use when a conflict exists. Is there an ethics committee or council? How is an ethics consult made, and who may request this consultation? What other resources are available to help resolve this conflict?

Planning

2. Collect information.
   - **a.** Include the following information: the medical facts, treatment options, nursing diagnoses, legal data, and the values, beliefs, cultures, and religious components.
   - **b.** Make a distinction between the factual information and the values/beliefs.
   - **c.** Validate the patient's capacity, or lack of capacity, to make decisions.
   - **d.** Identify any other relevant information that should be elicited.
   - **e.** Identify the ethical/moral issues and the competing claims.
   - **f.** If it is an end-of-life issue, determine whether an advance directive exists and whether a medical power of attorney or a heath care representative has been identified.

Implementation

3. List the alternatives. Compare alternatives with applicable ethical principles and the 2015 ANA *Code of Ethics for Nurses.* Choose either of the frameworks that follow, or other frameworks, and compare outcomes.
   - **a.** *Utilitarian approach:* Predict the consequences of the alternatives; assign a positive or negative value to each consequence; choose the consequence that predicts the highest positive value or "the greatest good for the greatest number."
   - **b.** *Deontologic approach:* Identify the relevant moral principles; compare alternatives with moral principles; appeal to the "higher-level" moral principle if there is a conflict.

Evaluation

4. Decide and evaluate the decision.
   - **a.** What is the best or morally correct action?
   - **b.** Give the ethical reasons for your decision.
   - **c.** What are the ethical reasons against your decision or your biases?
   - **d.** How do you respond to the reasons against your decision?

Resources

American Nurses Association, Center for Ethics and Human Rights: An online resource that contains a repository of positions papers, codes, and other materials aimed at improving the ethical competence of nurses, www.nursingworld.org/ethics

The Hastings Center: A nonprofit, nonpartisan research institute dedicated to interdisciplinary bioethics, www.thehastingscenter.org

National Center for Ethics in Health Care: Provides key analysis of topics in health care ethics, publishes ethics-related news, and posts seminal national reports in ethics, www.ethics.va.gov

Adapted from Beauchamp, T. L., & Childress, J. F. (2019). *Principles of biomedical ethics* (8th ed.). New York: Oxford University Press.

CRITICAL THINKING EXERCISES

1 ebp Recently a team of staff nurses working on a pulmonary step-down unit was asked to examine the incidence of tracheotomy-related skin breakdown and found a 30% increase over the last year. The team reported these findings to the evidence-based practice council who determined the need to examine nursing interventions to improve skin integrity. As part of this team, what steps will you take to identify best practices? Based on this review, how will you determine which nursing practices would be most effective in helping to reduce the incidence of tracheotomy-related skin breakdown on your unit?

2 ipc You are part of an interprofessional team discussing the plan of care for a patient who experienced an ischemic stroke. After the meeting, the physical therapist asks you to explain how you formulate a nursing diagnosis and prioritize goals and interventions for your patients. How do you respond? The physical therapist also asks you for suggestions on ways the team could improve communication and teamwork to better address collaborative problems. Using professional practice guidelines, what recommendations do you share with the physical therapist?

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*Asterisk indicates nursing research article.
**Double asterisk indicates classic reference.

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2 Medical-Surgical Nursing

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Discuss principles of medical-surgical nursing practice as well as characteristics and settings of select nursing practice specialties in today's health care delivery system.
2. Describe the significance of the nurse as coordinator of care transitions.
3. Specify the components of a comprehensive assessment of functional capacity.
4. Use the nursing process as a framework for care of the patient with self-care deficits or with impaired physical mobility.
5. Describe the role and practice settings of home health nursing and the significance of continuity of care in transition into community or home settings.

NURSING CONCEPTS

Accountability
Collaboration
Evidence-Based Practice
Functional Ability
Mobility
Safety

GLOSSARY

activities of daily living (ADLs): personal care activities, such as bathing, dressing, grooming, eating, toileting, and transferring

adaptive device: a type of assistive technology that is used to change the environment or help the person modify the environment

assistive device: a type of assistive technology that helps people with disability perform a given task

assistive technology: any item, piece of equipment, or product system that is used to improve the functional capabilities of individuals with disability; this term encompasses both assistive devices and adaptive devices

critical-care nursing: a specialty area of practice that provides nursing services to critically ill patients across the lifespan in acute care settings such as the hospital intensive unit; current practice settings have expanded to include virtual care and community settings

home health nursing: a specialty area of practice that provides nursing services to patients across the lifespan in a home setting; practice roles include holistic care planning which incorporates resource and service coordination as part of an interdisciplinary team

impairment: loss or abnormality of psychological, physiologic, or anatomic structure or function at the organ level (e.g., dysphagia, hemiparesis); an abnormality of body structure, appearance, an organ, or system function resulting from any cause

instrumental activities of daily living (IADLs): complex skills needed for independent living, such as shopping, cooking, housework, using the telephone, managing medications and finances, and being able to travel by car or public transportation

medical-surgical nursing: a specialty area of practice that provides nursing services to patients from adolescence through the end of life in hospital-based and community-based settings

orthosis: an external appliance that provides support, prevents or corrects joint deformities, and improves function

prosthesis: a device used to replace a body part

rehabilitation: making able again; learning or relearning skills or abilities or adjusting existing functions to meet maximum potential

rehabilitation nursing: a specialty area of evidence-based practice that provides holistically-focused nursing services to patients who have been incapacitated by illness or injury or are facing potentially life-altering health conditions throughout their lifespan

rehospitalization: admission to the hospital within 30 days of a prior discharge from a hospitalization

telehealth: the use of technology to provide health care services

third-party payer: an organization or insurance company that provides reimbursement for services covered by a health plan

transfer: movement of a patient from one place to another, such as a bed to chair, chair to commode, or wheelchair to tub

transitional care: a process of ensuring consistency and coordination of care as patients move within and between health care settings

The profession of nursing is ever expanding to meet the health needs of patients, families, and communities. The practice of medical-surgical nursing continues to evolve, too, and is no longer restricted to the traditional environment of the inpatient hospital-based medical-surgical unit. The shift in delivery of medical-surgical nursing from only inpatient settings to also include outpatient settings is a result of multiple factors, including population trends (the growing number of older adults), changes in federal legislation, tighter insurance regulations, and decreasing hospital revenues. Transitions in the health care industry, the nursing profession, and changing patterns of disease and wellness have also affected the shift in care delivery settings. On an increasing basis, hospitals, health care organizations, and providers are held accountable for providing health care using best practices, as evidenced by meeting performance benchmarks for quality and efficiency; this system is known as pay for performance or value-based purchasing. Under this system, hospitals, health care organizations, and providers can reduce costs and earn additional income by carefully monitoring the types of services they provide, discharging patients as soon as possible, and keeping patients who are discharged from the hospital from being readmitted. Consequently, patients who transition from the hospital to the home or to residential or long-term care facilities are in the early stages of recovery. With these changes in health care delivery and accountability, specialty practices under the scope of medical-surgical nursing practice have arisen to further identify evidence-based nursing care and interventions. This chapter provides an overview of medical-surgical nursing and other associated nursing specialty practices.

The Practice of Nursing in Today's Health Care Delivery System

Novice, entry-level registered nurses, as well as those with advanced degrees who work in highly specialized settings, all engage in the practice of nursing. The American Nurses Association (ANA, 2015b) notes that the profession of nursing's scope of practice encompasses the full range of nursing practice, pertinent to general and specialty practice. "The depth and breadth in which individual registered nurses and advanced practice registered nurses engage in the total scope of nursing practice is dependent on education, experience, role, and the population served" (p. 2). The ANA (2015b, pp. 7–9) also identifies the following tenets characteristic of all nursing practice:

- Caring and health are central to the practice of the registered nurse.
- Nursing practice is individualized.

- Registered nurses use the nursing process to plan and provide individualized care for health care consumers (see Chapter 1).
- Nurses coordinate care by establishing partnerships.
- A strong link exists between the professional work environment and the registered nurse's ability to provide quality health care and achieve optimal outcomes.

The profession of nursing has a distinct disciplinary body of knowledge, education, and specialty standards of practice (ANA, 2015b); social contract (ANA, 2010; Fowler, 2015); and code of ethics (ANA, 2015a). Nursing's Standards of Practice describe basic competencies in delivering nursing care using the nursing process, whereas the Standards of Professional Performance describe expectations for behavioral competencies (ANA, 2015b, pp. 5–6), which include that the registered nurse:

- Practices ethically
- Practices in a manner that is congruent with cultural diversity and inclusion principles
- Communicates effectively in all areas of practice
- Collaborates with the health care consumer and other key stakeholders in the conduct of nursing practice
- Leads within the professional practice setting and the profession
- Seeks knowledge and competence that reflect current nursing practice and promote futuristic thinking
- Integrates evidence and research findings into practice
- Contributes to quality nursing practice
- Evaluates one's own and others' nursing practice
- Utilizes appropriate resources to plan, provide, and sustain evidence-based nursing services that are safe, effective, and fiscally responsible
- Practices in an environmentally safe and healthy manner

Medical-Surgical Nursing

Medical-surgical nursing is a specialty area of practice that provides nursing services to patients from adolescence through the end of life in a variety of inpatient and outpatient clinical settings. These settings may include traditional hospital medical-surgical units as well as intensive care units (ICUs), acute and subacute care rehabilitation units, clinics, ambulatory care units, urgent care centers, home health care agencies, and long-term care facilities (Academy of Medical-Surgical Nurses [AMSN], 2018; AMSN 2019). The *Scope and Standards of Medical-Surgical Nursing Practice* (AMSN, 2018) mirror the scope of practice and standards for practice set by the ANA (2015b) for professional nursing practice; the AMSN (2018) further delineates specific role expectations for the medical-surgical nurse. Medical-surgical nurses can demonstrate proficiency in

their role by completing certification requirements. They may also enhance practice by completing graduate degree programs in nursing (AMSN, 2018).

The Nurse as Coordinator of Care Transitions

Nearly one third of the $3.5 trillion spent on health care in the United States is spent on hospitalizations, including hospital readmissions within 30 days of a prior hospital discharge, called **rehospitalizations** (Centers for Medicare & Medicaid Services [CMS], 2018a). Rehospitalizations raise concerns not only about costs, but also about health care quality (Bailey, Weiss, Barrett, et al., 2019). Approximately 20% of patients insured by Medicare experience rehospitalization. Rehospitalizations in those over 65 years of age are not only costly; these patients may experience weakness and stress which can make them vulnerable to falls and other adverse events (Agency for Healthcare Research and Quality [AHRQ], 2019). Medicare is one example of a health insurance plan holding hospitals accountable for readmissions within 30 days of hospital discharge through a reduction in reimbursement for costs associated with these readmissions (Bailey et al., 2019). Rehospitalizations can result from breakdowns in care transitions including during the discharge planning processes, as evidenced by patients' inability to manage their own care; and, as a result of poor communication between the hospital and the next level of care (e.g., home health agency, primary care office) regarding patients' needs and resources (AHRQ, 2019). Altogether, these factors have led to an increasing focus on **transitional care,** a process of ensuring consistency and coordination of care as patients move within and between care settings (Carr, 2019). For example, transitional care takes place as a patient is transferred from intensive care to a medical-surgical unit within an acute care setting. Another important time of transitional care occurs with patient discharge from the acute care setting to continued care out in the community. See Chart 2-1 for a Nursing Research Profile on transitional care and the important components needed to assure positive outcomes during this transition process. A number of models and programs of transitional care describe the process as an interdisciplinary team approach in which team members include both the patient and the caregivers. Nurses in a variety of settings are important transitional care team members, managing many aspects of the transition process (Carr, 2019).

Chart 2-1 **NURSING RESEARCH PROFILE**

Important Components of Transitional Care

Naylor, M. D., Shaid, E. C., Carpenter, D., et al. (2017). Components of comprehensive and effective transitional care. *Journal of the American Geriatrics Society*, *65*(6), 1119–1125.

Purpose

Transitional care is recognized as important in assuring improved health care outcomes and health care quality while decreasing costs associated with unnecessary hospital readmissions. A national study called Project ACHIEVE that focused on Medicare beneficiaries was conducted to identify key aspects of transitional care that lead to positive patient and caregiver outcomes.

Design

Project ACHIEVE included experts, patients, and caregivers in a multimethod approach that included interviews, focus groups, and review of literature, which led to the identification and definition of critical components of transitional care. The working group collected case studies to evaluate how these components connect to the real experience of transitional care, selecting one case study for concept mapping of the components, all leading to further refinement of the critical components.

Findings

Eight core components were identified and visualized on a transitional care model: patient engagement, caregiver engagement, complexity management, patient education, caregiver education, patient and caregiver well-being, care continuity, and accountability. Each of the eight components was defined with examples of the issues as they related to patients and caregivers. Additional information provided suggestions for interdisciplinary interventions from the reviewed evidence.

Nursing Implications

Transitional care is a team approach that includes the patient and caregiver, and so research into transitional care should include these important stakeholders. The model and definitions for transitional care yielded from Project ACHIEVE provide a common framework for interdisciplinary health care team members who can then focus on providing optimal patient outcomes. Nurses who work in transitional care can utilize these core components in assessment of individual patients, and then tailor interventions to needed components. The model also provides a framework for program development, evaluation, and future refinement through additional investigation of transitional care.

Patient care must be coordinated seamlessly from the inpatient hospital environment through transitions into the community setting. Various nursing roles have evolved to provide improved care coordination and care transitions, including the nurse navigator, case manager, and the clinical nurse leader (CNL). Nurse navigators are registered nurses employed by hospitals and health networks

who work with a given population of patients with a common diagnosis or disease (e.g., cancer). Their role involves helping the patient and the patient's family transition through different levels of care (e.g., from hospital to a skilled nursing facility, from home care to assisted care). One example of an essential role function for the oncology nurse navigator (ONN) is education. In this role, the ONN assesses patients, families, and caregivers for their educational needs and recognizes barriers to education, which can impact health in areas such as diagnosis, treatment, and management of treatment associated side effects (Baileys, McMullen, Lubejko, et al., 2018).

Case management is a system of coordinating health care services to ensure cost-effectiveness, accountability, and quality care. Case managers may be nurses or may have backgrounds in other health professions, such as social work. The case manager coordinates the care of a caseload of patients through facilitating communication between nurses, other health care personnel who provide care, and insurance companies. In some settings, particularly the community setting, the case manager focuses on coordinating the treatment plan of the patient with complex conditions. The case manager may follow the patient throughout hospitalization and at home after discharge in an effort to coordinate health care services that will avert or delay rehospitalization. The caseload is usually limited in scope to patients with similar diagnoses, needs, and therapies (Case Management Society of America [CMSA], 2019).

A CNL is a certified nurse generalist with a master's degree in nursing educated to help patients navigate the complex health care system (American Association of Colleges of Nursing [AACN], 2019a). The CNL coordinates care for a distinct group of patients, may provide direct care as the situation warrants, and assumes a leadership role among members of the health care team. The CNL integrates evidence-based practices with advocacy, care coordination, outcomes measurement, risk assessment, quality improvement, and interprofessional communication skills (AACN, 2019a). Currently, CNLs are being utilized in hospital-based environments as well as in community settings.

Critical-Care Nursing

Critical-care nursing is a specialty area of practice that provides nursing services to critically ill patients across the lifespan, traditionally delivered in acute care settings such as the hospital ICU. Current practice settings for critical-care nursing have now expanded to include virtual care and a variety of community settings, including the home (American Association of Critical-Care Nurses [AACN], 2019b). When patients face actual or potential life-threatening illness, critical-care nurses provide holistic nursing interventions individualized to each patient.

The *Scope and Standards for Progressive and Critical-Care Nursing* (AACN, 2019b) mirror the scope and standards set by the ANA (2015b) for professional nursing practice; these are revised as needed based on health care trends and technologic advances in the care of patients facing critical illness. The AACN

(2019b) further delineates specific role expectations with the nursing process as the foundation and guide. For example, the standard of assessment includes competencies in holistic data collection based on current evidence and the recognition of assessment priorities for each individual patient. The current *Scope and Standards* (AACN, 2019b) recognize two types of nursing care provided by the progressive care nurse and the critical-care nurse. The progressive care nurse provides care for the acutely ill patient who is moving toward physiologic stability yet still at risk for life-threatening illness. The critical-care nurse provides care for those acute care patients with an actual or at high risk of life-threatening illness. The AACN also sets the standards for proficiency in progressive and critical-care nursing that may lead to specialty certification. In addition to specialty certification, there are opportunities for nurses to enhance critical-care nursing practice by completing graduate nursing programs leading to advanced practice as a critical-care clinical nurse specialist or acute care nurse practitioner.

The AACN recognizes the role of the critical-care nurse in care transitions and the need to begin discharge planning early, even during the critical or acute phase of hospitalization (Alspach, 2018). With caregiver tasks ranging from activities of daily living (ADLs) and instrumental activities of daily living (IADLs) (see later discussion) to advocacy and coordination, the critical-care nurse can involve family members or significant others of the patient who is critically ill in rounds and patient care planning, begin to assess their capabilities, and start the education needed so that family members or significant others can manage the role of caregiver.

Rehabilitation Nursing

Rehabilitation means to make able again; it involves learning or relearning skills or abilities or adjusting existing functions to meet maximum potential. Thus, rehabilitation is a goal-oriented process of caring for people with disability or chronic disorders. This philosophy of practice works to restore or optimize abilities rather than focus on disability (Association of Rehabilitation Nursing [ARN], 2013). Rehabilitation is an integral part of nursing because every major illness or injury carries the threat of disability or **impairment**, which involves a loss of function or an abnormality in body structure or function. **Rehabilitation nursing** is a specialty area of practice that focuses on returning patients to optimal functionality through a holistic approach to care that is based on scientific evidence (ARN, 2019a). The ARN has developed an *ARN Competency Model for Professional Rehabilitation Nurses* with resources. The domains in the model (nurse-led interventions, promotion of successful living, leadership and interprofessional care) encompass all competencies needed to promote rehabilitation nursing of people with disability and/or chronic illness (ARN, 2019b). The ARN further describes the roles of the rehabilitation nurse as teacher, caregiver, collaborator, and patient advocate working in a variety of inpatient and outpatient settings (ARN, 2019a).

Rehabilitation services are required by more people than ever before because of advances in technology that save or prolong the lives of seriously ill and injured patients and patients with disability. Increasing numbers of patients who are recovering from serious illnesses or injuries are returning to their homes and communities with ongoing needs. Significant disability caused by war and terrorism also increases the demand for rehabilitation services. All patients, regardless of age, gender, ethnic group, socioeconomic status, or diagnosis, have a right to rehabilitation services.

A person is considered to have a disability, such as a restriction in performance or function in everyday activities, if they have difficulty talking, hearing, seeing, walking, climbing stairs, lifting or carrying objects, performing ADLs, doing schoolwork, or working at a job. The disability is considered severe if the person cannot perform one or more activities, receives federal benefits because of an inability to work, uses an assistive device for mobility, or needs help from another person to accomplish basic activities. The purpose of **assistive technology** is to incorporate devices to improve the functional capabilities of people with disability; these may include any item, piece of equipment, or product system that may be acquired commercially, off the shelf, modified, or customized. Types of assistive technology may include **adaptive devices**, which help a person with a disability to either modify or change the environment (e.g., an access ramp used in place of steps for a person who uses a wheelchair), and **assistive devices,** which help a person with a disability perform a given task (e.g., a lap board with pictures used to assist a person who cannot talk to communicate) (see Chapter 7 for further discussion on disability).

Assessment of Functional Ability

Comprehensive assessment of functional capacity is the basis for developing a rehabilitation program. Functional capacity is a person's ability to perform ADLs and IADLs. **Activities of daily living (ADLs)** are those self-care activities that the patient must accomplish each day to meet personal needs; they include personal hygiene/bathing, dressing/grooming, feeding, toileting, and transferring. Many patients cannot perform such activities easily. **Instrumental activities of daily living (IADLs)** include those complex skills needed for independent living, such as meal preparation, grocery shopping, household and financial management, medication management, telephone usage, and transportation.

The nurse observes the patient performing specific activities (e.g., eating, dressing) and notes the degree of independence; the time taken; the patient's mobility, coordination, and endurance; and the amount of assistance required. The nurse also carefully assesses joint motion, muscle strength, cardiovascular reserve, and neurologic function, because functional ability depends on these factors as well. Observations are recorded on a functional assessment tool. These tools provide a way to standardize assessment parameters and include a scale or score against which improvements may be measured. They also clearly communicate the patient's level of functioning to all members of the rehabilitation team. Rehabilitation staff members use these tools to provide an initial assessment

of the patient's abilities and to monitor the patient's progress in achieving independence.

One of the most frequently used tools to assess the patient's level of independence is the Functional Independence Measure (FIM™) (Keith, Granger, Hamilton, et al., 1987). The FIM is a minimum data set, measuring 18 self-care items including eating, bathing, grooming, dressing upper body, dressing lower body, toileting, bladder management, and bowel management. The FIM addresses transfers and the ability to ambulate and climb stairs and also includes communication and social cognition items. Scoring is based on a seven-point scale, with items used to assess the patient's level of independence. The Alpha FIM, a short version of the FIM, is used frequently within 72 hours of admission in acute care settings to measure functional independence and the amount of assistance the patient needs to perform ADLs.

Although there are many disease-specific tools used to assess the patient's functional ability, some frequently used generic measures include the following (Fidecki, Wysokiński, Wrońska, et al., 2017):

- The Katz Index of Independence in Activities of Daily Living (Katz Index) (Katz, Downs, Cash, et al., 1970) is used to assess six areas of ADLs (i.e., bathing, dressing, toileting, transferring, continence, feeding) and rate them as done independently or done with assistance.
- The Barthel Index (Mahoney & Barthel, 1965) is used to measure the patient's level of independence in ADLs, continence, toileting, transfers, and ambulation (or wheelchair mobility). This scale does not address communicative or cognitive abilities.

A detailed functional evaluation of secondary conditions related to the patient's disability, such as muscle atrophy and deconditioning, skin integrity, bowel and bladder control, and sexual function, together with residual strengths unaffected by disease or disability, is necessary. In addition, the nurse assesses the patient's physical, mental, emotional, spiritual, social, and economic status, as well as cultural and familial environment. These elements may provide a context to the functional findings and influence the rehabilitation plan. For example, the patient's perception of what it means to have a disability and the implications that this might have on familial and social roles can influence the rehabilitation process.

NURSING PROCESS

The Patient with Self-Care Deficits in Activities of Daily Living

An ADL program is started as soon as the rehabilitation process begins, because the ability to perform ADLs is frequently the key to independence, return to the home, and transition into the community.

Assessment

The nurse must observe and assess the patient's ability to perform ADLs to determine the level of independence in self-care and the need for nursing intervention. Chart 2-2 depicts behaviors that may indicate struggles with function or movement and thus should be assessed. For example, bathing requires obtaining bath water and items used for bathing (e.g., soap, washcloth), washing, and drying the body after bathing. Dressing requires getting clothes from the closet, putting on and taking off clothing, and fastening the clothing. Self-feeding requires using utensils to bring food to the mouth and chewing and swallowing the food. Toileting includes removing clothing to use the toilet, cleansing oneself, and readjusting clothing. Grooming activities include combing hair, brushing one's teeth, shaving or applying makeup, and handwashing. Patients who can sit up and raise their hands to their head can begin self-care activities. Assistive devices are often essential in achieving some level of independence in ADLs.

Additional assessment should include gaining an understanding of the patient's and family members' perspectives on the patient's condition and how it affects functional ability. The nurse should also be aware of the patient's medical conditions or other health problems, the effect that they have on the ability to perform ADLs, and the family's involvement in the patient's ADLs. This information is valuable in setting goals and developing the plan of care to maximize self-care.

Nursing Diagnoses

Based on the assessment data, major nursing diagnoses may include the following:

- Impaired ability to perform hygiene
- Impaired ability to dress
- Impaired self feeding
- Impaired self toileting
- Impaired health maintenance

Chart 2-2 **ASSESSMENT**

Assessing Potential Struggles in Function or Movement

Be alert for the following behaviors:

- Holding onto a hand rail to pull the body while going up stairs
- Holding onto a bedside rail or bedcovers to pull to a sitting position in bed
- Leaning to one side and using both hands on the hand rail while going down the stairs or a ramp
- Holding onto furniture or doorways and watching the feet while walking in the house
- Lifting a leg (or arm) by using the other leg (or arm) as support or by lifting with the pants leg (or sleeve)
- Tilting the head to reach the back or side of the hair while grooming
- Pushing up, rocking forward and back, and/or leaning the body over for momentum ("nose over toes") when rising to stand from a chair
- Leaning over from the waist without bending the knees and then placing one hand on the thigh, as if it were a prop, and pushing against the thigh to assist in moving to the upright position
- Turning to reach for an object and then using the other arm or an object to support the reaching arm at the elbow or wrist
- Positioning a chair before sitting down by using the front or back of the knees and then using the back of the knees to guide sitting down; using the torso and hips to lean against a table or chair
- Reaching and leaning with the body rather than with an arm
- Walking with a lean to one side, a limp, a waddle, or other variation of a gait
- Scanning (i.e., observing or being aware of surroundings) ineffectively while eating or grooming
- Rolling or scooting the body, sliding forward in a seat, or other maneuvers to move off a bed or out of a chair

Adapted from Weber, J. R., & Kelley, J. H. (2018). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Planning and Goals

Major goals for the patient include performing the following activities independently or with assistance, using adaptive or assistive devices as appropriate: bathing/hygiene, dressing/grooming, feeding, and toileting. A related goal is patient expression of satisfaction with the extent of independence achieved in self-care activities. Another major goal is that the patient acknowledges adjustments in new lifestyle and ADLs and can identify resources to facilitate optimal functioning (Carpenito, 2017).

Nursing Interventions

Repetition, practice, and demonstrations help patients achieve maximum independence in personal care activities. The nurse's role is to provide an

optimal learning environment that minimizes distractions. The nurse can identify the patient's optimal time to work on activities, encourage concentration, identify endurance issues that may affect safety, and provide cues and reminders to patients with specific disability, such as alteration in or loss of sensation that may occur with stroke (Gregory & Galloway, 2017). Patients with impaired mobility, sensation, strength, or dexterity may need to use assistive devices to accomplish self-care.

Fostering Self-Care Abilities

A patient's approach to self-care may be affected by altered or impaired mobility and influenced by family or cultural expectations. The inability to perform self-care as carried out previously may lead to ineffective coping behaviors, such as social isolation, dependency on caregivers, or depression. The nurse must motivate the patient to learn and accept responsibility for self-care. It helps to encourage an "I'd rather do it myself" attitude. The nurse must also help the patient identify the safe limits of independent activity; knowing when to ask for assistance is particularly important.

The nurse educates, guides, and supports the patient who is learning or relearning how to perform self-care activities while maintaining a focus on patient strengths and optimal level of function. Consistency in instructions and assistance given by health care providers, including rehabilitation therapists (e.g., physiotherapists, occupational therapists, recreation therapists, speech-language pathologists, primary providers) facilitates the learning process. Recording the patient's performance provides data for evaluating progress and may be used as a source for motivation and morale building. Guidelines for educating patients and families about ADLs are presented in Chart 2-3.

Often, performing a simple maneuver requires the patient with a disability to concentrate intensely and exert considerable effort; therefore, self-care techniques need to be adapted to accommodate the individual patient's lifestyle. Because a self-care activity usually can be accomplished in several ways, common sense and a little ingenuity may promote increased independence. For example, a person who cannot quite reach his or her head may be able to do so by leaning forward. Encouraging the patient to participate in a support group may also help the patient discover creative solutions to self-care problems.

Chart 2-3 PATIENT EDUCATION

Educating Patients About Activities of Daily Living

The nurse instructs the patient to:

1. Be realistic about the goal of the activity and set short-term goals that can be accomplished in the near future.
2. Identify several approaches to accomplish the task (e.g., there are several ways to put on a given garment).
3. Select the approach most likely to succeed.
4. Identify the motions necessary to accomplish the activity (e.g., to pick up a glass, extend arm with hand open; place open hand next to glass; flex fingers around glass; move arm and hand holding glass vertically; flex arm toward body).
5. Focus on gross functional movements initially, and gradually include activities that use finer motions (e.g., buttoning clothes, eating with a fork).

The nurse should also be sure to:

1. Specify the approach selected to accomplish the task on the patient's plan of care and the patient's level of accomplishment on the progress notes.
2. Encourage the patient to perform the activity up to maximal capacity within the limitations of the disability.
3. Monitor the patient's tolerance.
4. Minimize frustration and fatigue.
5. Support the patient by giving appropriate praise for effort put forth and for acts accomplished.
6. Assist the patient to perform and practice the activity in real-life situations and in a safe environment.

Preexisting cultural norms may influence the degree of self-care the patient is willing to consider. Cultural and ethnic beliefs about hygiene can vary among individuals and families. The nurse must recognize these beliefs, work through any issues with the patient and family, and communicate pertinent findings to the rehabilitation team.

Recommending Adaptive and Assistive Devices

If the patient has difficulty performing an ADL, an adaptive or assistive device (self-help device) may be useful. Such devices may be obtained commercially or can be constructed by the nurse, occupational therapist, patient, or family. The devices may include built-up handles on toothbrushes or razors; long, curved handles on mirrors or shoe horns; suction cups to hold items in place; shower chairs; raised toilet seats; and universal cuffs to grip self-care items. Some of these are shown in Figure 2-1. To assist premenopausal women with managing menstruation, clothing adaptations (e.g., Velcro crotch flaps for ease of access), mirrors, self-sticking sanitary pads, packaged wipes, and loose underwear may be used.

Quality and Safety Nursing Alert

To avoid injury or bleeding, people who take anticoagulant medication should be encouraged to use an electric razor. Women may wish to consider depilatory creams or electrolysis.

A wide selection of computerized devices is available, or devices can be designed to help individual patients with severe disability to function more independently. The AbleData project (see Resources list at the end of this chapter) offers a computerized listing of commercially available aids and equipment for patients with disability.

The nurse should be alert to "gadgets" coming on the market and evaluate their potential usefulness. The nurse must exercise professional judgment and caution in recommending devices, because in the past, unscrupulous vendors have marketed unnecessary, overly expensive, or useless items to patients.

Helping Patients Accept Limitations

If the patient has a severe disability, independent self-care may be an unrealistic goal. In this situation, the nurse educates the patient how to take charge by directing their care. The patient may require a personal caregiver to perform ADLs. Family members may not be appropriate for providing bathing/hygiene, dressing/grooming, feeding, and toileting assistance, and spouses may have difficulty providing bowel and bladder care for patients and maintaining the role of sexual partners. If a personal caregiver is necessary, the patient and family members must learn how to manage an employee effectively. The nurse helps the patient accept self-care dependency. Independence in other areas, such as social interaction, should be emphasized to promote a positive self-concept.

Ensuring Effective Health Management

The nurse ensures effective health management by educating the patient and caregiver in appropriate language so that they understand the nature of the health condition or disorder and the resulting changes in ADLs. This understanding facilitates transition to a new way of life upon discharge. Barriers that may impede successful health maintenance are identified and strategies employed to mitigate them. The transition team, under the guidance of the nurse, collaborates on identifying and securing resources that are needed to make the transition successful and prevent complications (Carpenito, 2017).

Evaluation

Expected patient outcomes may include:

1. Demonstrates independent self-care in bathing/hygiene or with assistance, using adaptive devices as appropriate
   a. Bathes self at maximal level of independence
   b. Uses adaptive and assistive devices effectively

c. Reports satisfaction with level of independence in bathing/hygiene

Figure 2-1 • Adaptive and assistive devices. **A.** Raised toilet seat. **B.** Shower chair.

2. Demonstrates independent self-care in dressing/grooming or with assistance, using adaptive devices as appropriate
   a. Dresses/grooms self at maximal level of independence
   b. Uses adaptive devices effectively
   c. Reports satisfaction with level of independence in dressing/grooming
   d. Demonstrates increased interest in appearance
3. Demonstrates independent self-care in feeding or with assistance, using adaptive and assistive devices as appropriate
   a. Feeds self at maximal level of independence
   b. Uses adaptive and assistive devices effectively
   c. Demonstrates increased interest in eating
   d. Maintains adequate nutritional intake
4. Demonstrates independent self-care in toileting or with assistance, using adaptive and assistive devices as appropriate
   a. Toilets self at maximal level of independence
   b. Uses adaptive and assistive devices effectively
   c. Indicates positive feelings regarding level of toileting independence
   d. Experiences adequate frequency of bowel and bladder elimination
   e. Does not experience incontinence, constipation, urinary tract infection, or other complications
5. Demonstrates knowledge about effective health maintenance

a. Verbalizes knowledge of health problem/disorder and resulting changes in functional abilities and lifestyle
b. Identifies and secures resources needed to maintain health upon discharge

NURSING PROCESS

The Patient with Impaired Physical Mobility

Problems commonly associated with immobility include weakened muscles, joint contracture, and deformity. Each joint of the body has a normal range of motion; if the range is limited, the functions of the joint and the muscles that move the joint are impaired, and painful deformities may develop. The nurse must identify patients at risk for such complications. The nurse needs to assess, plan, and intervene to prevent complications of immobility.

Another problem frequently seen in rehabilitation nursing is an altered ambulatory/mobility pattern. Patients with disability may be either temporarily or permanently unable to walk independently and unaided. The nurse assesses the mobility of the patient and designs care that promotes independent mobility within the prescribed therapeutic limits. If a patient cannot exercise and move his or her joints through their full range of motion, contractures may develop. A contracture is a shortening of the muscle and tendon that leads to deformity and limits joint mobility. When the contracted joint is moved, the patient experiences pain; in addition, more energy is required to move when joints are contracted.

Disability brings change to the patient and family unit as well as adjustments in lifestyle, mobility, and interactions as members of a community. Whether temporary or permanent, patients can grieve the loss of health and will need to process the loss as part of the adaptation process and plan of care (Carpenito, 2017).

Assessment

Mobility may be restricted owing to pain, paralysis, loss of muscle strength, systemic disease, an immobilizing device (e.g., cast, brace), or prescribed limits to promote healing. Assessment of mobility includes positioning, ability to move, muscle strength and tone, joint function, and the prescribed mobility limits. The nurse must collaborate with physical therapists or other team members to assess mobility.

During position change, transfer, and ambulation activities, the nurse assesses the patient's abilities, the extent of disability, and residual capacity for physiologic adaptation. The nurse observes for orthostatic hypotension, pallor, diaphoresis, nausea, tachycardia, and fatigue.

In addition, the nurse assesses the patient's ability to use various assistive devices that promote mobility. If the patient cannot ambulate without assistance, the nurse assesses the patient's ability to balance, transfer, and use assistive devices (e.g., crutches, walker). Crutch walking requires high energy expenditure and produces considerable cardiovascular stress; therefore, people with reduced exercise capacity, decreased arm strength, and problems with balance because of aging or multiple diseases may be unable to use crutches. A walker is more stable and may be a better choice for such patients. If the

patient uses an orthosis, the nurse monitors the patient for effective use and potential problems associated with its use.

The assessment process includes gaining an understanding of the meaning of illness or disability for the patient and family, whether it be a temporary or permanent loss of normal functioning or lifestyle. Signs and symptoms evidenced by the patient or family members such as disbelief, crying, expressions of emotions such as sorrow and anger can be part of the grieving process. The nurse collaborates with the interdisciplinary team to develop a holistic plan of care that addresses relevant actual or potential nursing diagnoses (Carpenito, 2017).

Nursing Diagnosis

Based on the assessment data, major nursing diagnoses may include the following:

- Impaired mobility
- Activity intolerance or risk for activity intolerance
- Risk for injury
- Risk for disuse
- Impaired walking
- Impaired wheelchair mobility
- Impaired mobility in bed
- Grief

Planning and Goals

Major goals for the patient may include absence of contracture and deformity, maintenance of muscle strength and joint mobility, independent mobility, increased activity tolerance, and prevention of further disability. A major goal for the patient and family may include that they express an understanding of the meaning of the illness or disability and its associated losses.

Nursing Interventions

Positioning to Prevent Musculoskeletal Complications

Deformities and contractures can often be prevented by proper positioning. Maintaining correct body alignment when the patient is in bed is essential regardless of the position selected. During each patient contact, the nurse evaluates the patient's position and assists the patient to achieve and maintain proper positioning and alignment. The most common positions that patients assume in bed are supine (dorsal), side-lying (lateral), and prone. The nurse helps the patient assume these positions and uses pillows to support the body in correct alignment. At times, a splint (e.g., wrist or hand splint) may be made by the occupational therapist to support a joint and prevent deformity. The nurse must ensure proper use of the splint and provide skin care.

Preventing External Rotation of the Hip. The patient who is in bed for an extended period of time may develop external rotation deformity of the hip because the ball-and-socket joint of the hip tends to rotate outward when the

patient lies on their back. A trochanter roll (i.e., a flannel sheet or bath towel folded in thirds lengthwise and rolled toward the patient or a commercially manufactured roll) extending from the crest of the ilium to the midthigh prevents this deformity; with correct placement, it serves as a mechanical wedge under the projection of the greater trochanter.

Concept Mastery Alert

Abduction moves the body part away from the body; adduction moves the body part toward the body. External rotation occurs as the leg moves outward. To prevent external rotation deformity, the patient's hip should *not* be abducted or moved away from the body.

Preventing Footdrop. Footdrop is a deformity in which the foot is plantar flexed (the ankle bends in the direction of the sole of the foot). If the condition continues without correction, the patient will not be able to hold the foot in a normal position and will be able to walk only on their toes, without touching the ground with the heel of the foot. The deformity is caused by contracture of both the gastrocnemius and soleus muscles. Damage to the peroneal nerve or loss of flexibility of the Achilles tendon may also result in footdrop. To prevent this disabling deformity, the patient is positioned to sit at a 90-degree angle in a wheelchair with the feet on the footrests or flat on the floor.

When the patient is supine in bed, padded splints or protective boots are used to keep the patient's feet at right angles to the legs. Frequent skin inspection of the feet must also be performed to determine whether positioning devices have created any unwanted pressure areas.

The patient is encouraged to perform the following ankle exercises several times each hour: dorsiflexion and plantar flexion of the feet, flexion and extension (curl and stretch) of the toes, and eversion and inversion of the feet at the ankles. The nurse provides frequent passive range-of-motion exercises if the patient cannot perform active exercises.

Quality and Safety Nursing Alert

Prolonged bed rest, lack of exercise, incorrect positioning in bed, and the weight of bedding that forces the toes into plantar flexion must be avoided to prevent footdrop. Patients should be encouraged to wear shoes for support and protection to prevent footdrop.

Maintaining Muscle Strength and Joint Mobility

Optimal function depends on the strength of the muscles and joint motion, and active participation in ADLs promotes maintenance of muscle strength and joint mobility. Range-of-motion exercises and specific therapeutic exercises may be included in the nursing plan of care.

Performing Range-of-Motion Exercises. Range of motion involves moving a joint through its full range in all appropriate planes (Chart 2-4). To maintain or increase the motion of a joint, range-of-motion exercises are initiated as soon as the patient's condition permits. The exercises are planned for individual patients to accommodate the wide variation in the degrees of motion that people of varying body builds and age groups can attain.

Range-of-motion exercises may be active (performed by the patient under the supervision of the nurse), assisted (with the nurse helping if the patient cannot do the exercise independently), or passive (performed by the nurse). Unless otherwise prescribed, a joint should be moved through its range of motion three times, at least two times a day. The joint to be exercised is supported, the bones above the joint are stabilized, and the body part distal to the joint is moved through the range of motion of the joint. For example, the humerus must be stabilized while the radius and ulna are moved through their range of motion at the elbow joint.

A joint should not be moved beyond its free range of motion; the joint is moved to the point of resistance and stopped at the point of pain. If muscle spasms are present, the joint is moved slowly to the point of resistance. Gentle, steady pressure is then applied until the muscle relaxes, and the motion is continued to the joint's final point of resistance.

Chart 2-4

Range-of-Motion Terminology

Abduction: movement away from the midline of the body
Adduction: movement toward the midline of the body
Flexion: bending of a joint so that the angle of the joint diminishes
Extension: the return movement from flexion; the joint angle is increased
Rotation: turning or movement of a part around its axis
Internal: turning inward, toward the center
External: turning outward, away from the center
Dorsiflexion: movement that flexes or bends the hand back toward the body or the foot toward the leg
Palmar flexion: movement that flexes or bends the hand in the direction of the palm
Plantar flexion: movement that flexes or bends the foot in the direction of the sole
Pronation: rotation of the forearm so that the palm of the hand is down
Supination: rotation of the forearm so that the palm of the hand is up
Opposition: touching the thumb to each fingertip on same hand
Inversion: movement that turns the sole of the foot inward
Eversion: movement that turns the sole of the foot outward

To perform assisted or passive range-of-motion exercises, the patient must be in a comfortable supine position with the arms at the sides and the knees extended. Good body posture is maintained during the exercises. The nurse also uses good body mechanics during the exercise session.

Performing Therapeutic Exercises. Therapeutic exercises are prescribed by the primary provider and performed with the assistance and guidance of the physical therapist or nurse. The patient should have a clear understanding of the goal of the prescribed exercise. Written instructions about the frequency, duration, and number of repetitions, as well as simple line drawings of the exercise, help to ensure adherence to the exercise program. Return demonstration of the exercises also helps the patient and family to follow the instructions correctly.

When performed correctly, exercise assists in maintaining and building muscle strength, maintaining joint function, preventing deformity, stimulating circulation, developing endurance, and promoting relaxation. Exercise is also valuable in helping to restore motivation and the well-being of the patient. Weight-bearing exercises may slow the bone loss that occurs with disability. There are five types of exercise: passive, active-assistive, active, resistive, and isometric. The description, purpose, and action of each of these exercises are summarized in Table 2-1.

Promoting Independent Mobility

When the patient's condition stabilizes, their physical condition permits, and the patient is able to stand, the patient is assisted to sit up on the side of the bed and then to stand. Tolerance of this activity is assessed. Orthostatic (postural) hypotension may develop when the patient assumes a vertical position. Because of inadequate vasomotor reflexes, blood pools in the splanchnic (visceral or intestinal) area and in the legs, resulting in inadequate cerebral circulation. If indicators of orthostatic hypotension (e.g., drop in blood pressure, pallor, diaphoresis, nausea, tachycardia, dizziness) are present, the activity is stopped, and the patient is assisted to a supine position in bed.

Some disabling conditions, such as spinal cord injury (SCI), acute brain injury, and other conditions that require extended periods in the recumbent position, prevent the patient from assuming an upright position at the bedside. Several strategies can be used to help the patient assume a 90-degree sitting position. A reclining wheelchair with elevating leg rests allows a slow and controlled progression from a supine position to a 90-degree sitting position. A tilt table (a board that can be tilted in 10-degree increments from a horizontal to a vertical position) may also be used. The tilt table promotes vasomotor adjustment to positional changes and helps patients with limited standing balance and limited weight-bearing activities avoid the decalcification of bones and low bone mass associated with disuse syndrome and lack of weight-bearing exercise. Physical therapists may use a tilt table for patients who have not been upright owing to illness or disability. Gradual elevation of the head of the bed may help. When getting patients with SCI out of bed, it is important to

gradually raise the head of the bed to a 90-degree angle; this may take approximately 10 to 15 minutes.

Graduated compression stockings are used to prevent venous stasis. For some patients, a compression garment (leotard) or snug-fitting abdominal binder and elastic compression bandaging of the legs are needed to prevent venous stasis and orthostatic hypotension. When the patient is standing, the feet are protected with a pair of properly fitted shoes. Extended periods of standing are avoided because of venous pooling and pressure on the soles of the feet. The nurse monitors the patient's blood pressure and pulse and observes for signs and symptoms of orthostatic hypotension and cerebral insufficiency (e.g., the patient reports feeling faint and weak), which suggest intolerance of the upright position. If the patient does not tolerate the upright position, the nurse should return the patient to the reclining position and elevate their legs.

TABLE 2-1 Therapeutic Exercises

	Description	Purposes	Action
Passive	An exercise carried out by the therapist or the nurse without assistance from the patient	To retain as much joint range of motion as possible; to maintain circulation	Stabilize the proximal joint and support the distal part; move the joint smoothly, slowly, and gently through its full range of motion; avoid producing pain.
Active-assistive	An exercise carried out by the patient with the assistance of the therapist or the nurse	To encourage normal muscle function	Support the distal part, and encourage the patient to take the joint actively through its range of motion; give no more assistance than is necessary to accomplish the action; short periods of activity should be followed by adequate rest periods.
Active	An exercise accomplished by the patient without assistance; activities include turning from side to side and from back to abdomen and moving up and down in bed	To increase muscle strength	When possible, active exercise should be performed against gravity; the joint is moved through full range of motion without assistance; make sure that the patient does not substitute another joint movement for the one intended.
Resistive	An active exercise carried out by the patient working against resistance produced by either manual or mechanical means	To provide resistance to increase muscle power	The patient moves the joint through its range of motion, while the therapist resists slightly at first and then with progressively increasing resistance; sandbags and weights can be used and are applied at the distal point of the involved joint; the movements should be performed smoothly.
Isometric or muscle setting	Alternately contracting and relaxing a muscle while keeping the part in a fixed position; this exercise is performed by the patient	To maintain strength when a joint is immobilized	Contract or tighten the muscle as much as possible without moving the joint, hold for several seconds, then let go and relax; breathe deeply.

Assisting Patients with Transfer. A **transfer** is movement of the patient from one place to another (e.g., bed to chair, chair to commode, wheelchair to tub). As soon as the patient is permitted out of bed, transfer activities are

started. The nurse assesses the patient's ability to participate actively in the transfer and determines, in conjunction with occupational therapists or physical therapists, the adaptive equipment required to promote independence and safety. A lightweight wheelchair with brake extensions, removable and detachable armrests, and leg rests minimize structural obstacles during the transfer. Tub seats or benches make transfers in and out of the tub easier and safer. Raised, padded commode seats may also be warranted for patients who must avoid flexing the hips greater than 90 degrees when transferring to a toilet. It is important that the nurse educate the patient about hip precautions (e.g., no adduction past the midline, no flexion greater than 90 degrees, and no internal rotation); abduction pillows can be used to keep the hip in correct alignment if precautions are warranted.

It is important that the patient maintains muscle strength and, if possible, performs push-up exercises to strengthen the arm and shoulder extensor muscles. The push-up exercises require the patient to sit upright in bed; a book is placed under each of the patient's hands to provide a hard surface, and the patient is instructed to push down on the book, raising the body. The nurse should encourage the patient to raise and move the body in different directions by means of these push-up exercises.

The nurse or physical therapist instructs the patient how to transfer. There are several methods of transferring from the bed to the wheelchair when the patient cannot stand, and the technique chosen should consider the patient's abilities and disability. It is helpful to demonstrate the technique to the patient. If the physical therapist is involved in teaching the patient to transfer, the nurse and physical therapist must collaborate so that consistent instructions are given to the patient. During transfer, the nurse assists and coaches the patient. Figure 2-2 shows weight-bearing and non–weight-bearing transfers. For example, with a weight-bearing transfer from bed to chair, the patient stands up, pivots until his back is opposite the new seat, and sits down. If the patient's muscles are not strong enough to overcome the resistance of body weight, a polished lightweight board (transfer board, sliding board) may be used to bridge the gap between the bed and the chair. The patient slides across on the board with or without assistance from a caregiver. This board may also be used to transfer the patient from the chair to the toilet or bathtub bench. It is important to avoid the effects of shear on the patient's skin while sliding across the board. The nurse should make sure that the patient's fingers do not curl around the edge of the board during the transfer, because the patient's body weight can crush the fingers as they move across the board.

Safety is a primary concern during a transfer, and the following guidelines are recommended:

- Wheelchairs and beds must be locked before transfer begins.
- Detachable arm- and footrests are removed to make getting in and out of the chair easier.
- One end of the transfer board is placed under the buttocks and the other end on the surface to which the transfer is being made (e.g., the chair).

- The patient is instructed to lean forward, push up with his or her hands, and then slide across the board to the other surface.

Nurses frequently assist patients who are weak and incapacitated out of bed. The nurse supports and gently assists the patient during position changes, protecting the patient from injury. The nurse avoids pulling on a weak or paralyzed upper extremity to prevent dislocation of the shoulder. The patient is assisted to move toward the stronger side.

In the home setting, getting in and out of bed and performing chair, toilet, and tub transfers are difficult for patients with weak muscles and loss of hip, knee, and ankle motion. A rope attached to the headboard of the bed enables a patient to move toward the center of the bed, and the use of a rope attached to the footboard facilitates getting in and out of bed. The height of a chair can be raised with cushions on the seat or with hollowed-out blocks placed under the chair legs. Grab bars can be attached to the wall near the toilet and tub to provide leverage and stability.

Preparing for Ambulation. Regaining the ability to walk is a prime morale builder. However, to be prepared for ambulation—whether with a brace, walker, cane, or crutches—the patient must strengthen the muscles required. Therefore, exercise is the foundation of preparation. The nurse and physical therapist instruct and supervise the patient in these exercises.

For ambulation, the quadriceps muscles, which stabilize the knee joint, and the gluteal muscles are strengthened. To perform quadriceps-setting exercises, the patient contracts the quadriceps muscle by attempting to push the popliteal area against the mattress and at the same time raising the heel. The patient maintains the muscle contraction for a count of five and relaxes for a count of five. The exercise is repeated 10 to 15 times hourly. Exercising the quadriceps muscles prevents flexion contractures of the knee. In gluteal setting, the patient contracts or "pinches" the buttocks together for a count of five, relaxes for a count of five; the exercise is repeated 10 to 15 times hourly.

If assistive devices (i.e., walker, cane, crutches) will be used, the muscles of the upper extremities are exercised and strengthened. Push-up exercises are especially useful. While in a sitting position, the patient raises the body by pushing the hands against the chair seat or mattress. The patient should be encouraged to do push-up exercises while in a prone position as well. Pull-up exercises done on a trapeze while lifting the body are also effective for conditioning. The patient is taught to raise the arms above the head and then lower them in a slow, rhythmic manner while holding weights. Gradually, the weight is increased. The hands are strengthened by squeezing a rubber ball.

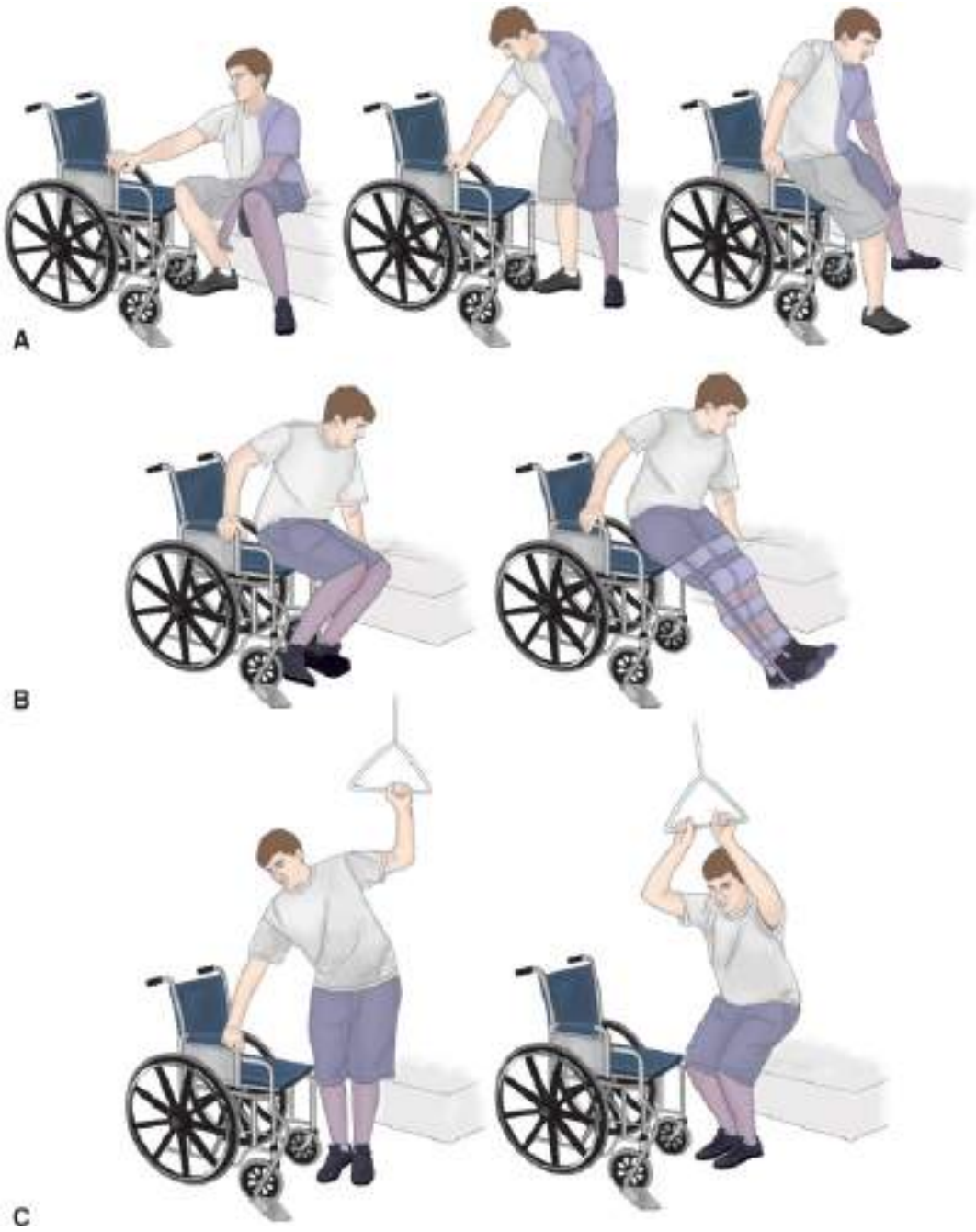

Figure 2-2 • Methods of patient transfer from the bed to a wheelchair. The wheelchair is in a locked position. Colored areas indicate non–weight-bearing body parts. **A.** Weight-bearing transfer from bed to chair. The patient stands up, pivots until his back is opposite the new seat, and sits down. **B.** (**Left**) Non–weight-bearing transfer from chair to bed. (**Right**) With legs braced. **C.** (**Left**) Non–weight-bearing transfer, combined method. (**Right**) Non–weight-bearing transfer, pull-up method. One of the wheelchair arms is removed to make getting in and out of the chair easier.

Typically, the physical therapist designs exercises to help the patient develop sitting and standing balance, stability, and coordination needed for

ambulation. After sitting and standing balance is achieved, the patient is able to use parallel bars. Under the supervision of the physical therapist, the patient practices shifting weight from side to side, lifting one leg while supporting weight on the other, and then walking between the parallel bars.

A patient who is ready to begin ambulation must be fitted with the appropriate assistive device, instructed about the prescribed weight-bearing limits (e.g., non–weight-bearing, partial weight-bearing ambulation), and taught how to use the device safely. Figure 2-3 illustrates some of the more common assistive devices used in rehabilitation settings. The nurse continually assesses the patient for stability and adherence to weight-bearing precautions and protects the patient from falling. The nurse provides contact guarding by holding on to a gait belt that the patient wears around the waist. The patient should wear sturdy, well-fitting shoes and be advised of the dangers of wet or highly polished floors and throw rugs. The patient should also learn how to ambulate on inclines, uneven surfaces, and stairs.

Ambulating with an Assistive Device: Crutches, a Walker, or a Cane

Crutches are for partial weight-bearing or non–weight-bearing ambulation. Good balance, adequate cardiovascular reserve, strong upper extremities, and erect posture are essential for crutch walking. Ambulating a functional distance (at least the length of a room or house) or maneuvering stairs on crutches requires significant arm strength, because the arms must bear the patient's weight (Fig. 2-4). The nurse or physical therapist determines which gait is best (Chart 2-5).

A walker provides more support and stability than a cane or crutches. A pick-up walker is best for patients with poor balance and poor cardiovascular reserve, and a rolling walker, which allows automatic walking, is best for patients who cannot lift. A cane helps the patient walk with balance and support and relieves the pressure on weight-bearing joints by redistributing weight.

Figure 2-3 • Mechanical aids to walking. **A.** Two types of walkers: pick-up and rolling. **B.** Three types of canes: C-cane, functional cane, and quad cane.

Before patients can be considered to be independent in walking with crutches, a walker, or a cane, they should learn to sit, stand from sitting, and go up and down stairs using the device. Table 2-2 describes how patients can ambulate and maneuver using each of the three devices and nursing actions to support using assistive devices.

Assisting Patients with an Orthosis or Prosthesis

Orthoses and prostheses are designed to facilitate mobilization and to maximize the patient's quality of life. An **orthosis** is an external appliance that provides support, prevents or corrects deformities, and improves function. Orthoses include braces, splints, collars, corsets, and supports that are designed and fitted by orthotists or prosthetists. Static orthoses (no moving parts) are used to stabilize joints and prevent contractures. Dynamic orthoses are flexible and are used to improve function by assisting weak muscles. A **prosthesis** is an artificial body part that may be internal, such as an artificial knee or hip joint, or external, such as an artificial leg or arm.

Figure 2-4 • For a person walking with crutches, the tripod stance, with crutches out to the sides and in front of the toes, increases stability.

In addition to learning how to apply and remove the orthosis and maneuver the affected body part correctly, patients must learn how to properly care for the skin that comes in contact with the appliance. Skin problems or pressure injuries may develop if the device is applied too tightly or too loosely, or if it is adjusted improperly. The nurse instructs the patient to clean and inspect the skin daily, to make sure the brace fits snugly without being too tight, to check that the padding distributes pressure evenly, and to wear a cotton garment without seams between the orthosis and the skin.

If the patient has had an amputation, the nurse promotes tissue healing, uses compression dressings to promote residual limb shaping, and minimizes contracture formation. A permanent prosthetic limb cannot be fitted until the tissue has healed completely and the residual limb shape is stable and free from edema. The nurse also helps the patient cope with the emotional issues surrounding loss of a limb and encourages acceptance of the prosthesis. The prosthetist, nurse, and primary provider collaborate to provide instructions related to skin care and care of the prosthesis.

Supporting the Grieving Process

Developing a trusting nurse–patient relationship provides an opportunity to support patients and families as they grieve and process the meaning of the illness or disability, whether it be a temporary or permanent loss of normal functioning and lifestyle. The nurse helps the grieving process by providing clear, simple communications that do not minimize the loss. The nurse also educates the patient and family about the grieving process, normal grief reactions, and signs and symptoms of complicated grieving. Time should be planned to share feelings in a safe setting which provides needed privacy. In many cases, just being present and listening supports the grieving process. Patients and families may benefit from community resources such as support groups as well as connection to their local faith community for spiritual support through the changes associated with disability (Carpenito, 2017).

Chart 2-5

Crutch Gaits

Shaded areas are weight bearing. Arrow indicates advance of foot or crutch. (Read chart from bottom, starting with beginning stance.)

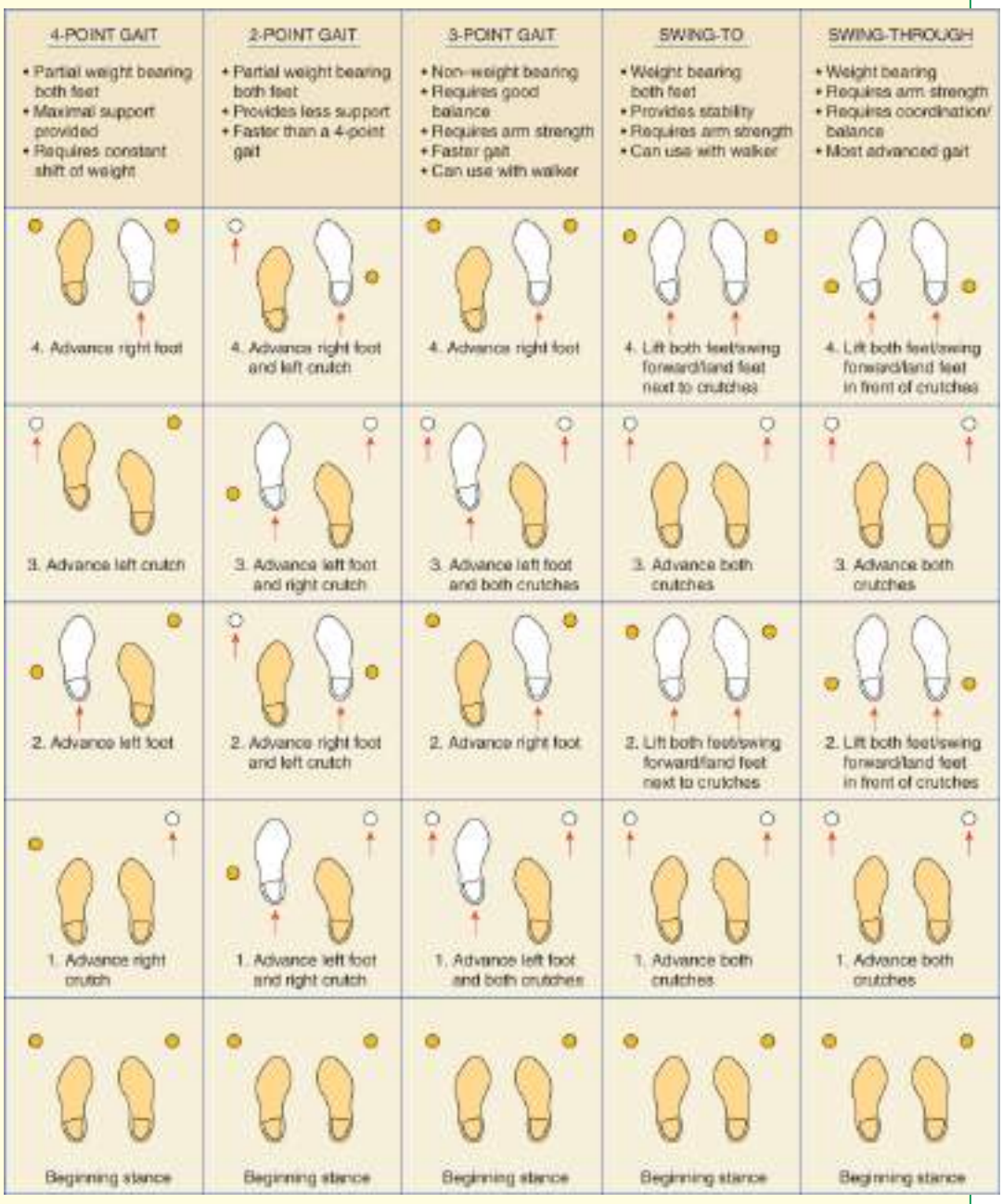

TABLE 2-2 Nursing Actions Involved in Using Assistive Devices

	Crutches	Walker	Cane
Patient Preparation Adjusting device to fit patient	Measure patient standing or lying down: If standing, set crutch length approximately 5 cm (2 inches) below axilla. If lying down, measure from anterior fold of axilla to sole of the foot and add 5 cm. If using patient's height, subtract 40 cm (16 inches) to obtain crutch height. Adjust hand grip to allow 20 to 30 degrees of flexion at elbow. Use foam rubber pad on underarm piece to relieve pressure of crutch.	Adjust height to individual patient. Patient's arms should be in 20 to 30 degrees of flexion at elbows when hands are resting on hand grips.	With patient flexing elbow at 30-degree angle, hold handle of cane level with greater trochanter and place tip of cane 15 cm (6 inches) lateral to base of 5th toe. Fit cane with gently flaring tip that has flexible, concentric rings to provide stability, absorb shock, and enable greater speed and less fatigue with walking.
Assessment	Assess safety. Crutches should have large rubber tips, and patients should wear firm-soled, well-fitting shoes. Assess balance by asking patient to stand on unaffected leg by a chair. Assess stability and stamina (tolerance). Sweating and shortness of breath indicate that rest is necessary.	Assess safety. Patients should wear firm-soled, well-fitting shoes. Assess stability and stamina (tolerance). Sweating and shortness of breath indicate that rest is necessary.	Assess safety. Patients should wear firm-soled, well-fitting shoes. Assess stability and stamina (tolerance). Sweating and shortness of breath indicate that rest is necessary.
Interventions and patient education	Assist with balance by using a transfer belt or holding patient near waist. Have patient practice shifting weight and maintaining balance. Protect patient from falls.	Walk with patient, holding at waist if needed for balance. Instruct patient to never pull self up using walker and to	Walk with patient, holding at waist if needed for balance. Have patient hold cane in hand opposite to affected extremity, if possible, to widen the base of support and reduce stress on involved extremity.

	To maximize stability, encourage patient to use tripod stance, with crutches to the front and sides of toes. Have patient perform prescribed preparatory exercises to strengthen shoulder girdle and upper extremity muscles.[a]	look up when walking. Discuss full, partial, or non–weight bearing as prescribed. Protect patient from falls.	Instruct patient to move opposite arm and leg together. Protect patient from falls.
Ambulation Gait/action used	Determine which gait is best (see Chart 2-5, Tripod Gait)[b] Four-point Three-point Two-point Swing-to Swing-through	Instruct patient to: Pick-up walker: lift device and move it forward with each step. Rolling walker: roll device forward and walk automatically.	Instruct patient to: Advance cane at same time that affected leg is moved forward. Keep cane fairly close to body to prevent leaning. Bear down on cane when unaffected extremity begins swing phase.
Sitting	Instruct patient to: Grasp hand-piece for control. Bend forward slightly while assuming sitting position. Place affected leg forward to prevent weight bearing and flexion while sitting.	Instruct patient to hold walker on hand grips for stability.	
Standing	Instruct patient to: Move forward to edge of chair, and keep unaffected leg slightly under seat. Place both crutches on side of affected extremity. Push down on hand-piece while rising to standing position.	Instruct patient to: Push off chair or bed to come to a standing position. Rolling walker: if walker has a brake, apply it before standing. Lift walker, placing it in front of self while leaning	Instruct patient to: Push off chair or bed to come to a standing position. Hold cane for stability. Step forward on unaffected extremity. Swing cane and affected extremity forward in a normal walking gait.

		slightly forward. Walk into walker, supporting weight on hands when advancing. Balance on feet. Lift walker and place it in front of self again.	
Going down stairs	Instruct patient to: Walk forward as far as possible. Advance crutches to lower step; advance affected leg, then unaffected leg.	Continue pattern.	Instruct patient to: Step down on affected extremity. Place the cane and then unaffected extremity on down step.
Going up stairs	Instruct patient to: Advance unaffected leg first up next step. Advance crutches and affected extremity. Unaffected leg goes up first.	n/a	Instruct patient to: Step up on unaffected extremity. Place cane and affected extremity up on step.

[a]For patients who cannot support their weight through the wrist and hand because of arthritis or fracture, platform crutches that support the forearm and allow the weight to be borne through the elbow are available. If weight is borne on the axilla, the pressure of the crutch can damage the brachial plexus nerves, producing "crutch paralysis."

[b]Teach patients two gaits so that they can change from one to another to avoid fatigue. In addition, a faster gait can be used when walking an uninterrupted distance, and a slower gait can be used for shorter distances or in crowded places.

n/a, not applicable.

Evaluation

Expected patient outcomes may include:

1. Demonstrates improved physical mobility
   a. Maintains muscle strength and joint mobility
   b. Does not develop contractures
   c. Participates in exercise program
2. Transfers safely
   a. Demonstrates assisted transfers
   b. Performs independent transfers
3. Ambulates with maximum independence
   a. Uses ambulatory aid safely
   b. Adheres to weight-bearing prescription
   c. Requests assistance as needed

4. Demonstrates increased activity tolerance
   a. Does not experience episodes of orthostatic hypotension
   b. Reports absence of fatigue with ambulatory efforts
   c. Gradually increases distance and speed of ambulation
5. Patient and family members verbalize loss and express feelings of grief
   a. Describe the meaning of the loss as it relates to function or lifestyle
   b. Share grief with each other and those who are important to well-being
   c. Acquire knowledge of resources for support after discharge

Promoting Home, Community-Based, and Transitional Care

An important goal of rehabilitation is to assist the patient to return to the home environment after learning to manage the disability. A referral system maintains continuity of care when the patient is transferred to the home or to a long-term care facility. The plan for discharge is formulated when the patient is first admitted to the hospital, and discharge plans are made with the patient's functional potential in mind.

Educating Patients About Self-Care

Significant expenditures of time and resources are necessary to ensure that patients gain the skills and confidence to self-manage their health effectively after discharge from the hospital (Naylor, Shaid, Carpenter, et al., 2017). Formal programs provide patients with effective strategies for interpreting and managing disease-specific issues and skills needed for problem solving, as well as building and maintaining self-awareness and self-efficacy. Self-care programs often use multifaceted approaches, including didactic teaching, group sessions, individual learning plans, and Web-based resources. When planning the approach to self-care, the nurse must consider the individual patient's knowledge, experience, social and cultural background, level of formal education, and psychological status. The preparation for self-care must also be spread out over the course of the recovery period, and it must be monitored and updated regularly as the patient masters aspects of self-care. Preparation for self-care is also highly relevant for informal caregivers of patients in rehabilitation.

When a patient is discharged from acute care or a rehabilitation facility, informal caregivers, typically family members, often assume the care and support of the patient. Although the most obvious care tasks involve physical care (e.g., personal hygiene, dressing, meal preparation), other elements of the caregiving role include psychosocial support and a commitment to this supportive role. Thus, the nurse must assess the patient's support system (family, friends) well in advance of discharge. The positive attitudes of family and friends toward the patient, the patient's disability, and the return home are important in making a successful transition to home. Not all families can carry out the arduous programs

of exercise, physical therapy, and personal care that the patient may need. They may not have the resources or stability to care for family members with a severe disability. The physical, emotional, economic, and energy strains of a disabling condition may overwhelm even a stable family. Members of the rehabilitation team must not judge the family but rather should provide supportive interventions that help the family to attain its highest level of function.

The family members need to know as much as possible about the patient's condition and care so that they do not fear the patient's return home. The nurse develops methods to help the patient and family cope with problems that may arise. For example, the nurse may develop an ADLs checklist individualized for the patient and family to ensure that the family is proficient in assisting the patient with certain tasks (Chart 2-6).

Continuing and Transitional Care

A home health or transitional care nurse may visit the patient prior to discharge, interview the patient and the family, and review the ADLs sheet to learn which activities the patient can perform. This helps to ensure that continuity of care is provided and that the patient does not regress yet maintains the independence gained while in the hospital or rehabilitation setting. The family may need to purchase, borrow, or improvise needed equipment, such as safety rails, a raised toilet seat or commode, or a tub bench. Ramps may need to be built or doorways widened to allow full access.

Family members are taught how to use equipment and are given a copy of the equipment manufacturer's instruction booklet, the names of resource people, lists of equipment-related supplies, and locations where they may be obtained. A written summary of the care plan is included in family education. The patient and family members are reminded about the importance of routine health screening and other health promotion strategies.

A network of support services and communication systems may be required to enhance opportunities for independent living. The nurse uses collaborative, administrative skills to coordinate these activities and pull together the network of care. The nurse also provides skilled care, initiates additional referrals when indicated, and serves as a patient advocate and counselor when obstacles are encountered. The nurse continues to reinforce prior patient education and helps the patient to set and achieve attainable goals. The degree to which the patient adapts to the home and community environment depends on the confidence and self-esteem developed during the rehabilitation process and on the acceptance, support, and reactions of family members, employers, and community members.

Chart 2-6 **HOME CARE CHECKLIST**

Managing the Therapeutic Regimen at Home

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of disability on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- State changes in lifestyle (e.g., diet, activity) necessary to maintain health.
- State the name, dose, side effects, frequency, and schedule for all medications.
- State how to obtain medical supplies after discharge.
- Identify durable medical equipment needs, proper usage, and maintenance necessary for safe utilization:
  - Wheelchair—manual/power
  - Cushion
  - Grab bars
  - Sliding board
  - Mechanical lift
  - Raised padded commode seat
  - Padded commode wheelchair
  - Bedside commode
  - Crutches
  - Walker
  - Cane
  - Prosthesis
  - Orthosis
  - Shower chair
  - Specialty bed
- Demonstrate usage of adaptive equipment for activities of daily living:
  - Long-handled sponge
  - Reacher
  - Universal cuff
  - Plate mat and guard
  - Rocker knife, spork, weighted utensils
  - Special closures for clothing
  - Other
- Demonstrate mobility skills:
  - Transfers: bed to chair; in and out of toilet and tub; in and out of car
  - Negotiate ramps, curbs, stairs
  - Assume sitting from supine position
  - Turn side to side in bed
  - Maneuver wheelchair; manage armrests and leg rests; lock brakes
  - Ambulate safely using assistive devices
  - Perform range-of-motion exercises
  - Perform muscle-strengthening exercises

- Identify community resources for peer and caregiver/family support:
  - Identify sources of support (e.g., friends, relatives, faith community)
  - Identify phone numbers of support groups for people with disability and their caregivers/families
  - State meeting locations and times
- Demonstrate how to access transportation:
  - Identify locations of wheelchair accessibility for public buses or trains
  - Identify phone numbers for private wheelchair van
  - Contact Division of Motor Vehicles for handicapped parking permit
  - Contact Division of Motor Vehicles for driving test when appropriate
  - Identify resources for adapting private vehicle with hand controls or wheelchair lift
- Identify vocational rehabilitation resources:
  - State name and phone number of vocational rehabilitation counselor
  - Identify educational opportunities that may lead to future employment
- Identify community resources for recreation:
  - State local recreation centers that offer programs for people with disability
  - Identify leisure activities that can be pursued in the community
  - State how to reach primary provider with questions or if complications arise
  - State time and date of follow-up appointments
  - Identify the need for health promotion, disease prevention, and screening activities

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

There is a growing trend toward independent living by people with severe disability, either alone or in groups that share resources. Preparation for independent living should include training in managing a household and working with personal caregivers as well as training in mobility. The goal is integration into the community—living and working in the community with accessible housing, employment, public buildings, transportation, and recreation.

State rehabilitation administration agencies provide services to assist people with disability in obtaining the help they need to engage in gainful employment. These services include diagnostic, medical, and mental health services. Counseling, training, placement, and follow-up services are available to help people with disability select and obtain jobs.

If the patient is transferred to a long-term care facility, the transition is planned to promote continued progress. Independence gained continues to be supported, and progress is fostered. Adjustment to the facility is promoted through communication. Family members are encouraged to visit, to be involved, and to take the patient home on weekends and holidays if possible.

Home Health Nursing

Home health care is a unique component of posthospital care for patients who return home to complete recuperation following an acute illness episode or exacerbation of chronic illness. Home health agencies can also provide advanced technologies in the home setting. All together, these services provided in the home setting work to maximize the patient's ability to function at his highest level of wellness (Rector, 2018).

The ANA defines **home health nursing** as a specialty area of practice that provides nursing services to patients across the lifespan in a home setting (Wilson, 2019). Home health nursing practice roles include holistic care planning, which incorporates resource and service coordination as part of a collaborative interdisciplinary team. This team includes home health aides; social workers; physical, speech, and occupational therapists; and primary providers. The approach provides health and social services with oversight of the total health care plan by a case manager, clinical nurse specialist, or nurse practitioner. Interdisciplinary collaboration is required if a home health agency is to receive Medicare certification (Rector, 2018).

Most home health agencies are reimbursed by various sources, including Medicare and Medicaid programs, private insurance, and direct patient payment. Older adults are the most frequent users of home care expenditures financed by Medicare, which allows nurses to manage and evaluate care of seriously ill patients who have complex, labile conditions and are at high risk for rehospitalization. Each funding source has its own requirements for services rendered, number of visits allowed, and amount of reimbursement the agency receives. The Omaha System's care documentation, referred to as the Outcome and Assessment Information Set (OASIS), has been a requirement for some time to ensure that outcome-based care is provided for all care reimbursed by Medicare. This system uses sociodemographic, environment, support system, health status, and functional status domains to assess and plan care for adult patients. OASIS is also used to collect data and improve performance or quality outcomes (CMS, 2018b).

Services Provided

Many home care patients are acutely ill or have chronic health problems or disability requiring that nurses provide more education and monitoring to patients and families. Home health nurses make home visits to provide skilled nursing care, follow-up care, and education to promote health and prevent complications. Home health care visits may be intermittent or periodic, and case management via telephone or Internet may be used to promote communication with home care consumers. The nurse instructs the patient and family about skills, self-care strategies, and health maintenance and promotion activities (e.g., nutritional counseling, exercise programs, stress management). Nursing care includes skilled assessment of the patient's physical, psychological, social, and environmental status (Fig. 2-5). Nursing interventions may include intravenous (IV) therapy and injections, parenteral nutrition, venipuncture, catheter insertion, pressure injury treatment, wound care, ostomy care, and patient and family education. Complex

technical equipment such as mechanical ventilation and procedures such as peritoneal dialysis may be involved in home health care. Nurses have a role in evaluating the safety and effectiveness of technology in the home setting. In addition, **telehealth** is useful in home health care in facilitating exchange of information via telephone or computers between patients and nurses regarding health information such as blood glucose readings, vital signs, and cardiac parameters. The use of a broad spectrum of computer and Internet resources, such as webcams, also facilitates exchange of information (Rector, 2018).

Figure 2-5 • Assessment is an important part of any home health visit.

The Home Setting

The home health nurse is a guest in the patient's home and must have permission to visit and give care. The nurse has minimal control over the lifestyle, living situation, and health practices of the visited patients. This lack of full decision making authority can create a conflict for the nurse and lead to problems in the nurse–patient relationship. To work successfully with patients in any setting, the nurse must be nonjudgmental and convey respect for patients' beliefs, even if they differ sharply from those of the nurse. This can be difficult when a patient's lifestyle involves activities that a nurse considers harmful or unacceptable, such as smoking, excessive use of alcohol, use of illicit drugs or misuse of prescription drugs, or overeating (Rector, 2018).

The cleanliness of a patient's home may not meet the standards of a hospital. Although the nurse can provide education points about maintaining clean surroundings, the patient and family decide if they will implement the nurse's

suggestions. The nurse must accept their decisions and deliver the care required regardless of the conditions of the setting. The kind of equipment and the supplies or resources that usually are available in acute care settings are often unavailable in the patient's home. The nurse has to learn to improvise when providing care, such as when changing a dressing or catheterizing a patient in a regular bed that is not adjustable and lacks a bedside table (Rector, 2018).

Infection control is as important in the home as it is in the hospital; however, it can be more challenging in the home and requires creative approaches. As in any situation, it is important to perform hand hygiene before and after giving direct patient care, even in a home that does not have running water. If aseptic technique is required, the nurse must have a plan for implementing this technique before going to the home. This applies to universal precautions, transmission-based precautions, and disposal of bodily secretions and excretions. If injections are given, the nurse must use a closed container to dispose of syringes. Injectable and other medications must be kept out of the reach of children during visits and stored in a safe place if the medications remain in the home.

Quality and Safety Nursing Alert

Friends, neighbors, or family members may ask the nurse about the patient's condition. The patient has a right to confidentiality, and information should be shared only with the patient's permission. The nurse should be mindful of any sensitive information (e.g., electronic health records [EHRs]) taken into the home and prevent it from being misplaced or picked up by others.

Home Health Visits

Most agencies have a policy manual that identifies the agency's philosophy and procedures and defines the services provided. The eligibility of a patient and provision of services may be prescribed by the type of insurance the patient carries. For example, Medicare beneficiaries must meet certain eligibility requirements such as homebound criteria and may be permitted only intermittent skilled services of a registered nurse or licensed therapist (CMS, 2019). Becoming familiar with these policies is essential before initiating a home visit. It is also important to know the state laws regarding what actions to take if the nurse finds a patient dead, suspects abuse, determines that a patient cannot safely remain at home, or observes a situation that possibly indicates harm to the community at large.

Preparing for a Home Visit

Before making a home visit, the nurse should review pertinent data about the patient that is typically provided on a referral form. It may be necessary to contact the referring agency if the purpose for the referral is unclear or important

information is missing. The nurse calls the patient to obtain permission to visit, schedules a time for the visit, and verifies the address. This initial phone conversation provides an opportunity to introduce oneself, identify the agency, and explain the reason for the visit. If the patient does not have a telephone, the nurse should see if the person who made the referral is able to contact the patient regarding the visit. If an unannounced visit to a patient's home must be made, the nurse should ask permission to come in before entering the house. Explaining the purpose of the referral at the outset and setting up the times for future visits before leaving are also recommended.

Conducting a Home Visit

Personal Safety Precautions

Home health nurses must pay attention to personal safety, because they often practice in unknown environments. Based on the principle of due diligence, agencies should investigate at-risk working environments prior to making the assignment and must inform employees accordingly. Agencies have policies and procedures concerning the promotion of safety for clinical staff, and training is provided to facilitate personal safety. The individual nurse and agency must proactively assess environments for safety. Suggested precautions to take when making a home visit are presented in Chart 2-7.

Initial Home Visit

The first visit sets the tone for subsequent visits and is crucial in establishing the nurse–patient relationship. The situations encountered depend on numerous factors. Patients may be in pain and have additional factors that make them unable to care for themselves. Family members may be overwhelmed and doubt their ability to care for loved ones. They may not understand why the patient was sent home from the hospital before being totally rehabilitated. They may not comprehend what home care is or why they cannot have 24-hour nursing services. It is critical that the nurse conveys an understanding of what patients and families are experiencing and how the illness is affecting their lives.

Chart 2-7

Safety Precautions in Home Health Care

- Learn, or preprogram a phone with, the telephone numbers of the agency, police, and emergency services. Most agencies provide phones for nurses so that the agency can contact the nurse and the nurse can easily contact the agency.
- Carry agency identification and a charged phone to make telephone calls if you become lost or have problems; a mobile phone charger provides additional backup.
- Let the agency know your daily schedule and the telephone numbers of your patients (if available) so that you can be located if you do not return when expected.
- Know where the patient lives before leaving to make the visit, and either carry a map or use the navigation system in your car or the GPS software on your smartphone for quick referral.
- Keep your car in good working order, and have sufficient gas in the tank.
- Park the car near the patient's home, and lock the car during the visit.
- Do not drive an expensive car or wear expensive jewelry when making visits.
- Know the regular bus schedule, and know the routes when using public transportation or walking to the patient's house.
- When making visits in high-crime areas, visit with another person rather than alone (if possible).
- Try to schedule visits during daylight hours (when possible).
- Never walk into a patient's home uninvited; be vigilant for unrestrained pets.
- If you do not feel safe entering a patient's home, leave the area.
- Become familiar with the layout of the house, including exits from the house.
- If a patient or family member is visibly intoxicated, under the influence, or hostile, leave and reschedule the visit.
- If a family is having a serious argument or abusing the patient or anyone else in the household, leave, reschedule the visit, contact your supervisor, and report the abuse to the appropriate authorities.

GPS, Global Positioning System.

During the initial home visit, which may take 1 hour or more, the patient is evaluated and a plan of care is established that may be modified on subsequent visits. The nurse informs the patient of the agency's practices, policies, and hours of operation. If the agency is to be reimbursed for the visit, the nurse asks for insurance information, such as a Medicare or Medicaid card. The initial assessment includes evaluating the patient, the home environment (Chart 2-8), the patient's self-care abilities or the family's ability to provide care, and the patient's need for additional resources. After the assessment, necessary skilled interventions are accomplished. Most agencies provide nurses with bags that contain standard supplies and equipment needed during home visits. It is

important to keep the bag properly supplied and to bring any additional items that might be needed for the visit. Depending on insurance coverage, supplies may be delivered to the home or may need to be purchased by the patient. Home health nurses need to be prepared for the inevitability that a patient may not have the medical supplies needed for treatment, and work to procure all needed items.

One important aspect of the transition from hospital to home is self-management of the medication regimen. Older adults may have multiple prescribers, or may use alternative therapies such as herbal remedies as well as vitamins and other over-the-counter medications. While the patient is under the care of the home health agency, the home health nurse promotes medication management through the process of medication reconciliation. The nurse reviews current medication orders and assists with solving problems or medication discrepancies such as wrong dosages, duplicate medications, omissions, or use of a medication for something other than the prescribed reason (Kollerup, Curtis, & Schantz Laursen, 2018). Home health agencies may mandate medication reconciliation at each skilled nursing visit. As patients and families observe medication reconciliation, they begin to understand the importance of medication management. Managing the medication regimen is an important part of a successful transition home; without it, there is risk for readmission to the hospital.

Chart 2-8 **ASSESSMENT**

Assessing the Home Environment

Physical Facilities (check all that apply)

Exterior

- Steps
- Unsafe steps
- Porch
- Litter
- Noise
- Adequate lighting
- Other

Interior

- Accessible bathroom
- Level, safe floor surface
- Number of rooms
- Privacy
- Sleeping arrangements
- Refrigeration
- Trash management
- Animals
- Adequate lighting
- Steps/stairs
- Other

Safety Hazards (check all that apply)

- None
- Inadequate floor, roof, or windows
- Inadequate lighting
- Unsafe gas/electric appliances
- Inadequate heating
- Inadequate cooling
- Lack of fire safety devices
- Unsafe floor coverings
- Inadequate stair rails
- Lead-based paint (particularly for homes built prior to 1978) or lead in drinking water (particularly in homes built prior to 1986)
- Improperly stored hazardous material
- Improper wiring/electrical cords
- Other

Safety Factors (check all that apply)

- Fire/smoke detectors
- Working telephone

- Placement of electrical cords
- Emergency plan
- Emergency phone numbers displayed
- Safe portable heaters
- Oxygen in use
- Obstacle-free paths
- Other

Determining the Need for Future Visits

While assessing a patient's situation, the home health nurse evaluates and clearly documents the need for future visits and the optimal frequency for those visits. To make these judgments, the nurse should consider the questions listed in Chart 2-9. With each subsequent visit, these same factors are evaluated to determine the continuing health needs of the patient. As progress is made and the patient—with or without the help of significant others—becomes more capable of self-care and more independent, the need for home visits may decline.

Ending the Visit

As the visit comes to a close, the nurse summarizes the main points of the visit for the patient and family and identifies expectations for future visits or patient achievements. The following points should be considered at the end of each visit:

- What are the main points the patient or family should remember from the visit?
- What positive attributes have been noted about the patient and the family that will give a sense of accomplishment?
- What were the main points of the education plan or the treatments needed to ensure that the patient and family understand what they must do? A written set of instructions should be left with the patient or family, provided they can read and see (alternative formats include video or audio recordings). Printed material must be in the patient's primary language and in large print when indicated.
- Whom should the patient or family call if someone needs to be contacted immediately? Are current emergency telephone numbers readily available? Is telephone service available, or can an emergency phone service be provided?
- What signs of complications should be reported immediately?
- How frequently will visits be made? How long will they last (approximately)?
- What is the day and time of the next visit? Will a different nurse make the visit?

Documenting the Visit

Documentation considerations for home visits follow fairly specific regulations. The patient's needs and the nursing care provided must be documented to ensure

that the agency qualifies for payment for the visit. Medicare, Medicaid, and other **third-party payers** (i.e., organizations that provide reimbursement for services covered under a health care insurance plan) require documentation of the patient's homebound status and the need for skilled professional nursing care. The medical diagnosis and specific detailed information on the functional limitations of the patient are usually part of the documentation. The goals and the actions appropriate for attaining those goals must be identified. Expected outcomes of the nursing interventions must be stated in terms of patient behaviors and must be realistic and measurable. In addition, the goals must reflect the nursing diagnosis or the patient's problems and must specify those actions that address the patient's problems. Inadequate documentation may result in nonpayment for the visit and care services.

Chart 2-9 **ASSESSMENT**

Assessing the Need for Home Visits

Current Health Status

- How well is the patient progressing?
- How serious are the present signs and symptoms?
- Has the patient shown signs of progressing as expected, or does it seem that recovery will be delayed?

Home Environment

- Are safety concerns apparent?
- Are family or friends available to provide care, or is the patient alone?

Level of Self-Care Ability

- Is the patient capable of self-care?
- What is the patient's level of independence?
- Is the patient ambulatory or bedridden?
- Does the patient have sufficient energy, or are they frail and easily fatigued?
- Does the patient need and use assistive devices?

Level of Nursing Care Needed

- What level of nursing care does the patient require?
- Does the care require basic skills or more complex interventions?

Prognosis

- What is the expectation for recovery in this particular instance?
- What are the chances that complications may develop if nursing care is not provided?

Educational Needs

- How well has the patient or family grasped the education points made?
- Is there a need for further follow-up and retraining?
- What level of proficiency does the patient or family show in carrying out the necessary care?

Mental Status

- How alert is the patient?
- Are there signs of confusion or thinking difficulties?
- Does the patient tend to be forgetful or have a limited attention span?

Level of Adherence

- Is the patient following the instructions provided?
- Does the patient seem capable of following the instructions?

- Are the family members helpful, or are they unwilling or unable to assist in caring for the patient as expected?

Discharge Planning for Transition to the Community or Home Care Setting

Discharge planning is an essential component of facilitating the transition of the patient from the acute care to the community or home care setting, or for facilitating the transfer of the patient from one health care setting to another. A documented discharge plan is mandatory for patients who receive Medicare or Medicaid health insurance benefits. Discharge planning begins with the patient's admission to the hospital or health care setting and must consider the potential for necessary follow-up care in the home or another community setting. Several different personnel (e.g., social workers, home health nurses, case managers) or agencies may be involved in the planning process.

The development of a comprehensive discharge plan requires collaboration between professionals at the referring agency and the home care agency, as well as other community agencies that provide specific resources upon discharge. The process involves identifying the patient's needs and developing a thorough plan to meet them. It is essential to have open lines of communication with family members to ensure understanding and cooperation.

Continuing the Transition through Community Resources and Referrals

Case managers and discharge planners often make referrals to other team members, such as home health aides and social workers. These nurses work collaboratively with the health care team and the referring agency or person. Continuous coordinated care among all health care providers involved in a patient's care is essential to avoid duplication of effort by the various personnel caring for the patient. These nurses must also be knowledgeable about community resources available to patients, as well as services provided by local agencies, eligibility requirements for those services, and any charges for the services (i.e., co-pays). Most communities have directories, which may include online directories or resource booklets, that list local health and social service agencies and their offerings. The Internet is useful in helping patients identify the location and accessibility of grocery and drug stores, banks, health care facilities, ambulances, primary providers, dentists, pharmacists, social service agencies, and senior citizens' programs. In addition, a patient's place of worship or faith community may be an important resource for services. The process includes informing the patient and family about the community resources available to meet their needs. When appropriate, nurses may make the initial contact.

CRITICAL THINKING EXERCISES

1 pq An 80-year-old community-dwelling woman with a new diagnosis of heart failure was transferred to your medical-surgical unit from the intensive care unit (ICU). The transfer report from the ICU nurse included the notation that prior to this admission and diagnosis, the patient lived alone at home. The patient has one son who lives locally. Both the patient and son agree with a plan to transition the patient from living alone to living with her son at his home. She has been prescribed new medications to take at home and will need to see her primary provider in 2 weeks. What are your priorities as you work on discharge planning for this patient? What referrals will you consider to achieve a successful transition from hospital to home?

2 ebp An 82-year-old man newly diagnosed with diabetes is being referred for home care after discharge from the hospital. He needs regular monitoring and diabetes education. He has several family members at home who have assisted with IADLs in the past; however, they all work. You are concerned about his ability to manage his diabetes as his family reports he will be home alone during the day and has decreased activity tolerance related to ADLs since his hospitalization and new diagnosis of diabetes. Identify a specific evidence-based question related to this patient in order to conduct a relevant and focused literature search. What key words would you use in this search, and what sources would be appropriate to search? What resources could you use to assist him to remain in his home for as long as possible? How would you go about obtaining this information? What is the strength of the evidence?

3 ipc You are a home health nurse caring for a 75-year-old man who has transitioned home from inpatient rehabilitation following a fall in which his hip was fractured. He had surgery to reduce the fracture and stabilize the hip. He lives with his wife who is also 75 and who has memory impairment. Both need assistance with IADLs. He needs assistance with ADLs as he continues the rehabilitation process at home. As the home health nurse and case manager, develop a list of resources and interdisciplinary services that will enhance this transition to the home setting.

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3 Health Education and Health Promotion

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the purposes and significance of health education.
2. Distinguish between the concepts of adherence to a therapeutic regimen and health literacy.
3. Explain the variables that affect learning and apply them to the teaching—learning process.
4. Describe the components of health promotion and discuss major health promotion models.
5. Specify the variables that affect health promotion activities across the life cycle, and describe the role of the nurse in health promotion.

NURSING CONCEPTS

Community-Based Practice
Family
Health Promotion
Health, Wellness, and Illness
Managing Care
Stress and Coping
Teaching and Learning

GLOSSARY

adherence: the process of faithfully following guidelines or directions

community: an interacting population of individuals living together within a larger society

feedback: the return of information given to a person

health education: various learning experiences designed to promote behaviors that facilitate health

health literacy: the capability of a person to obtain, communicate, process, and understand essential health information for the purpose of securing health care services and for making health care decisions

health promotion: activities that assist people in developing resources to maintain or enhance well-being and improve quality of life

learning: the act of acquiring knowledge, attitudes, or skills

learning readiness: the optimum time for learning to occur; usually corresponds to the learner's perceived need and desire to obtain specific knowledge

nutrition: the science that deals with food and nourishment in humans

physical fitness: the condition of being physically healthy as a result of proper exercise and nutrition

self-responsibility: personal accountability for one's actions or behavior

stress management: behaviors and techniques used to strengthen a person's resources against stress

teaching: helping another person learn

therapeutic regimen: a routine that promotes health and healing

Effective health education lays a solid foundation for individual and **community** (population of individuals living together within a larger society) wellness. All nurses use teaching as a tool to assist patients and families in developing effective health behaviors and altering lifestyle patterns that predispose people to health risks. Health education is an influential factor directly related to positive health outcomes.

Purpose of Health Education

Today's health care environment mandates the use of an organized approach to **health education** (learning experiences designed to promote behaviors that facilitate health) so that patients can meet their specific health care needs. There are many reasons for providing health education.

Meeting Nursing Standards

Teaching, as a function of nursing, is included in all state nurse practice acts and in the American Nurses Association's (ANA's) *Scope and Standards of Practice* (ANA, 2015). Health teaching and health promotion are independent functions of nursing practice and essential nursing responsibilities. All nursing care is directed toward promoting, maintaining, and restoring health; preventing illness; and helping people adapt to the residual effects of illness. Many of these nursing activities are accomplished through patient education. Nurses are challenged to focus on the health education needs of communities and to provide specific patient and family education. Health education is important to nursing care because it affects the abilities of people and families to perform important self-care activities.

Every contact a nurse has with a health care consumer, whether or not that person is ill, should be considered an opportunity for health education. Although people have a right to decide whether to learn, nurses have the responsibility to present information that motivates people to recognize the need to learn. Therefore, nurses must use opportunities in all health care settings to promote wellness. There are many educational environments. Some examples include homes, hospitals, community health centers, schools, places of business, service agencies, shelters, and consumer action or support groups (deChesnay & Anderson, 2020).

Supporting Informed Decision Making and Self-Care

The emphasis on health education stems in part from the public's right to comprehensive health care, which includes up-to-date health information. It also reflects the emergence of an informed public that is asking more questions about health and health care. Because of the importance that American society places on health and the responsibility that all people must maintain and promote their own health, members of

the health care team, specifically nurses, are obligated to make health education available. Significant factors to consider when planning patient education include the availability of health care, the use of diverse health care providers to accomplish care management goals, and the increased use of complementary and alternative strategies rather than traditional approaches to care. Without adequate knowledge and training in self-care skills, consumers cannot make informed decisions about their health. Guidance from nurses may assist consumers to obtain health information from trustworthy, credible, and timely Internet resources, as well as from appropriate health promotion practitioners and researchers (Cohn, Lyman, Broshek, et al., 2018). People with chronic illnesses and disability are among those most in need of health education. As the lifespan of the population increases, the number of people with such illnesses also increases. Health information targeted at identifying and managing the exacerbations or issues commonly associated with having a chronic illness or disability is a major focus of health education. People with chronic illness need health care information to participate actively in and assume responsibility for self-care. Health education can help those with chronic illness adapt to their illness, prevent complications, carry out prescribed therapy, and solve problems when confronted with new situations. It can also help to prevent crisis situations and reduce the potential for rehospitalization resulting from inadequate information about self-care. The goal of health education is to teach people to live a healthy life and strive toward achieving their maximum health potential.

In addition to the public's right to and desire for health education, patient education is also a strategy for promoting self-care at home and in the community, reducing health care costs by preventing illness, effectively managing necessary therapies, avoiding expensive medical interventions, decreasing lengths of hospital stay, and facilitating earlier discharge. For health care agencies, offering community wellness programs is a public relations tool for increasing patient satisfaction and for developing a positive image of the institution. Patient education is also a cost-avoidance strategy in that positive staff–patient relationships may avert malpractice suits. Some insurance companies support health education through reimbursement for programs, such as diabetes management classes and fitness and weight management programs.

Promoting Adherence to the Therapeutic Regimen

One of the goals of patient education is to encourage people to adhere to their **therapeutic regimen** (a routine that promotes health and healing). **Adherence** (the process of faithfully following guidelines or directions) to treatment usually requires that a person make one or more lifestyle changes to carry out specific activities that promote and maintain health. Common examples of behaviors facilitating health include taking prescribed medications, maintaining a healthy diet, increasing daily activities and exercise, self-monitoring for signs and symptoms of illness and changes in baseline health status, practicing specific hygiene measures, seeking recommended health evaluations and screening, and performing other therapeutic and preventive measures.

Factors Affecting Adherence

Many people do not adhere to their prescribed regimens; rates of adherence are generally low, especially when the regimens are complex or of long duration (e.g., therapy for chronic inflammatory rheumatic diseases, hypertension, breast cancer, human immune deficiency virus [HIV] infection, hemodialysis). Nonadherence to prescribed therapy has been the subject of many studies (Al-Noumani, Wu, Barksdale, et al., 2019; Hine, Smith, Eshun-Wilson, et al., 2018; Lambert, Balneaves, Howard, et al., 2018; Lavielle, Puyraimond-Zenmour, Romand, et al., 2018). For the most part, findings have been inconclusive, and no one predominant causative factor has been identified. Instead, a wide range of variables influences the degree of adherence, including the following:

- Demographic variables, such as age, gender, race, socioeconomic status, and level of education
- Illness variables, such as the severity of the illness and the relief of symptoms afforded by the therapy
- Therapeutic regimen variables, such as the complexity of the regimen, treatment fatigue, and uncomfortable side effects
- Psychosocial variables, such as intelligence, motivation, availability of significant and supportive people (especially family members and significant others), competing or conflicting demands, attitudes toward health professionals, acceptance or denial of illness, substance abuse, and religious or cultural beliefs
- Financial variables, especially the direct and indirect costs associated with a prescribed regimen

Another factor to consider when the nurse is developing strategies to promote patient adherence is the concept of **health literacy** or the capability of a person to obtain, communicate, process, and understand essential health information for the purpose of securing health care services and for making health care decisions. A challenge for all health care providers is to improve the health literacy of patients. In establishing suitable health education materials, technologic innovations and services, providers must communicate health information in plain language and work with patients to promote accurate processing and understanding of the health information. Nurses must consider their knowledge of the myriad factors that affect health literacy in any given population. The primary factors influencing health literacy are the effective use of communication and cultural skills, along with the presentation of health care information, and a basic background of mathematical skills. Without such skills, patients are at risk for being unable to share personal health information, perform self-care management for both acute and chronic health conditions, navigate through health systems and complete health forms, and calculate information such as nutritional information on food labels (Carrara & Schulz, 2018; Osborne, 2018).

Health literacy skills are basic to understanding the body and how it functions, assessing lifestyle choices along with the variables that cause and perpetuate disease, as well as making health care decisions. If people have low health literacy, the consequence is poor overall health. Deconstructing this cycle of low health literacy leading to poor health status and higher risk of health problems is essential. To increase health literacy, providers must design and distribute accurate health information and must ensure that these health materials are culturally appropriate for various populations. It is imperative to build community partnerships to support education and public health activities. Nurses can be instrumental in performing evaluation research on the educational undertakings that support individuals, groups, or communities. Furthermore, nurses must be directly involved in facilitating change through the development of health care policies that address the promotion of a health literate society (Patton, Zalon, & Ludwick, 2019).

Nurses' success with health education is determined by both the development of strong health literacy and the ongoing assessment of the variables that affect patients' ability to adopt specific behaviors to obtain resources, and maintain a healthy social environment (Edelman & Kudzma, 2018). Programs are more likely to succeed if patients have

improved health literacy and providers pay careful attention to the variables affecting patient adherence. Both health literacy and the concept of adherence must be considered in the patient's teaching plan. Teaching strategies are discussed later in the chapter.

Motivation

The problem of nonadherence to therapeutic regimens is substantial and must be addressed before patients can achieve their maximum health potential. Patients' need for knowledge has not been found to be a sufficient stimulus for acquiring knowledge and thereby enabling complete adherence to a health regimen. Teaching directed toward stimulating patient motivation results in varying degrees of adherence. Research suggests that factors such as personal relevance of strategies for self-care, perceived control, and type of health problem must also be considered (Seibre, Toumpakari, Turner, et al., 2018; Whiteley, Brown, Lally, et al., 2018). The variables of choice, establishment of mutual goals, and quality of the patient–provider relationship also influence the behavioral changes that can result from patient education. Many factors are linked to motivation for learning.

Using a learning contract or agreement can also be a motivator for learning. Such a contract is based on assessment of patient needs; health care data; and specific, measurable goals (Miller & Stoeckel, 2019). The learning contract is recorded in writing and contains methods for ongoing evaluation. A well-designed learning contract is realistic and positive. In a typical learning contract, a series of measurable goals is established, beginning with small, easily attainable objectives and progressing to more advanced goals. Frequent, positive reinforcement is provided as the person moves from one goal to the next. For example, incremental goals such as weight loss of 1 to 2 pounds per week are more appropriate in a weight reduction program than a general goal such as a 30-pound weight loss.

Gerontologic Considerations

Nonadherence to therapeutic regimens is a significant problem for older adults, leading to increased morbidity, mortality, and cost of treatment (Abada, Clark, Sinha, et al., 2019; Taylor, Coogle, Cotter, et al., 2019). Many admissions to nursing homes and hospitals are associated with nonadherence.

Older adults frequently have one or more chronic illnesses that are managed with numerous medications, and their disease course may be complicated by periodic acute episodes (Miller, 2019). Older adults may have additional issues that affect adherence to therapeutic regimens, such as increased sensitivity to medications and their side effects, difficulty in adjusting to change and stress, financial constraints, forgetfulness, inadequate support systems, lifetime habits of self-treatment with over-the-counter medications, visual and hearing impairments, and mobility limitations. To promote adherence among older adults, all variables that may affect health behavior should be assessed (Fig. 3-1). Nurses must also consider that cognitive impairment may result in the older adult's inability to draw inferences, apply information, or understand the major points (Mauk, 2017; Touhy & Jett, 2018). The person's strengths and limitations must be assessed to encourage the use of existing strengths to compensate for limitations. Above all, health care professionals must work together to provide continuous, coordinated care; otherwise, the efforts of one health care professional may be negated by those of another.

The Nature of Teaching and Learning

Learning can be defined as acquiring knowledge, attitudes, or skills. **Teaching** is defined as helping another person learn. These definitions indicate that the teaching–learning process is an active one, requiring the involvement of both the teacher and the learner in the effort to reach the desired outcome—a change in behavior. The teacher does not simply give knowledge to the learner but instead serves as a facilitator of learning. Although learning can take place without teachers, most people who are attempting to learn new or altered health behaviors benefit from contact with a nurse. The interpersonal interaction between the person and the nurse who is attempting to meet the person's learning needs may be formal or informal, depending on the method and techniques of teaching.

Figure 3-1 • Taking time to teach patients about their medication and treatment program promotes interest and cooperation. Older adults who are actively involved in learning about their medication and treatment program and the expected effects may be more likely to adhere to the therapeutic regimen.

There is no definitive theory about how learning occurs and how it is affected by teaching. However, learning can be affected by factors, such as readiness to learn, the learning environment, and the teaching techniques used (Miller & Stoeckel, 2019).

Learning Readiness

One of the most significant factors influencing learning is a person's **learning readiness** or the optimum time for learning to occur, which usually corresponds to the learner's perceived need and desire to obtain specific knowledge. For adults, readiness is based on culture, personal values, physical and emotional status, and past experiences in learning. The "teachable moment" occurs when the content and skills being taught are congruent with the task to be accomplished (Miller & Stoeckel, 2019).

Culture encompasses values, ideals, and behaviors, and the traditions within each culture provide the framework for solving the issues and concerns of daily living. Because people with different cultural backgrounds have different values and lifestyles, choices about health care vary. Culture is a major variable influencing readiness to learn because it affects how people learn and what information can be learned. Sometimes people do not accept health teaching because it conflicts with culturally mediated values. Before beginning health teaching, nurses must conduct an individual cultural assessment instead of relying only on generalized assumptions about a particular culture. A patient's social and cultural patterns must be appropriately incorporated into the teaching–learning interaction. See Chapter 4, Chart 4-7, which describes cultural assessment components to consider when formulating a teaching plan.

A person's values include beliefs about behaviors that are desirable and undesirable. The nurse must know what value the patient places on health and health care. In clinical situations, patients express their values through their actions and the level of knowledge pursued (deChesnay & Anderson, 2020). When the nurse is unaware of the patient's values (cultural and personal), misunderstanding, lack of cooperation, and negative health outcomes may occur (McFarland & Wehbe-Alamah, 2018). A person's values and behaviors can be either an asset or a deterrent to readiness to learn. Therefore, patients are unlikely to accept health education unless their values and beliefs about health and illness are respected (Kersey-Matusiak, 2018).

Physical readiness is of vital importance, because until the person is physically capable of learning, attempts at teaching and learning may be both futile and frustrating. For example, a person in acute pain is unable to focus attention away from the pain long enough to concentrate on learning. Likewise, a person who is short of breath concentrates on breathing rather than on learning.

Emotional readiness also affects the motivation to learn. A person who has not accepted an existing illness or the threat of illness is not motivated to learn. A person who does not accept a therapeutic regimen, or who views it as conflicting with their present lifestyle, may consciously avoid learning about it. Until the person recognizes the need to learn and demonstrates an ability to learn, teaching efforts may be thwarted. However, it is not always wise to wait for the person to become emotionally ready to learn, because that time may never come unless the nurse makes an effort to stimulate the person's motivation. For example, a person with colon cancer who has a fasting blood sugar twice

the expected normal value may focus only on the cancer diagnosis and exclude or deny the health consequences of an abnormal blood sugar.

Illness and the threat of illness are usually accompanied by anxiety and stress. Nurses who recognize such reactions can use simple explanations and instructions to alleviate these anxieties and provide further motivation to learn. Because learning involves behavior change, it often produces mild anxiety, which can be a useful motivating factor.

Emotional readiness can be promoted by creating a warm, accepting, positive atmosphere and by establishing realistic learning goals. When learners achieve success and a feeling of accomplishment, they are often motivated to participate in additional learning opportunities. One example of a strategy that facilitates learner success is the teach-back technique. This technique is used to evaluate the recall and understanding of the learner after health teaching has occurred. It is a useful, in-the-moment feedback and evaluation method because it allows the educator to discover if the learner can effectively verbalize information or demonstrate a particular health behavior (Miller & Stoeckel, 2019). In addition, the teach-back strategy can be used with family members and caregivers to ascertain if they have retained and understood the health content. Having a strategy to actively involve the adult learner in making health care decisions and performing self-management skills promotes learner receptivity and motivation to integrate health principles into one's daily life. Furthermore, **feedback** (the return of information given to a person) about progress also motivates learning. Such feedback should be presented in the form of positive reinforcement when the learner is successful, and in the form of constructive suggestions for improvement when the learner is unsuccessful.

Experiential readiness refers to past experiences that influence a person's ability to learn. Previous educational experiences and life experiences in general are significant determinants of a person's approach to learning. People with little or no formal education may not be able to understand the instructional materials presented. People who have had difficulty learning in the past may be hesitant to try again. Many behaviors required for reaching maximum health potential require knowledge, physical skills, and positive attitudes. In their absence, learning may be very difficult and very slow. For example, a person who does not understand the basics of normal **nutrition** (the science that deals with food and nourishment in humans) may not be able to understand the restrictions of a specific diet. A person who does not view

the desired learning as personally meaningful may reject teaching efforts. A person who is not future oriented may be unable to appreciate many aspects of preventive health teaching. Experiential readiness is closely related to emotional readiness, because motivation tends to be stimulated by an appreciation for the need to learn and by those learning tasks that are familiar, interesting, and meaningful.

The Learning Environment

Learning may be optimized by minimizing factors that interfere with the learning process. For example, the room temperature, lighting, noise levels, use of functional assistive devices such as glasses and hearing aids, and other environmental conditions should be appropriate to the learning situation. In addition, the time selected for teaching should be suited to the needs of the individual person. Scheduling a teaching session at a time of day when a patient is fatigued, uncomfortable, or anxious about a pending diagnostic or therapeutic procedure, or when visitors are present, is not conducive to learning. However, if the family is to participate in providing care, the sessions should be scheduled when family members are present so that they can learn any necessary skills or techniques.

Teaching Techniques and Resources

Teaching techniques and methods enhance learning if they are appropriate to the patient's needs. Nurses use a variety of teaching techniques to educate patients in many different settings. Techniques that are available include the following:

- *Lectures:* Lectures are explanation methods of teaching and should be accompanied by discussion, because discussion affords learners opportunities to express their feelings and concerns, ask questions, and receive clarification.
- *Group teaching:* Group teaching allows people not only to receive needed information but also to feel secure as members of a group (promoting moral support). Assessment and follow-up are imperative to ensure that each person has gained sufficient knowledge and skills. Not all patients relate or learn well in groups.
- *Demonstration and practice:* Demonstration and practice are especially important when teaching skills. The nurse should

demonstrate the skill and then give the learner ample opportunity for practice. When special equipment is involved, such as syringes or colostomy bags, it is important to teach with the same equipment that will be used in the home setting to avoid confusion, frustration, and mistakes.

- *Reinforcement and follow-up:* Nurses must allow ample time for patients to learn and provide reinforcement. Follow-up sessions are imperative to promote the learner's confidence in their abilities and to plan for additional teaching sessions.
- *Motivational interviewing:* Pilot research suggests that using motivational interviewing as an enhanced educational method in an acute inpatient setting can increase both patient and caregiver knowledge as well as patient self-care (McKillop, Grace, de Melo Ghisi, 2018).
- *Electronic, online, or Internet information:* Electronic technologies are used to provide health information. Examples are interactive or noninteractive Internet learning, an online self-paced program, or a structured online course. There are also DVD, CD-ROM, podcasts, and recorded programs available over a television channel.
- *Teaching aids:* Teaching aids include books, pamphlets, pictures, films, slides, audiotapes, models, programmed instruction, other visual aids (e.g., charts), mobile device applications, and computer-assisted learning modules. They are invaluable when used appropriately and can save a significant amount of personnel time and related cost. However, all such aids should be reviewed before use to ensure that they meet the patient's learning needs and are free of advertisements that may confuse the patient. (See Resources section at the end of the chapter for additional information.)

The likelihood of success for educating patients is maximized when nurses, families, and other health care professionals work collaboratively to facilitate learning. Successful learning should result in improved self-care management skills, enhanced self-esteem, confidence, and a willingness to learn in the future. There are specific considerations for educating special populations. Table 3-1 outlines some of the strategies to use when educating people with disability. (See Chapters 7 and 8 for additional teaching strategies for people with disability and older adults.)

The Nursing Process in Patient Education

The nurse relies on the steps of the nursing process when constructing an individualized teaching plan to meet the patient's teaching and learning needs (Chart 3-1).

TABLE 3-1 Educating People with Disability

Type of Disability	Educational Strategy
Physical, Emotional, or Cognitive Disability	Adapt information to accommodate the person's cognitive, perceptual, and behavioral disabilities. Give clear written and oral information. Highlight significant information for easy reference. Avoid medical terminology or "jargon."
Hearing Impairment	Use slow, directed, deliberate speech. Use sign language or interpreter services if appropriate. Position yourself so that the person can see your mouth if speech reading. Use telecommunication devices (TTY or TDD) for the person with hearing impairment. Use written materials and visual aids, such as models and diagrams. Use captioned videos, films, and computer-generated materials. Speak on the side of the "good ear" if unilateral deafness is present.
Sensory Disability	Use optical devices such as a magnifying lens. Use proper lighting and proper contrast of colors on materials and equipment. Use or convert information to auditory and tactile formats if appropriate (e.g., Braille or large-print materials). Obtain audiotapes, CDs, digital audio available on smartphones or tablets, and talking books. Explain noises associated with procedures, equipment, and treatments. Arrange materials in clockwise pattern.
Learning Disabilities Input disability	If visual perceptual disorder: Explain information verbally; repeat and reinforce frequently. Use audiotapes, CDs, and digital audio. Encourage learner to verbalize information received. If auditory perceptual disorder: Speak slowly with as few words as possible; repeat and reinforce frequently. Use direct eye contact (as appropriate for the person's culture) to help focus on the task. Use demonstration and return demonstration, such as modeling, role-playing, and hands-on experiences. Use visual tools; written materials; and computers, tablets, and smartphones.
Output disability	Use all senses as appropriate.

	Use written, audiotape, and computerized or other electronic information. Review information and give time verbally to interact and ask questions. Use hand gestures and motions.
Developmental disability	Base information and teaching on developmental stage, not chronologic age. Use nonverbal cues, gestures, signing, and symbols as needed. Use simple explanations and concrete examples with repetition. Encourage active participation. Demonstrate information, and have person perform return demonstrations.

Assessment

Assessment in the teaching–learning process is directed toward the systematic collection of data about the patient's and family's learning needs and readiness to learn. The nurse identifies all internal and external variables that affect the patient's readiness to learn. Many learning assessment guides are available. Some guides are directed toward the collection of general health information (e.g., healthy eating), whereas others are specific to medication regimens or disease processes (e.g., stroke risk assessments). Such guides facilitate assessment but must be adapted to the responses, problems, and needs of each person. The nurse organizes, analyzes, synthesizes, and summarizes the assessment data collected and determines the patient's need for teaching.

Nursing Diagnosis

The process of formulating nursing diagnoses makes educational goals and evaluations of progress more specific and meaningful. Teaching is an integral intervention implied by all nursing diagnoses, and for some diagnoses, education is the primary intervention. Examples of nursing diagnoses that help in planning for educational needs are impaired health maintenance and decisional conflict. A nursing diagnosis that relates specifically to a patient's and family's learning needs serves as a guide in the development of the teaching plan.

Planning

Once the nursing diagnoses have been identified, the planning component of the teaching–learning process is established in accordance with the steps of the nursing process:

1. Assigning priorities to the diagnoses
2. Specifying the immediate, intermediate, and long-term goals of learning
3. Identifying specific teaching strategies appropriate for attaining goals
4. Specifying the expected outcomes
5. Documenting the diagnoses, goals, teaching strategies, and expected outcomes of the teaching plan

The assignment of priorities to the diagnoses should be a collaborative effort by the nurse and the patient or family members. Consideration must be given to the urgency of the patient's learning needs; the most critical needs should receive the highest priority.

Chart 3-1

Summary of the Nursing Process for Individualized Patient Education

Assessment

1. Assess the person's readiness for health education.
   a. What are the person's health beliefs and behaviors?
   b. What physical and psychosocial adaptations does the person need to make?
   c. Is the learner ready to learn?
   d. Is the person able to learn these behaviors?
   e. What additional information about the person is needed?
   f. Are there any variables (e.g., hearing or visual impairment, cognitive issues, literacy issues) that will affect the choice of teaching strategy or approach?
   g. What are the person's expectations?
   h. What does the person want to learn?
2. Organize, analyze, synthesize, and summarize the collected data.

Nursing Diagnosis

1. Formulate the nursing diagnoses that relate to the person's learning needs.
2. Identify the learning needs, their characteristics, and their etiology.

Planning

1. Assign priority to the nursing diagnoses that relate to the person's learning needs.
2. Specify the immediate, intermediate, and long-term learning goals established by teacher and learner together.
3. Identify teaching strategies appropriate for goal attainment.
4. Establish expected outcomes.
5. Develop the written teaching plan.
   a. Include diagnoses, goals, teaching strategies, and expected outcomes.
   b. Put the information to be taught in logical sequence.
   c. Write down the key points.
   d. Select appropriate teaching aids.
   e. Keep the plan current and flexible to meet the person's changing learning needs.
6. Involve the learner, family or significant others, nursing team members, and other health care team members in all aspects of planning.

Implementation

1. Put the teaching plan into action.
2. Use language that the person can understand.
3. Use appropriate teaching aids and provide Internet resources if appropriate.
4. Use the same equipment that the person will use after discharge.
5. Encourage the person to participate actively in learning.
6. Record the learner's responses to the teaching actions.
7. Provide feedback.

Evaluation

1. Collect objective data.
   a. Observe the person.
   b. Ask questions to determine whether the person understands.
   c. Use rating scales, checklists, anecdotal notes, and written tests when appropriate.
2. Compare the person's behavioral responses with the expected outcomes. Determine the extent to which the goals were achieved.
3. Include the person, family or significant others, nursing team members, and other health care team members in the evaluation.
4. Identify alterations that need to be made in the teaching plan.
5. Make referrals to appropriate sources or agencies for reinforcement of learning after discharge.
6. Continue all steps of the teaching process: assessment, diagnosis, planning, implementation, and evaluation.

Concept Mastery Alert

The nurse needs to keep in mind that before the teaching strategy can be determined, the goals of learning must be developed.

After the diagnostic priorities have been mutually established, it is important to identify the immediate and long-term goals and the teaching strategies appropriate for attaining the goals. Teaching is most effective when the objectives of both the patient and the nurse are in agreement (Bastable, 2017). Learning begins with the establishment of goals that are appropriate to the situation and realistic in terms of the patient's ability and desire to achieve them. Involving the patient and family in

establishing goals and in planning teaching strategies promotes their cooperation in the implementation of the teaching plan.

Outcomes of teaching strategies can be stated in terms of expected behaviors of patients, families, or both. Outcomes should be realistic and measurable, and the critical time periods for attaining them should be identified. The desired outcomes and the critical time periods serve as a basis for evaluating the effectiveness of the teaching strategies.

During the planning phase, the nurse must consider the sequence in which the subject matter is presented. Critical information (e.g., survival skills for a patient with diabetes) and material that the person or family identifies to be of particular importance must receive high priority. An outline is often helpful for arranging the subject matter and for ensuring that all necessary information is included. In addition, appropriate teaching aids to be used in implementing teaching strategies are prepared or selected at this time. Patient Education charts throughout this textbook guide teaching about self-care.

The entire planning phase concludes with the formulation of the teaching plan. This teaching plan communicates the following information to all members of the nursing team:

- The nursing diagnoses that specifically relate to the patient's learning needs and the priorities of these diagnoses
- The goals of the teaching strategies
- The teaching strategies that are appropriate for goal attainment
- The expected outcomes, which identify the desired behavioral responses of the learner
- The critical time period within which each outcome is expected to be met
- The patient's behavioral responses (which are documented on the teaching plan)

The same rules that apply to writing and revising the plan of nursing care apply to the teaching plan.

Implementation

In the implementation phase of the teaching–learning process, the patient, family, and other members of the nursing and health care team carry out the activities outlined in the teaching plan. The nurse coordinates these activities.

Flexibility during the implementation phase of the teaching–learning process and ongoing assessment of patient responses to the teaching strategies support modification of the teaching plan as necessary. Creativity in promoting and sustaining the patient's motivation to learn is essential. New learning needs that may arise after discharge from the hospital or after home care visits have ended should also be taken into account.

The implementation phase ends when the teaching strategies have been completed and when the patient's responses to the actions have been recorded. This serves as the basis for evaluating how well the defined goals and expected outcomes have been achieved.

Evaluation

Evaluation of the teaching–learning process determines how effectively the patient has responded to teaching and to what extent the goals have been achieved. An evaluation must be made to determine what was effective and what needs to be changed or reinforced. It cannot be assumed that patients have learned just because teaching has occurred; learning does not automatically follow teaching. An important part of the evaluation phase addresses the question, "What could be done to improve teaching and enhance learning?" Answers to this question direct the changes to be made in the teaching plan.

Various measurement techniques can be used to identify changes in patient behavior as evidence that learning has taken place. These techniques include directly observing the behavior; using rating scales, checklists, or anecdotal notes to document the behavior; and indirectly measuring results using oral questioning and written tests. All direct measurements should be supplemented with indirect measurements whenever possible. Using more than one measuring technique enhances the reliability of the resulting data and decreases the potential for error from a measurement strategy.

In many situations, measurement of actual behavior is the most accurate and appropriate evaluation technique. Nurses often perform comparative analyses using patient admission data as the baseline: Selected data points observed when nursing care is given and self-care is initiated are compared with the patient's baseline data. In other cases, indirect measurement may be used. Some examples of indirect measurement are patient satisfaction surveys, attitude surveys, and instruments that evaluate specific health status variables.

Measurement is only the beginning of evaluation, which must be followed by data interpretation and judgments about learning and teaching. These aspects of evaluation should be conducted periodically throughout the teaching–learning program, at its conclusion, and at varying periods after the teaching has ended.

Evaluation of learning after teaching that occurs in any setting (e.g., clinics, offices, nursing centers, hospitals) is essential, because the analysis of teaching outcomes must extend into aftercare. With shortened lengths of hospital stay and with short-stay and same-day surgical procedures, follow-up evaluation is especially important. Coordination of efforts and sharing of information between hospital- and community-based nursing personnel facilitate postdischarge teaching and home care evaluation.

Evaluation is not the final step in the teaching–learning process but is the beginning of a new patient assessment. The information gathered during evaluation should be used to redirect teaching actions, with the goal of improving the patient's responses and outcomes.

Health Promotion

Health teaching and health promotion are linked by a common goal—to encourage people to achieve as high a level of wellness as possible so that they can live maximally healthy lives and avoid preventable illnesses. The call for health promotion has become a cornerstone in health policy because of the need to control costs and reduce unnecessary sickness and death.

Health goals for the nation are established in the publication *Healthy People 2030.* The priorities from this initiative were identified as health promotion, health protection, and the use of preventive services. *Healthy People 2030* defines the current national health promotion and disease prevention initiative for the nation. Measurable goals for key health topics for the nation are shown in Chart 3-2. The overall goals are to (1) increase the quality and years of healthy life for people and (2) eliminate health disparities among various segments of the population (Haskins, 2017; U.S. Department of Health and Human Services, 2017).

Definition

Health promotion may be defined as those activities that assist people in developing resources that maintain or enhance well-being and improve their quality of life. These activities involve people's efforts to remain healthy in the absence of symptoms, may not require the assistance of a health care team member, and occur within or outside of the health system (Haber, 2019; O'Donnell, 2017).

Chart 3-2

Select Topics from the Proposed Objectives for *Healthy People 2030*

Access to Health Services
Adolescent Health
Arthritis, Osteoporosis, and Chronic Back Conditions
Blood Disorders and Blood Safety
Cancer
Chronic Kidney Disease
Dementias, Including Alzheimer's Disease
Diabetes
Disability and Health
Educational and Community-Based Programs

Adapted from Haskins, J. (2017). Healthy People 2030 to create objectives for health of nation: Process underway for next 10-year plan. *The Nation's Health*, *47*(6), 1–14; U.S. Department of Health and Human Services. (2017). *Healthy People 2030*. Retrieved on 7/15/2019 at: www.healthypeople.gov/2020/About-Healthy-People/Development-Healthy-People-2030/framework

The purpose of health promotion is to focus on the person's potential for wellness and to encourage appropriate alterations in personal habits, lifestyle, and environment in ways that reduce risks and enhance health and well-being. As discussed in Chapter 1, health is viewed as a dynamic, ever-changing condition that enables people to function at an optimal potential at any given time, whereas wellness, a reflection of health, involves a conscious and deliberate attempt to maximize one's health. Health promotion is an active process—that is, it is not something that can be prescribed or dictated. It is up to each person to decide whether to make changes to promote a higher level of wellness. Only the individual can make these choices.

Health Promotion Models

Several health promotion models identify health-protecting behaviors and seek to explain what makes people engage in preventive behaviors. A health-protecting behavior is defined as any behavior performed by people, regardless of their actual or perceived health condition, for the purpose of promoting or maintaining their health, whether or not the behavior produces the desired outcome (Murdaugh, Parsons, & Pender, 2019).

The Health Belief Model was designed to foster understanding of why some healthy people choose actions to prevent illness while others do not. Developed by Becker (1974), the model is based on the premise that four variables influence the selection and use of health promotion behaviors. Demographic and disease factors, the first variable, include patient characteristics, such as age, gender, education, employment, severity of illness or disability, and length of illness. Barriers, the second variable, are defined as factors leading to unavailability or difficulty in gaining access to a specific health promotion alternative. Resources, the third variable, encompass such factors as financial and social support. Perceptual factors, the fourth variable, consist of how the person views his or her health status, self-efficacy, and the perceived demands of the illness. Further research has demonstrated that these four variables have a positive correlation with a person's quality of life (Becker, Stuifbergen, Oh, et al., 1993).

Another model, the Resource Model of Preventive Health Behavior, addresses the ways in which people use resources to promote health (Murdaugh et al., 2019). It is based on Social Learning Theory and emphasizes the importance of motivational factors in acquiring and sustaining health promotion behaviors. This model explores how cognitive-perceptual factors affect the person's view of the importance of health. It also examines perceived control of health, self-efficacy, health status, and the benefits and barriers to health-promoting behaviors. Nurse educators can use this model to assess how demographic variables, health behaviors, and social and health resources influence health promotion.

The Canadian health promotion initiative, Achieving Health for All, builds on the work of Lalonde (1977), in which four determinants of health—human biology, environment, lifestyle, and the health care delivery system—were identified. Determinants of health were defined as factors and conditions that have an influence on the health of

individuals and communities. Since the 1970s, a total of 12 health determinants have been identified, and this number will continue to increase as population health research progresses. Determinants of health provide a framework for assessing and evaluating the population's health.

A model crafted to address organizational and individual health behavior change is the Awareness, Motivation, Skills, and Opportunity (AMSO) Model. The four components of this model focus on empowering people, understanding their individual priorities, and assisting them to change in personal ways that promote and maintain their optimal level of health. The dimensions of optimal health are physical, emotional, social, intellectual, and spiritual. This model promotes the process of creating and maintaining a balance among these five dimensions (O'Donnell, 2017). Optimal health is a dynamic condition kept in balance by a combination of efforts to sustain awareness, maintain motivation, build skills, and have opportunities to practice positive health behaviors.

The Transtheoretical Model of Change, also known as the Stages of Change Model, is a framework that focuses on the motivation of a person to make decisions that promote healthy behavior change (DiClemente, 2007). Table 3-2 shows the six stages in the model. Research indicates that people working with health professionals progress through these stages of change (Blake, Stanulewicz, & McGill, 2017; Chen, Palmer, & Lin, 2018; Das, Rouseff, Guzman, et al., 2019; Wen, Li, Wang, et al., 2018). Any of the models can serve as an organizing framework for clinical work and research that support the enhancement of health. Research suggests that the application of health promotion models, concepts, and frameworks increases the nurse's understanding of the health promotion behaviors of families and communities (Støle, Nilsen, & Joranger, 2019).

TABLE 3-2 Stages in the Transtheoretical Model of Change

Stage	Description
1. Precontemplative	The person is not thinking about making a change.
2. Contemplative	The person is only thinking about change in the near future.
3. Decision making	The person constructs a plan to change behavior.
4. Action	The person takes steps to operationalize the plan of action.
5. Maintenance	The person works to prevent relapse and to sustain the gains made from the actions taken.
6. Termination	The person has the ability to resist relapse back to unhealthy behavior(s).

Adapted from DiClemente, C. (2007). The transtheoretical model of intentional behavior change. *Drugs & Alcohol Today*, *7*(1), 29–33; Miller, C. A. (2019). *Nursing for wellness in older adults* (8th ed.). Philadelphia, PA: Wolters Kluwer.

Components of Health Promotion

Health promotion as an active process includes the following components: self-responsibility, nutritional awareness, stress reduction and management, and physical fitness.

Self-Responsibility

Taking responsibility for oneself is the key to successful health promotion. The concept of **self-responsibility**, personal accountability for one's actions or behavior, is based on the understanding that individuals control their lives. Each person alone must make the choices that determine the health of his or her lifestyle. As more people recognize that lifestyle and behavior significantly affect health, they may assume responsibility for avoiding high-risk behaviors, such as smoking or use of any electronic nicotine delivery systems (ENDS) (including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars), misuse of alcohol as well as prescription drugs and illegal drugs, overeating, driving under the influence, risky sexual practices, and other unhealthy habits. They may also assume responsibility for adopting routines that have been found to have a positive influence on health, such as engaging in regular exercise, wearing seat belts, and eating a healthy diet.

Various techniques have been used to encourage people to accept responsibility for their health, including public service announcements, educational programs, and reward systems. No one technique has been found to be superior to any other. Instead, self-responsibility for health

promotion is individualized and depends on a person's desires and inner motivations. Health promotion programs are important tools for encouraging people to assume responsibility for their health and to develop behaviors that improve health.

Nutritional Awareness

Nutrition, as a component of health promotion, has become the focus of considerable attention and publicity with the growing epidemic of obesity in the United States. A vast array of books and magazine articles address the topics of special diets; natural foods; and the hazards associated with certain substances, such as sugar, salt, cholesterol, trans fats, carbohydrates, artificial colors, and food additives. Research suggests that good nutrition is the single most significant factor in determining health status, longevity, and weight control (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2015).

Nutritional awareness involves an understanding of the importance of a healthy diet that supplies all essential nutrients. Understanding the relationship between diet and disease is an important facet of a person's self-care. Some clinicians believe that a healthy diet is one that substitutes "natural" foods for processed and refined ones and reduces the intake of sugar, salt, fat, cholesterol, caffeine, alcohol, food additives, and preservatives.

Chapter 4 contains further information about the assessment of a person's nutritional status. It describes the physical signs indicating nutritional status, assessment of food intake (food record, 24-hour recall), the dietary guidelines presented in the MyPlate plan (see Fig. 4-5), and calculation of body mass index (see Table 4-1).

Stress Reduction and Management

Stress management (behaviors and techniques used to strengthen a person's resources against stress), and stress reduction are important aspects of health promotion. Studies suggest the negative effects of stress on health and a cause-and-effect relationship between stress and infectious diseases, traumatic injuries (e.g., motor vehicle crashes), and some chronic illnesses. Stress has become inevitable in contemporary societies in which demands for productivity have become excessive. More and more emphasis is placed on encouraging people to manage stress appropriately and to reduce the pressures that are

counterproductive. Research suggests that including techniques such as relaxation training, exercise, yoga, and modification of stressful situations in health promotion programs assist patients in dealing with stress (Davidson, Graham, Montross-Thomas, et al., 2017; Hoogland, Lechner, Gonzalez, et al., 2018; Kim, Lee, Lee, et al., 2019; Morgan, Hourani, & Tueller, 2017; Moscoso, Goese, Van Hyfte, et al., 2019; Yadav, Yadav, Sarvottam, et al., 2017). Further information on stress management, including health risk appraisal and stress reduction methods such as the Benson Relaxation Response, can be found in Chapter 5.

Physical Fitness

Physical fitness (the condition of being physically healthy as a result of proper exercise and nutrition) is an important component of health promotion. Clinicians and researchers (Katsura, Takeda, Hara, et al., 2019; Loprinzi & Wade, 2019; Wisnieski, Dalimente-Merckling, & Robbins, 2019) who have examined the relationship between health and physical fitness have found that a regular exercise program can promote health in the following ways:

- Improve the function of the circulatory system and the lungs
- Decrease cholesterol and low-density lipoprotein levels
- Decrease body weight by increasing calorie expenditure
- Delay degenerative changes such as osteoporosis
- Improve flexibility and overall muscle strength and endurance

An appropriate exercise program can have a positive effect on a person's performance capacity, appearance, and level of stress and fatigue, as well as their general state of physical, mental, and emotional health (Gilbertson, Mandelson, Hilovsky, et al., 2019; Ma, West, Martin Ginis, et al., 2019; Pettigrew, Burton, Farrier, et al., 2019). An exercise program should be designed specifically for a given person, with consideration to age, physical condition, and any known cardiovascular or other risk factors. Exercise can be harmful if it is not started gradually and increased slowly in accordance with a person's response.

A significant amount of research suggests that people, by virtue of what they do or fail to do, influence their own health. Many diseases and disorders (e.g., diabetes, coronary artery disease, lung and colon cancer, chronic obstructive pulmonary diseases, hypertension, cirrhosis, traumatic injury, HIV infection) have been closely related to lifestyle behaviors. To a large extent, a person's health status may be reflective of

their lifestyle. For example, there is research examining how emerging adult patients with inflammatory bowel disease self-manage their chronic condition through the use of social support (Kamp, Luo, Holmstrom, et al., 2019). (See the Nursing Research Profile in Chart 3-3.)

Chart 3-3 **NURSING RESEARCH PROFILE**

Adherence to a Medication Regimen and Informational Support

Kamp, K. J., Luo, Z., Holmstrom, A., et al. (2019). Self-management through social support among emerging adults with inflammatory bowel disease. *Nursing Research*, *68*(4), 285–295.

Purpose

The purpose of this study was to examine the relationship between two conceptualizations of social support, (the first type was received social support and the second type was perceived availability of social support) and the self-management behaviors by emerging adults ages 18 to 29 years with inflammatory bowel disease (IBD).

Design

In this quantitative, cross-sectional study the researchers administered an online survey to 61 emerging adults with IBD who lived in the United States. This convenience sample was recruited from ResearchMatch, Facebook, and through word of mouth. The participants completed a composite survey consisting of a demographic data form, the Inventory of Dimensions of Emerging Adulthood, the Inventory of Socially Supportive Behaviors, the Medical Outcomes: Social Support Survey, the Medication Adherence Report Scale, and the Dietary Screener Questionnaire.

Findings

Of the 61 study participants, 90% were female and 10% were male. The sample was noted to be primarily single and educated. The major findings of the study indicated that emerging adults who had received high informational support reported greater adherence to the prescribed medication regimen as compared to participants who had received low informational support. Within this study the researchers controlled for medications, time since diagnosis, symptom frequency, and feeling in-between adolescence and adulthood. Neither one of the two types of social support were related to modification of participants' diet.

Nursing Implications

Nurses should be aware of the needs of emerging adults living with IBD. Often emerging adults allow others to make decisions about their health management. By providing informational support, the nurse may significantly influence their patients' ability to more actively learn about themselves and how to manage their IBD through the use of group interventions and peer-to-peer mentoring. From this study it was noted

that only the received social support was useful in the participants' self-management behaviors for medication adherence. More research must be directed toward the benefits of received social support for effective self-management of chronic conditions faced by emerging adults.

Unfolding Patient Stories: Vincent Brody • Part 1

Vincent Brody, a 67-year-old male with chronic obstructive pulmonary disease (COPD), is experiencing increased fatigue. He spends most of the day in a recliner chair watching television and smoking 1 to 2 packs/d. His nutritional intake is poor due to shortness of breath. What patient education can the nurse provide to promote self-care behaviors for symptom improvement and a healthier lifestyle? (Vincent Brody's story continues in Chapter 55.)

Care for Vincent and other patients in a realistic virtual environment: vSim (**thepoint.lww.com/vSimMedicalSurgical**). Practice documenting these patients' care in DocuCare (**thepoint.lww.com/DocuCareEHR**).

Health Promotion Strategies Throughout the Lifespan

Health promotion is a concept and a process that extends throughout the lifespan. The health of a child can be affected either positively or negatively by the health practices of the mother during the prenatal period. Therefore, health promotion starts before birth and extends through childhood, adolescence, adulthood, and old age (Haber, 2019).

Health promotion includes health screening, counseling, immunizations, and preventive medications. The U.S. Preventive Services Task Force (2019) evaluates clinical research to assess the merits of preventive measures. Table 3-3 presents general population guidelines, including adult immunization recommendations (Centers for Disease Control and Prevention [CDC], 2021; U.S. Preventive Services Task Force, 2019).

Adolescents

Health screening has traditionally been an important aspect of adolescent health care. The goal has been to detect health problems at an early age so that they can be treated at that time. Today, health promotion goes beyond the mere screening for illnesses and disability and includes extensive efforts to promote positive health practices at an early age. Because health habits and practices are formed early in life, adolescents should be encouraged to develop positive health attitudes. For this reason, more programs are being offered to adolescents to help them develop good health habits. Although the negative results of practices such as smoking, risky sex, misuse of drugs and alcohol, and poor nutrition are explained in these educational programs, emphasis is also placed on values training, self-esteem, and healthy lifestyle practices. The projects are designed to appeal to a particular age group, with emphasis on learning experiences that are fun, interesting, and relevant.

Young and Middle-Aged Adults

Young and middle-aged adults represent an age group that not only expresses an interest in health and health promotion but also responds enthusiastically to suggestions that show how lifestyle practices can improve health. Adults are frequently motivated to change their lifestyles in ways that are believed to enhance their health and wellness. Many adults who wish to improve their health turn to health promotion programs to help them make the desired changes in their lifestyles. Many have responded to programs that focus on topics such as general wellness, smoking cessation, exercise, physical conditioning, weight control, conflict resolution, and stress management. Because of the nationwide emphasis on health during the reproductive years, young adults actively seek programs that address prenatal health, parenting, family planning, and women’s or men’s health issues.

TABLE 3-3 Select Health Promotion Screening for Adults

Type of Screening	Suggested Time Frame
Routine health examination	Yearly
Blood chemistry profile	Baseline at age 20 y, then as mutually determined by patient and clinician
Complete blood count	Baseline at age 20 y, then as mutually determined by patient and clinician
Lipid profile	Baseline at age 20 y, then as mutually determined by patient and clinician
Hemoccult screening	Yearly after age 50 y
Electrocardiogram	Baseline at age 40 y, then as mutually determined by patient and clinician
Blood pressure	Yearly at age 45, then as mutually determined by patient and clinician
Tuberculosis skin test	Every 2 y, or as mutually determined by patient and clinician
Chest x-ray or film	For positive PPD results
Mammogram	Every year for women beginning at age 45, or earlier or more often as indicated; women age 55 and older may continue yearly screening or transition to every 2 y
Clinical breast examination	Yearly
Gynecologic examination	Yearly
Papanicolaou (Pap) test	Every 3 y
Bone density screening	Based on identification of primary and secondary risk factors (prior to onset of menopause, if indicated)
Nutritional screening	As mutually determined by patient and clinician
Digital rectal examination	Yearly
Colonoscopy	Every 5–10 y after age 50 y or as mutually determined by patient and clinician
Prostate examination	Yearly
Testicular examination	Monthly

Skin examination	Yearly or as mutually determined by patient and clinician
Vision screening: Glaucoma	Every 2–3 y
Hearing screening	As needed
Health risk appraisal	As needed
Select Adult Immunizations	
Hepatitis B (if not received as a child)	Series of 2 doses one month apart
Human papillomavirus (HPV)	3 doses for males up to the age of 21 y, females up to the age of 26 y; men who have sex with men between 22 and 26 y; if lacking documentation of prior immunization
Influenza vaccine	Yearly
Meningococcal	1 or more doses after age 19 y
Td or Tdap vaccine (Tetanus, diphtheria, and pertussis)	Every 10 y
Zoster	After age 50 y
Pneumococcal conjugate vaccine (PCV13)	Given once to adults 65 y and older regardless of health status Given to those ages 19 to 64 y if immunocompromised, with cerebrospinal fluid (CSF) leakage or cochlear implants
Pneumococcal polysaccharide vaccine (PPSV23)	Given once to adults 65 years and older if they have previously received the PCV13, regardless of health status. For those adults 65 years and older who have not received either PCV13 or PPSV23, the PCV13 should be given first and the PPSV23 should be given at least 1 y later. Given to adults younger than 65 years who have chronic heart, lung or liver disease; diabetes; alcoholism, and smoking.
COVID-19	Administer within the scope of the Emergency Use Authorization or Biologics License Application for the particular vaccine.

Note: Any of these screenings may be performed more frequently if deemed necessary by the patient or recommended by the health care provider.

Adapted from Adult Immunization Schedule approved by CDC Advisory Committee on Immunization Practices. (2021). Recommendations. Retrieved on 4/19/2021 at: www.cdc.gov/vaccines/schedules/hcp/imz/adult.html; American Cancer Society (ACS). (2019). Breast Cancer Facts & Figures 2019-2020. Retrieved on 9/9/2019 at: www.cancer.org/content/dam/cancer-org/research/cancer-facts-and-statistics/breast-cancer-facts-and-figures/breast-cancer-facts-and-figures-2019-2020.pdf; Centers for Disease Control and Prevention (CDC). (2017). Pneumococcal disease: Pneumococcal vaccination. Retrieved on 9/23/2019 at:

www.cdc.gov/pneumococcal/vaccination.html; Ezeanolue, E., Harriman, K., Hunter, P., et al. (2019). General best practice guidelines for Immunization Advisory Committee on Immunization Practices (ACIP). Retrieved on 05/19/2019 at: www.cdc.gov/vaccines/hcp/acip-recs/general-recs/downloads/general-recs.pdf; U.S. Preventive Services Task Force. (2019). Recommendations. Retrieved on 7/10/2019 at: www.uspreventiveservicestaskforce.org/BrowseRec/Index/browse-recommendations

Programs that provide health screening, such as those that screen for cancer, high cholesterol, hypertension, diabetes, abdominal aneurysm, and visual and hearing impairments, are quite popular with young and middle-aged adults. Programs that involve health promotion for people with specific chronic illnesses such as cancer, diabetes, heart disease, and pulmonary disease are also popular. Chronic disease and disability do not preclude health and wellness; rather, positive health attitudes and practices can promote optimal health for people who must live with the limitations imposed by their chronic illnesses and disability.

Health promotion programs can be offered almost anywhere in the community, or in online venues. Common physical sites include local clinics, schools, colleges, recreation centers, places of worship, and even private homes. Health fairs are frequently held in civic centers and shopping malls. The outreach idea for health promotion programs has served to meet the needs of many adults who otherwise would not avail themselves of opportunities to strive toward a healthier lifestyle.

The workplace has become a center for health promotion activity for several reasons. Employers have become increasingly concerned about the rising costs of health care insurance to treat illnesses related to lifestyle behaviors, and they are also concerned about increased absenteeism and lost productivity. Some employers use health promotion specialists to develop and implement these programs, some contract with employee assistance programs, and others purchase packaged programs that have already been developed by health care agencies or private health promotion corporations.

Programs offered at the workplace usually include employee health screening and counseling, physical fitness, nutritional awareness, work safety, and stress management and stress reduction. In addition, efforts are made to promote a safe and healthy work environment. Many large businesses provide exercise facilities for their employees and offer their health promotion programs to retirees.

Gerontologic Considerations

Health promotion is as important for older adults as it is for others. Although 80% of people older than 65 years have one or more chronic illnesses and many are limited in their activity, the older adult population experiences significant gains from health promotion. Older adults are very health conscious, and most view their health positively and are willing to adopt practices that will improve their health and well-being (Touhy & Jett, 2018). Although their chronic illness and disability cannot be eliminated, these adults can benefit from activities and education that help them maintain independence and achieve an optimal level of health (Harbottle, Bartholomaeus, Van Agteren, et al., 2019).

Figure 3-2 • Health promotion for older adults includes physical fitness. Here, a nurse teaches simple exercises at a senior center.

Various health promotion programs have been developed to meet the needs of older Americans. Both public and private organizations

continue to be responsive to health promotion, and more programs that serve this population are emerging. Many of these programs are offered by health care agencies, places of worship, community centers, senior citizen residences, and various other organizations. The activities directed toward health promotion for older adults are the same as those for other age groups: physical fitness and exercise, nutrition, safety, and stress management (Fig. 3-2).

Nursing Implications of Health Promotion

By virtue of their expertise in health and health care and their long-established credibility with consumers, nurses play a vital role in health promotion. In many instances, they initiate health promotion and health screening programs or participate with other health care personnel in developing and providing wellness services in various settings.

As health care professionals, nurses have a responsibility to promote activities that foster well-being, self-actualization, and personal fulfillment. Every interaction with consumers of health care must be viewed as an opportunity to promote positive health attitudes and behaviors. Health Promotion charts and tables throughout this textbook identify opportunities for promoting health.

CRITICAL THINKING EXERCISES

1 ebp A male college student has been to the student health center three times in 2 months for sore throats, mild headaches, coughing and other cold symptoms. He tells you that he does not smoke cigarettes anymore, but he has started vaping on an almost daily basis. However, he does not think that vaping is contributing to his respiratory problems, and he thinks that his symptoms are due to stress. What health promotion factors can guide you in educating the student about his health situation? What is the evidence base to use for providing health promotion information to help this student make appropriate health decisions and engage in positive health behaviors? Identify the criteria used to evaluate the strength of the evidence for this practice.

2 ipc At the cardiology clinic where you work as a nurse navigator, a 45-year-old woman presents with a history of cardiac disease, depression, and recent addiction to alcohol due to her anxiety and self-medicating her depression. You think it prudent to consult other health team members to provide services for her health care needs. What interdisciplinary health team members are the essential providers to facilitate interdisciplinary care? How will the team best address the patient's health care needs? What care modalities must be established to treat the patient's cardiac needs, addiction, rehabilitation process, and psychological health treatment?

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

Centers for Disease Control and Prevention (CDC), www.cdc.gov/chronicdideaser/index.htm
Health Education Resource Exchange, Washington State Department of Health, www.doh.wa.gov/Publications/HERE
Healthy People 2030, www.healthypeople.gov/2020/About-Healthy-People/Development-Healthy-People-2030/framework
Take Charge of Your Life by Making Healthy Choices, www.helpguide.org
U.S. Army Public Health Command (USAPHC), phc.amedd.army.mil/topics/healthyliving/Pages/default.aspx
U.S. Department of Agriculture (USDA), www.choosemyplate.gov
U.S. Department of Health and Human Services, National Institutes of Health, www.nih.gov/icd
U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion, www.health.gov
World Health Organization, www.who.int

4 Adult Health and Physical, Nutritional, and Cultural Assessment

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the components of a holistic and comprehensive health history and assessment.
2. Describe the techniques of inspection, palpation, percussion, and auscultation to perform a basic physical assessment.
3. Discuss the techniques of measurement of body mass index, biochemical assessment, clinical examination, and assessment of food intake to assess a person's nutritional status.
4. Describe the techniques of conducting a cultural assessment.

NURSING CONCEPTS

Culture
Diversity
Health, Wellness, and Illness
Nutrition

GLOSSARY

auscultation: listening to sounds produced within different body structures created by the movement of air or fluid

body mass index (BMI): a calculation done to estimate the amount of body fat of a person

culture: the knowledge, belief, art, morals, laws, customs, and any other capabilities and habits acquired by humans as members of society

cultural assessment: a systematic appraisal or examination of individuals, families, groups, and communities in terms of their cultural beliefs, values, and practices

culturally competent care: effective, individualized care that demonstrates respect for the dignity, personal rights, preferences, beliefs, and practices of the person receiving care while acknowledging the biases of the caregiver and preventing these biases from interfering with the care provided

electronic health record (EHR): computerization of health records; also referred to as electronic medical record (EMR)

ethnicity: affiliation relating to large groups of people classed according to common racial, national, tribal, religious, linguistic, or cultural background

faith: trust in God, belief in a higher power or something that a person cannot see

health history: the collection of subjective data, most often a series of questions that provides an overview of the patient's current health status

inspection: visual assessment of different aspects of the patient (e.g., visual assessment of the patient's body systems and body movements)

palpation: examination of different organs of the body using the sense of touch

percussion: the use of sound to examine different organs of the body

physical examination: collection of objective data about the patient's health status

self-concept: a person's view of themself/themselves

spirituality: connectedness with self, others, a life force, or God that allows people to find meaning in life

substance use disorder: a maladaptive pattern of substance use that causes physical and emotional harm with the potential for disruption of daily life

The ability to assess patients in a holistic manner is a skill integral to nursing, regardless of the practice setting. Eliciting a complete health history, using appropriate physical assessment skills, while respecting spiritual and cultural considerations, is critical to identifying physical and psychological problems

and concerns experienced by the patient. As the first step in the nursing process, a holistic patient assessment is necessary to obtain data that enable the nurse to make accurate nursing diagnoses, identify and implement appropriate interventions, and assess their effectiveness. This chapter covers health assessment, including the complete health history and basic physical assessment techniques. Because a patient's nutritional status and culture are important factors in overall health and well-being, specific components of nutritional and cultural assessments are addressed.

The Role of the Nurse Conducting a Health Assessment

The role of the nurse in today's health care system is rooted in a health care model that emphasizes wellness, health promotion, and disease prevention. The professional nurse uses foundational knowledge of scientific evidence and best clinical judgment when assessing patients (Weber & Kelley, 2018). Various formats for obtaining the **health history** (the collection of subjective data about the patient's health status) and performing the **physical examination** (the collection of objective data about the patient's health status) have been developed. Regardless of the format, the information obtained by the nurse complements the data obtained by other members of the health care team and focuses on nursing's unique concerns for the patient. The nurse completes a health assessment by obtaining the patient's health history and performing a physical assessment, which can be carried out in a variety of settings. These settings may include an acute care facility, a clinic or outpatient office, a long-term care facility, a school, or the patient's home. The nursing process is a systematic process used by the nurse for assessing, planning, implementing, and evaluating care for the patient (see Chapter 1). Data are collected and documented in the patient's health record. This record may be on paper or in the **electronic health record (EHR)**, also called the electronic medical record (EMR), enabling clear communication among care team members and the collection of data for continuous improvement in patient care (Ackley, Ladwig, Flynn Makic, et al., 2019).

Effective Communication

People who seek health care for a specific problem are often anxious. Their anxiety may be increased by fear about potential diagnoses, possible disruption of lifestyle, and other concerns. With this in mind, the nurse attempts to establish rapport, put the patient at ease, encourage honest communication, make eye contact, and listen carefully to the patient's responses to questions about health issues (Fig. 4-1).

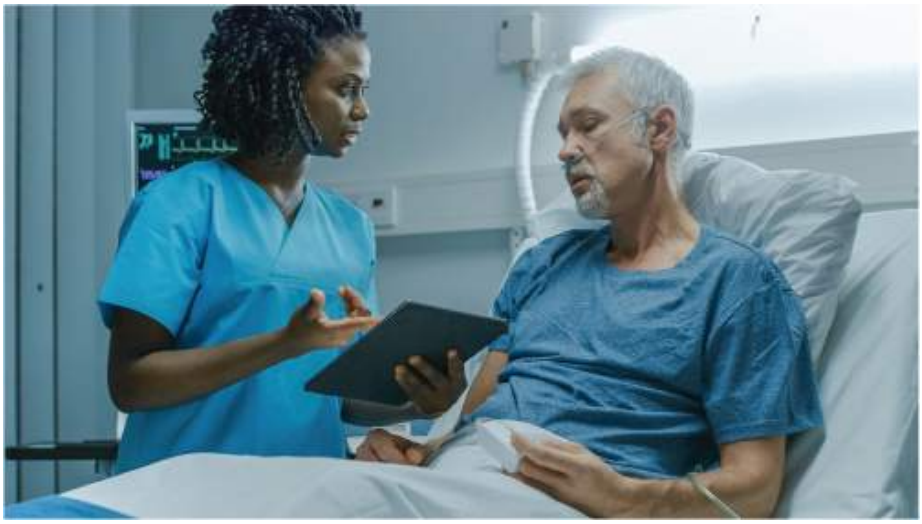


Figure 4-1 • A comfortable, relaxed atmosphere and an attentive interviewer are essential for a successful clinical interview.

When obtaining a health history or performing a physical examination, nurses must be aware of their own nonverbal communication, as well as that of the patient. The nurse should take into consideration the patient's educational background, language proficiency, and cultural background (see following discussion on Cultural Concepts and Cultural Competence). Questions and instructions to the patient should be phrased so that they are easily understandable. Technical terms and medical jargon should be avoided. In addition, the nurse must consider any disability or impairments (hearing, vision, cognitive, and physical limitations). At the end of the assessment, the nurse summarizes and clarifies the information obtained and asks the patient whether they have any questions; this gives the nurse the opportunity to correct misinformation and add facts that may have been omitted.

Cultural Concepts

The concept of culture and its relationship to the health care beliefs and practices of patients and their family or significant others provide the foundation for transcultural nursing. This awareness of culture in the delivery of nursing care has been described in different terms and phrases, including respect for cultural diversity or cultural humility; cultural awareness or sensitivity; comprehensive care; cultural consciousness or culturally congruent nursing care (Alexander-Ruff & Kinion, 2019; Henderson, Horne, Hills, et al., 2018).

Culture is commonly defined as the knowledge, belief, art, morals, laws, customs, and any other capabilities and habits acquired by humans as members of society. Such groups may distinguish themselves by socioeconomic class, race, ethnicity, religion, gender, sexual orientation, nationality, physical disability, or some other specific characteristic (Fioravanti, Puskar, Knapp, et al., 2018). During the past century, many other definitions of culture have been

offered that integrate these themes as well as the themes of ethnic variations of a population. Culture also implies that something is learned or developed, a process that occurs over time. Leininger (2002), founder of the specialty known as transcultural nursing, noted that culture involves learned and transmitted knowledge about values, beliefs, rules of behavior, and lifestyle practices that guide designated groups in their thinking and actions in patterned ways. Culture guides each person's thinking, doing, and being, and becomes patterned expressions of who that person is and becomes.

Ethnicity is defined as an affiliation relating to large groups of people classed according to common racial, national, tribal, religious, linguistic, or cultural background.

Ethnic culture has four basic characteristics:

- Learned from birth through language and socialization
- Shared by members of the same cultural group, and it includes an internal sense and external perception of distinctiveness
- Influenced by specific conditions related to environmental and technical factors and to the availability of resources
- Dynamic and ever changing

With the exception of the first characteristic, culture related to age, physical appearance, and lifestyle, as well as other less frequently acknowledged aspects, also shares these characteristics.

Cultural Competence

By the middle of the 21st century, the non–Hispanic Caucasian population is projected to proportionally decrease so that it will no longer comprise the *majority* population, and other ethnic and racial populations (i.e., *minority* populations as compared to non–Hispanic Caucasians) will collectively comprise the majority of all Americans. This projected phenomenon is called the *majority–minority* crossover (Colby & Ortman, 2015).

According to the 2017 National Nursing Workforce Survey, more than 80% of all nurses are Caucasian (Smiley, Lauer, Bienemy, et al., 2018). Progress toward increasing the percentage of culturally diverse nurses has been significantly slower than the increasing percentage of ethnic minorities in the United States. Educational institutions must prepare nurses to deliver culturally competent care and must work to increase the number of ethnic minority providers in the nursing workforce. **Culturally competent care** is defined as effective, individualized care that demonstrates respect for the dignity, personal rights, preferences, beliefs, and practices of the person receiving care while acknowledging the biases of the caregiver and preventing these biases from interfering with the care provided. Nurse educators are exploring creative ways to promote cultural competence and humanistic care in nursing students, including offering multicultural health studies in their curricula. Simulation

methods and role-playing could be effective methods to practice person-centered culturally competent care (Fioravanti et al., 2018).

Cultural diversity remains an important issue in health care today. Nurses are expected to provide culturally competent care for patients. To do so, nurses must work effectively with the increasing number of patients, nurses, and health care team members whose ancestry reflects the multicultural complexion of contemporary society.

Ethical Use of Health Assessment Data

Whenever information is elicited from a person through a health history or physical examination, the person has the right to know why the information is sought and how it will be used. Information is only shared with appropriate heath care team members (Weber & Kelly, 2018). It is also important that the person knows that the decision to participate is voluntary. A private setting for the history interview and physical examination should promote trust and encourage open, honest communication. After the history and examination are completed, the nurse selectively records the data pertinent to the patient's health status. This record of the patient's history and physical examination findings is then securely maintained and made available only to those health professionals directly involved in the care of the patient. The Health Insurance Portability and Accountability Act (HIPAA), passed in 1996, established national standards to protect individuals' medical records and other personal health information and applies to health plans, health care clearinghouses, and those health care providers that conduct certain health care transactions electronically. The act requires appropriate safeguards to protect the privacy of personal health information and sets limits and conditions on the uses and disclosures that may be made of such information without patient authorization. HIPAA outlines patients' rights over their health information, including rights to examine and obtain a copy of their health records and to request corrections (U.S. Department of Health & Human Services [HHS], 2019a).

The Role of Technology

The use of technology to augment the information-gathering process, particularly through the use of EHRs, has become an increasingly important aspect of obtaining a health history and physical examination. An EHR offers convenient access to health data for the patient and for providers who can use the information more effectively to improve the quality and efficiency of patient care. The information in EHRs also can be shared with other organizations involved in care of the patients if the systems interface (HHS, 2019b). Nurses must be sensitive to the needs of older adults and others who may not be comfortable with newer technology. Nurses may need to allow extra time, provide detailed instructions, explanations, or assistance. It is important to

establish and maintain eye contact with the patient during the health history and to not focus solely on the computer screen for data entry.

Assessment in the Home or Community

Assessment of patients in community settings, including the home, consists of collecting information specific to existing health problems, including data on the patient's physiologic and emotional status, the community and home environment, the adequacy of support systems or care given by family and other care providers, and the availability of needed resources. In addition, it is important to evaluate the ability of the person and the family to cope with and address their respective needs. The physical assessment in the community and the home consists of similar techniques to those used in the hospital, outpatient clinic, or office setting. Privacy is provided, and the patient is made as comfortable as possible. See Chapter 2 for more information on community-based nursing practice.

Health History

The health history is a series of questions used to provide an overview of the patient's current health status. Many nurses are responsible for obtaining a detailed history of the patient's current health problems, past health history and family history, and a review of the patient's functional status. This results in a total health profile that focuses on lifestyle and health, as well as on illness.

While obtaining the health history, attention is focused on the impact of psychosocial and cultural background and ethnicity on a patient's health, illnesses, and health promotion behaviors. The interpersonal and physical environments, as well as the patient's lifestyle and activities of daily living, are explored in depth.

The format of the health history traditionally combines the medical history and the nursing assessment. Both the review of systems and the patient profile are expanded to include individual and family relationships, lifestyle patterns, health practices and nutritional assessment, and coping strategies. These components of the health history are the basis of nursing assessment and can be easily adapted to address the needs of any patient population in any setting, institution, or agency (Hogan-Quigley, Palm, & Bickley, 2017; Weber & Kelley, 2018).

The health history format discussed in this chapter is only one approach that is useful in obtaining and organizing information about a patient's health status. Some experts consider this traditional format to be inappropriate for nurses, because it does not focus exclusively on the assessment of human responses to actual or potential health problems. Several attempts have been made to develop an assessment format and database with this focus in mind. One example is a

nursing database developed by NANDA International and its 13 domains: health promotion, nutrition, elimination and exchange, activity/rest, perception/cognition, self-perception, role relationships, sexuality, coping/stress tolerance, life principles, safety/protection, comfort, and growth/development (Ackley et al., 2019) (see Chapter 1, Chart 1-6 for further details). Although there is support in nursing for using this approach, no consensus for its use has been reached.

The National Information Center on Health Services Research and Health Care Technology (NICHSR) and other groups from the public and private sectors have focused on assessing not only biologic health but also other dimensions of health. These dimensions include physical, functional, emotional, mental, and social health. Efforts to assess health status have focused on the manner in which disease or disability affects a patient's functional status—that is, the ability of patients to function normally and perform their usual physical, mental, and social activities. An emphasis on functional assessment is viewed as more holistic than the traditional medical history. Instruments to assess health status in these ways may be used by nurses along with their own clinical assessment skills to determine the impact of illness, disease, disability, and health problems on functional status (U.S. National Library of Medicine, 2019).

Regardless of the assessment format used, the focus of nurses during data collection is different from that of primary providers and other health care team members. Combining the information obtained by the primary provider and the nurse into one health history prevents duplication of information and minimizes efforts on the part of the patient to provide this information repeatedly. This also encourages collaboration among members of the health care team who share in the collection and interpretation of the data.

The Informant

The informant, or the person providing the health history, may not always be the patient, as in the case of a patient with a developmental or cognitive disability or those who are disoriented, confused, unconscious, or comatose. The interviewer should assess the reliability of the informant and the usefulness of the information provided. For example, a patient who is disoriented is often unable to provide reliable information; people who use alcohol and illicit drugs often deny using these substances. The interviewer must make a clinical judgment about the reliability of the information (based on the context of the entire interview) and include this assessment in the record. Chart 4-1 provides special considerations for obtaining a health history from an older adult.

Chart 4-1

Health Assessment in the Older Adult

- Obtain the health history from older adult patients in a calm, unrushed manner.
- Consider possible vision or hearing impairments. Ensure that lighting is adequate but not glaring, and keep distracting noises to a minimum.
- Assume a position that enables the older adult patient to read lips and facial expressions. Sometimes sitting at a 90-degree angle to the patient is helpful because some visual impairments, such as macular degeneration, can limit the patient's vision to only peripheral vision. It is best to ask the patient where the interviewer should sit in relation to the patient to optimize the patient's view of the interviewer.
- Determine if the patient uses a hearing aid and ask the patient to use it during the interview. Check if the patient usually wears glasses and ensure that they are worn as well.
- Be aware that older adults often assume that new physical problems are a result of age rather than a treatable illness. Some of these problems may limit their activities of daily living and lifestyle patterns.
- Ask questions related to changes in the level of functioning. The signs and symptoms of illness in older adults are often more subtle than those in younger adults and may go unreported. A question such as "What interferes most in your daily activities?" may be useful in focusing the clinical evaluation.
- Obtain a complete history of medications used, because many older adult patients take many different kinds of prescription and over-the-counter (OTC) medications.
- Consider including a member of the family in the interview process. Although older adults may experience a decline in mental function, it should not be assumed that they are unable to provide an adequate history. Including a spouse, adult child, sibling, or caretaker may validate information and provide missing details. However, this should be done after obtaining the patient's permission (further details about assessment of the older adult are provided in Chapter 8).

Adapted from Weber, J. R., & Kelley, J. H. (2018). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Components of the Health History

When a patient is seen for the first time by a member of the health care team, the first requirement is that baseline information be obtained (except in emergency situations). The sequence and format of obtaining data about a patient may vary; however, the content, regardless of format, usually addresses

the same general topics. A traditional health history includes the following: biographical data, chief complaint, present health concern (or history of present illness), past health history, family history, review of systems, and patient profile.

Biographical Data

Biographical information puts the patient's health history into context. This information includes the person's name, address, age, gender, marital status, occupation, and ethnic origins. Some interviewers prefer to ask more personal questions at this part of the interview, whereas others wait until more trust and confidence have been established or until a patient's immediate or urgent needs are first addressed. A patient who is in severe pain or has another urgent problem is unlikely to have a great deal of patience for an interviewer who is more concerned about marital or occupational status than with quickly addressing the problem at hand.

Chief Complaint

The chief complaint is the issue that caused the patient to seek the care of the health care provider. Questions such as "Why have you come to the health center today?" or "Why were you admitted to the hospital?" usually elicit the chief complaint. However, a statement such as "My doctor sent me" should be followed up with questions that identify and clarify the chief complaint (Weber & Kelley, 2018). In the home setting, the initial question might be, "What is bothering you most today?" When a problem is identified, the person's exact words are usually recorded in quotation marks. Sometimes patients have no specific complaints. The nurse should report their goals instead. For example, patients might report that "I have come for my regular checkup" or "I've been admitted for a thorough evaluation of my heart" (Hogan-Quigley et al., 2017).

Present Health Concern or Illness

The history of the present health concern or illness is the single most important factor in helping the health care team arrive at a diagnosis or determine the patient's current needs. The physical examination is also helpful and often validates the information obtained from the history. A careful history and physical examination assist in the correct selection of appropriate diagnostic tests. Although diagnostic test results can be helpful, they often support rather than establish the diagnosis.

If the present illness is only one episode in a series of episodes, the nurse records the entire sequence of events. For example, a history from a patient whose chief complaint is an episode of chest pain should describe the entire course of their disease to put the current episode into context. The history of the present illness or problem includes information such as the date and type of onset (sudden or gradual) in which the problem occurred, the setting in which

the problem occurred (at home, at work, after an argument, after exercise), manifestations of the problem, and the course of the illness or problem. This should include self-treatment (including complementary and alternative therapies), medical interventions, progress and effects of treatment, and the patient's perceptions of the cause or meaning of the problem.

Specific symptoms such as headaches, fever, or changes in bowel habits are described in detail. The interviewer should also ask whether the symptom is persistent or intermittent, what factors aggravate or alleviate it, and whether any associated manifestations exist. If the patient complains of pain, the location, quality, severity, and duration of the pain are determined (see Chapter 9 for a more detailed discussion of pain).

Associated manifestations are symptoms that occur simultaneously with the chief complaint. The presence or absence of such symptoms may help determine the origin or extent of the problem, as well as the diagnosis. These symptoms are referred to as significant positive or negative findings and are obtained from a review of systems directly related to the chief complaint. For example, if a patient reports a vague symptom such as fatigue or weight loss, all body systems are reviewed. On the contrary, if a patient's chief complaint is something specific, such as chest pain, then the cardiopulmonary and gastrointestinal systems will be the focus of the history of the present illness. In either situation, both positive and negative findings are recorded to further define the issue.

Past Health History

A detailed summary of a patient's past health is an important part of the health history. After determining the patient's general health status, the interviewer should inquire about immunization status and compare it with the General Best Practice Guidelines for Immunization Advisory Committee on Immunization Practices (ACIP) (Ezeanolue, Harriman, Hunter, et al., 2019) (see Chapter 3, Table 3-3 for an adult immunization schedule) and then record the dates of immunization (if known). The interviewer should also inquire about any known allergies to medications or other substances, along with the nature of the allergy and associated adverse reactions. Other relevant material includes information, if known, about the patient's last physical examination, chest x-ray, electrocardiogram, eye examination, hearing test, dental checkup, Papanicolaou (Pap) smear and mammogram (if female), digital rectal examination of the prostate gland (if male), bone density testing, colon cancer screening, and any other pertinent tests.

The interviewer discusses previous illnesses and records negative as well as positive responses to a list of specific diseases. The dates of illnesses, or the age of the patient at the time, as well as the names of the primary providers and hospitals, the diagnoses, and the treatments, are noted. The interviewer elicits a history of the following areas:

- Childhood illnesses—rubeola, rubella, polio, whooping cough, mumps, measles, chickenpox, scarlet fever, rheumatic fever, strep throat
- Adult illnesses
- Psychiatric illnesses
- Injuries—burns, fractures, head injuries, traumatic injuries
- Hospitalizations
- Surgical and diagnostic procedures

If a particular hospitalization or major medical intervention is related to the present illness, the account of it is not repeated here; rather, the report refers to the appropriate part of the record, such as (see present health concern or illness) on the patient's health record.

Family History

To identify diseases that may be genetic, communicable, or possibly environmental in origin, the interviewer asks about the age and health status, or the age and cause of death, of first-order relatives (parents, siblings, spouse, children) and second-order relatives (grandparents, cousins). The nurse records the age and health, or age and cause of death, of each relative. In addition, each of the following conditions should be reviewed with the patient to determine whether they are present or absent among family members: hypertension, coronary artery disease, elevated cholesterol levels, stroke, diabetes, thyroid or renal disease, arthritis, tuberculosis, asthma or lung disease, headache, seizure disorder, mental illness, substance use disorder, cancer and the site or type, genetic diseases, and allergies; the nurse should also determine if there is a family history of suicide (Hogan-Quigley et al., 2017). One of the easiest methods of recording such data is by using the family tree, genogram, or pedigree (Fig. 4-2). The results of genetic testing or screening, if known, are recorded. Chart 4-2 provides genetic considerations related to health assessment (see Chapter 6 for a detailed discussion of genetics).

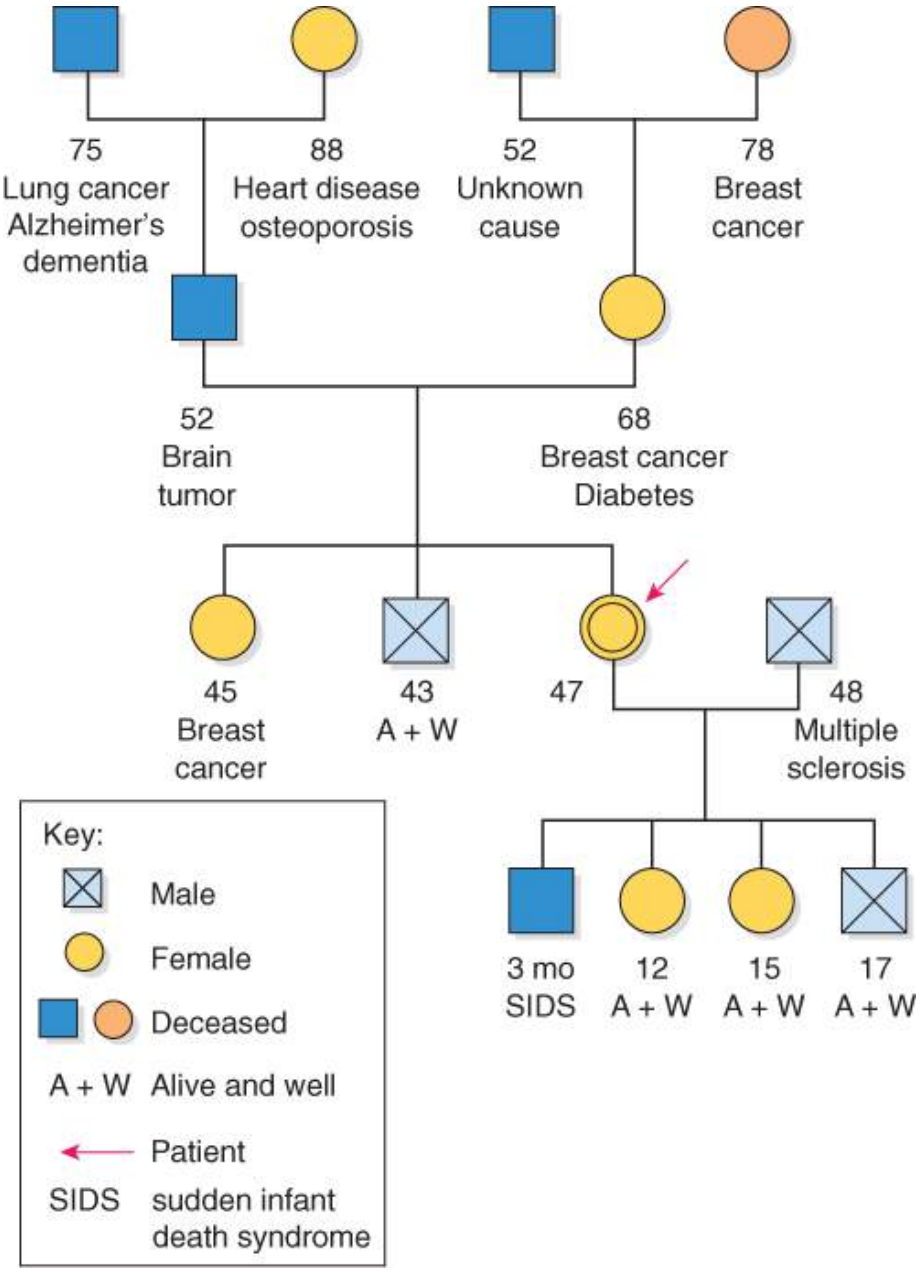


Figure 4-2 • Diagram (called a *genogram*) used to record history of family members, including their age and cause of death or, if living, their current health status.

Review of Systems

The review of systems includes an overview of general health as well as symptoms related to each body system. Questions are asked about each of the major body systems for information about past and present symptoms. Negative and positive answers should be recorded. If a patient responds positively to questions about a particular system, the information is analyzed carefully. If any illnesses were previously mentioned or recorded, it is not necessary to repeat them in this part of the history.

A review of systems can be organized in a formal checklist, which becomes part of the health history. One advantage of a checklist is that it can be easily audited and is less subject to error than a system that relies heavily on the interviewer's memory.

Patient Profile

In the patient profile, more biographical information is gathered. A complete composite, or profile, of the patient is critical to the analysis of the chief complaint and of the patient's ability to deal with the problem. A complete patient profile is summarized in Chart 4-3.

At this point in the interview, the information elicited is highly personal and subjective. People are encouraged to express feelings honestly and to discuss significant health events. It is best to begin with general, open-ended questions and to move to direct questioning when specific facts are needed. Interviews that progress from information that is less personal (birthplace, occupation, education) to information that is more personal (sexuality, body image, coping abilities) often reduce anxiety.

A general patient profile consists of the following content areas: past life events related to health; current medications; complementary, alternative and integrative health therapies; education and occupation; financial resources; environment (physical, spiritual, interpersonal); lifestyle patterns; presence of a physical or mental disability; self-concept; sexuality; risk for abuse or intimate partner violence (IPV); and stress and coping response.

Past Life Events Related to Health

The patient profile begins with a brief life history. Questions about place of birth and past places of residence help focus attention on the earlier years of life. Personal experiences during childhood or adolescence that have special significance may be elicited by asking a question such as, "Were there any events that occurred when you were a child or adolescent that would be helpful for me to know about?" The interviewer's intent is to encourage the patient to make a quick review of their earlier life, highlighting information of particular significance. Although many patients may not recall anything significant, others may share information such as a personal achievement, a failure, a developmental crisis, or an instance of physical, emotional, or sexual abuse. The life history should include a brief medication history as appropriate for the patient.

Current Medications

A review of the patient's current medications is necessary to complete a comprehensive health history. Particular attention is given to allergies or adverse reactions to medications. The interviewer should inquire about the use of over-the-counter (OTC) medications and herbal supplements and

complementary therapies (see next section); patients often include only prescription medications when they list their current medications.

When gathering information on use of current medications, the nurse must also consider the physiologic impact of ethnicity and culture on patients' response to medications. Data have been collected for many years regarding differences in the effect that some medications have on people of diverse ethnic or cultural origins. Genetic predispositions to different rates of metabolism cause some patients to be prone to adverse reactions to the standard dose of a medication, whereas other patients are likely to experience a greatly reduced benefit from the standard dose of the medication (Giger, 2016). For example, an antihypertensive agent may work well at reducing blood pressure to acceptable levels for a Caucasian man within a 4-week time span, but may take much longer to work or not work at all for an African American man with hypertension. In the future, genomic research may capitalize on the work of transdisciplinary teams that are building the skills needed to design and assess multilevel interventions aimed at improving the health of minorities and reducing health disparities (Agurs-Collins, Persky, Paskett, et al., 2019). Nurses must be aware that ethnicity and related factors such as values and beliefs regarding the use of herbal supplements, dietary intake, and genetic factors can affect the effectiveness of treatment and adherence to the prescribed medication regimen (Giger, 2016).

Chart 4-2 **GENETICS IN NURSING PRACTICE**

Genetic Aspects of Health Assessment

Nursing Assessments

Family History Assessment

- Obtain information about maternal and paternal sides of family for three generations.
- Obtain history of known diseases or disorders for three generations for:
  - Clustering of diseases or disorders.
  - Early onset of disease or illness (e.g., blood clots in an active, otherwise apparently healthy 30 year old, or colon cancer in a 40 year old).
  - Similar disorder or disease in two or more close relatives.
  - History of multiple miscarriages, birth defects, or developmental delays.
  - Close biologic relationship between parents.
- Assess for individual and family perceptions and beliefs around genetics topics through a cultural, social, and spiritual assessment.
- Acknowledge ethnic risk for particular genetic disorders.
- Determine whether the patient or a direct family member has had an unexpected response to medications or anesthesia.
- Recognize and evaluate for patterns of inheritance.
- Ascertain family relationships (family structure, roles, communication patterns, support system).

Patient Assessment

- Assess physical findings that may suggest a genetic condition (e.g., unusually tall stature—Marfan syndrome, low set ears, and epicanthal folds—Down syndrome).
- Is there a presence of two or more dysmorphic features?
- Is there a presence of disability (physical or intellectual) or a history of developmental delay?
- Assess for conditions that occur in a less-often affected gender (e.g., stuttering in females, breast cancer in males, inguinal hernia in females).
- Presence of disease without known risk factors (e.g., hyperlipidemia).
- Acknowledge genetic-related risk related to ethnic background.
- Identify religious health, spiritual health, beliefs, and practices.

Management Issues Specific to Genetics

- Assess patient's understanding of genetic information and factors related to their health risks.
- Refer for risk assessment when a hereditary disease or disorder is suspected.
- Determine if genetic testing has been performed and if other family members are affected.

- Educate patient and family about the *Genetic Information Nondiscrimination Act (GINA),* passed in 2008.
- Offer appropriate genetic information and resources.
- Refer to a genetic counselor.
- Ensure that consent obtained for genetic testing is voluntary and informed.
- Provide support to patients and families with known genetic test results for hereditary disease or disorders, and refer to support groups as indicated.
- Participate in the management and coordination of risk-reduction measures for those with known gene mutations.

Genetics Resources

Genetic Information Nondiscrimination Act. Retrieved on 6/17/2019 at: www.ginahelp.org

For additional genetic resources, see Chapter 6, Chart 6-7: Components of Genetics Counseling.

Complementary, Alternative, and Integrative Health Therapies

Interventions for alterations in health and wellness vary among cultures. Interventions most commonly used in the United States have been labeled as *conventional medicine,* which is also variously referred to as allopathy, Western medicine, regular medicine, mainstream medicine, and biomedicine (National Center for Complementary and Integrative Health [NCCIH], 2019). Therapy used to supplement conventional medicine is referred to as *complementary therapy,* whereas therapy used to replace conventional medicine is referred to as *alternative therapy* (NCCIH, 2019). Interest in interventions that are not an integral part of conventional medicine prompted the National Institutes of Health to create the Office of Alternative Medicine and then to establish the National Center for Complementary and Alternative Medicine, which is now called the National Center for Complementary and Integrative Health (NCCIH, 2019). Integrative health care is viewed as a comprehensive, interdisciplinary approach to preventing and treating illness and promoting health that brings together complementary, alternative, and conventional therapies. The use of an integrative approach to health and wellness has grown within mainstream health care settings in the United States (NCCIH, 2019). More than 30% of adults use health care approaches that are not typically part of conventional medical care or that may have origins outside of usual Western practice. Most people who use nonmainstream approaches also use conventional health care (NCCIH, 2019).

Integrative health therapies are classified by product or practice type into two subgroups—natural products or mind and body practices (NCCIH, 2019):

- *Natural products* include herbs (also known as botanicals), vitamins and minerals, and probiotics. These are widely marketed to consumers

and often sold and used as dietary supplements.

- *Mind and body practices* include large and diverse procedures and techniques given or taught by trained practitioners or teachers and include practices such as yoga, meditation, chiropractic and osteopathic manipulation, massage therapy, acupuncture, relaxation techniques, and T'ai chi.

Patients may choose to seek a complementary or alternative approach to conventional medical or surgical therapies. Nurses must assess all patients for the use of complementary therapies, be alert to the danger of natural product–drug interactions or conflicting treatments, and be prepared to provide information to patients about treatments that may be harmful or helpful, based upon best evidence from research findings. However, nurses must be accepting of patients' beliefs and right to autonomy—that is, to control their own care. As patient advocates, nurses facilitate the integration of conventional medical, complementary, and alternative therapies.

Chart 4-3 **ASSESSMENT**

Patient Profile

Past Life Events Related to Health

Place of birth
Places lived
Significant childhood/adolescent events

Current Medications

Prescription, over-the-counter, home remedies, complementary and alternative therapies

Education and Occupation

Jobs held in past
Current position/job
Length of time at position
Educational preparation
Work satisfaction and career goals

Financial Resources

Income
Insurance coverage
Concerns

Environment

Physical—living arrangements (type of housing, neighborhood, presence of hazards)
Spiritual—extent to which religion or spirituality is a part of a person's life; religious or spiritual beliefs related to perception of health and illness; religious or spiritual practices
Interpersonal—ethnicity (language spoken, customs and values held, folk practices used to maintain health or cure illness); support systems (family relationships and friendships)

Lifestyle Patterns

Sleep (time person retires, hours per night, comfort measures, awakens rested)
Nutrition (24-h diet recall, idiosyncrasies, restrictions)
Health promotion (exercise and recreation: type, duration, frequency; health screenings)
Caffeine (type: coffee, tea, cola, chocolate), amount
Alcohol (type, amount, pattern over past year)
Smoking (type: cigarette, pipe, cigar, marijuana, or electronic nicotine delivery systems (ENDS) including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars; amount per day; number of years; desire to quit)
Drugs (type, amount, route of administration)

Physical or Mental Disability

Presence of a disability (physical or mental)
Effect of disability on function and health access
Accommodations needed to support functioning

Self-Concept

View of self in present
View of self in future
Body image (level of satisfaction, concerns)

Sexuality

Perception of self as a heterosexual, lesbian, gay, bisexual or transgender
Quality of sexual relationships
Concerns related to sexuality or sexual functioning

Risk for Intimate Partner Violence (IPV)

Physical injury in past
Afraid of partner, caregiver, or family member
Refusal of caregiver to provide necessary equipment or assistance

Stress and Coping Response

Major concerns or problems at present
Daily "hassles"
Past experiences with similar problems
Past coping patterns and outcomes
Present coping strategies and anticipated outcomes
Person's expectations of family/friends and health care team in problem resolution

Education and Occupation

Inquiring about a patient's current occupation can reveal much about their economic status and educational preparation. A statement such as "Tell me about your job" often elicits information about role, job tasks, and satisfaction with the position. Direct questions about past employment and career goals may be asked if the person does not provide this information.

It is important to learn about a patient's educational background. Asking what kind of educational requirements were necessary for a patient to attain their present job is a more sensitive approach than asking whether they graduated from high school.

Financial Resources

Information about the patient's general financial status may be obtained by asking questions such as "Do you have any financial concerns at this time?" Inquiries about the person's insurance coverage and plans for health care payment are also appropriate.

Environment

The concept of environment includes a person's physical environment and its potential hazards. It also includes a person's spiritual awareness, ethnicity, and support systems.

Physical Environment

Information is elicited about the type of housing (e.g., apartment, duplex, single family) in which the person lives, its location, the level of safety and comfort within the home and neighborhood, and the presence of environmental hazards (e.g., social isolation, potential fire risks, inadequate sanitation). If the patient is homeless, details about available resources are important to ascertain.

Spiritual Environment

Spirituality is defined as connectedness with self, others, a life force, or God that allows people to experience self-transcendence and find meaning in life. Spirituality helps many people discover a purpose in life, understand the ever-changing qualities of life, and develop their relationship with God or a higher power. Spirituality in nursing practice includes concerns with the personal spiritual and religious needs of the patient and nurse, as well as the spiritual dimension of the nurse–patient interaction (O'Brien, 2017).

Spiritual behavior can be expressed through devotion, sacrifice, self-discipline, and spending time in activities that focus on the inner self or the soul. Although religion and nature are two vehicles that people use to connect themselves with God or a higher power, bonds to religious institutions, beliefs, or dogma are not required to experience the spiritual sense of self. **Faith,** considered the foundation of spirituality, is trust in God and belief in a higher power or something that a person cannot see. The spiritual part of a person views life as a mystery that unfolds over one's lifetime, encompassing questions about meaning, hope, relatedness to a higher power, acceptance or forgiveness, and transcendence.

A person's spiritual environment refers to the degree to which they think about or contemplate existence, accept challenges in life, and seek and find answers to personal questions. Spirituality may be expressed through identification with a particular religion. Spiritual values and beliefs often direct a person's behavior and approach to health problems and can influence responses to sickness. A strong sense of spirituality or religious faith can have a positive impact on health. Spirituality is also a component of hope, and, especially during chronic, serious, or terminal illness, patients and their families often find comfort and emotional strength in their religious traditions or spiritual beliefs. At other times, illness and loss can cause a loss of faith or meaning in life and a spiritual crisis, which can place considerable stress on a person's internal resources and beliefs. It is important that the spiritual beliefs of people and families be acknowledged, valued, and respected for the comfort and guidance they provide. Inquiring about spirituality can identify possible support

systems as well as beliefs and customs that need to be considered in planning care. Information is gathered about the extent to which religion is a part of the person's life as well as religious beliefs and practices related to health and illness.

A spiritual assessment may involve asking the following questions:

- Is religion or spirituality important to you?
- If no, what is the most important thing in your life?
- If yes, in what way? For instance:
- Are there any religious or spiritual practices that are important to you?
- Do you belong to a faith community or have a place of worship?
- Do you have any religious or spiritual concerns because of your present health problem?

The nurse should assess spiritual strength further by inquiring about the patient's sense of spiritual well-being, hope, and peacefulness. It is also necessary to assess whether spiritual beliefs and values have changed in response to illness or loss. The nurse assesses current and past participation in religious or spiritual practices and notes the patient's responses to questions regarding spiritual needs to help determine the patient's need for spiritual care. Another simple assessment technique is to inquire about the patient's and family's desire for spiritual support (O'Brien, 2017).

Interpersonal Environment

A patient's ethnicity and support system are considered when obtaining a health history. Attitudes and beliefs about health, illness, health care, hospitalization, the use of medications, and the use of complementary and alternative therapies, which are derived from personal experiences, vary according to ethnicity. A person from another culture may have different views of personal health practices from those of the health care practitioner (Hogan-Quigley et al., 2017; Weber & Kelley, 2018) (see later discussion on Cultural Assessment).

The beliefs, customs, and practices that have been shared from generation to generation are known as ethnic patterns. The influence of these patterns on health-related behaviors and patient's perceptions of health and illness, as well as on how a patient reacts to health problems and interacts with health care providers, cannot be underestimated. Ethnic patterns can be expressed through language, dress, dietary choices, and role behaviors. The following questions may assist in obtaining relevant information:

- Where did your parents or ancestors come from? When?
- What language do you speak at home?
- Are there certain customs or values that are important to you?
- Do you have any specific practices to keep in good health or for treating illness?

Support systems are another important aspect of a patient's interpersonal environment. The evaluation of a patient's family structure (members, ages, and

roles), patterns of communication, and the quality of the patient's relationships is an integral part of assessing support systems. Although the traditional family is recognized as a mother, a father, and children, many different types of living arrangements exist within our society. "Family" may mean two or more people bound by emotional ties or commitments. Live-in companions, roommates, and close friends can also play a significant role in a person's support system. Keeping this in mind, nurses should use neutral terms and be sensitive when evaluating family structure. For example, the interview can begin with an open-ended question, such as "Tell me about your family and social support system." Neutral terms should also be used when asking follow-up questions about partners/significant others and parents/guardians (for further discussion, see Chapter 54, Table 54-1).

Lifestyle Patterns

The lifestyle section of the patient profile provides information about health-related behaviors. These behaviors include patterns of sleep, nutrition, and health promotion, as well as personal habits such as smoking and the use of illicit drugs, alcohol, and caffeine. Adequate sleep and nutrition are important to maintain optimal health; therefore, it is important to inquire about usual sleep habits and bedtime routines, as well as perform a nutritional assessment. Although most people readily describe their exercise patterns or recreational activities, many are unwilling to report their smoking, alcohol use, and illicit drug use, and many deny or understate the degree to which they use such substances. The Centers for Disease Control and Prevention (CDC) reports that abuse of prescription drugs has replaced abuse of illicit drugs as a leading cause of drug-induced deaths (CDC, 2019c). Questions such as "What kind of alcohol do you enjoy drinking?" may elicit more accurate information than "Do you drink?" Determining the specific type of alcohol (e.g., wine, liquor, beer) the patient drinks and the last time they had a drink is an important aspect of the assessment. Every patient should be asked about alcohol use, substance use disorder, and misuse of prescription drugs (Hogan-Quigley et al., 2017).

The lifestyle of some people includes the use of mood-altering substances. People with **substance use disorder** (SUD) use illegally obtained drugs, prescribed or OTC medications, and alcohol alone or in combination with other drugs in ineffective attempts to cope with the pressures, strains, and burdens of life. Over time, physiologic, emotional, cognitive, and behavioral problems develop as a result of SUD.

If alcohol abuse is suspected, additional information may be obtained by using common alcohol screening questionnaires such as the CAGE (Cutting down, Annoyance by criticism, Guilty feeling, and Eye-openers) (Ewing, 1984), AUDIT (Alcohol Use Disorders Identification Test), or the shorter AUDIT-C questionnaire (Drug and Alcohol Clinical Advisory Service [DACAS], 2019).

Similar questions can be used to elicit information about smoking and caffeine consumption. Questions about illicit drug use follow naturally after

questions about smoking, caffeine consumption, and alcohol use. A nonjudgmental approach makes it easier for a person to respond truthfully and factually. If street names or unfamiliar terms are used to describe drugs, the person is asked to define the terms used.

Investigation of the patient's lifestyle patterns should also include questions about complementary, alternative, and integrative health therapies, which may include energy and breath work, botanical and manual healing, and mind–body therapies (Fontaine, 2018).

Marijuana is used for the management of symptoms, especially pain and anorexia, in several chronic conditions. Since the marijuana plant contains chemicals, called cannabinoids, that may help treat a range of illnesses or symptoms, many people have argued that it should be legal for medical purposes. This has led to the legalization of marijuana for medical use in many states. The U.S. Food and Drug Administration (FDA) has not recognized or approved the marijuana plant as medicine; however, the FDA has approved medications that contain cannabinoids in pill form. Currently, the two main cannabinoids from the marijuana plant that are of medical interest are delta-9-tetrahydrocannabinol (THC) and cannabidiol (CBD). The FDA-approved drugs dronabinol and nabilone both contain THC. They are indicated specifically to treat nausea caused by chemotherapy and to increase appetite in patients with extreme weight loss caused by acquired immune deficiency syndrome (AIDS). THC also may decrease pain, inflammation, and muscle control problems. Unlike THC, drugs that contain CBD are not intoxicating and do not make people "high." CBD is useful in reducing pain, inflammation, controlling epileptic seizures, and possibly even treating mental illness and addiction (National Institute on Drug Abuse, 2019).

The assessment of a patient's lifestyle patterns also includes questions about continuing health promotion and health-screening practices. The health history assessment should include the type, frequency, and duration of exercise and recreational activities. Inquiry should also include the types of health screenings the patient has completed. If the person has not been involved in these practices in the past, they should be educated about their importance and referred to the appropriate health care providers. Nurses should recognize the importance of encouraging culturally competent care and health promotion activities (Giger, 2016).

Disability

The general patient profile needs to contain information about any hearing, vision, or other type of physical disability. In addition, developmental, intellectual, sensory, or cognitive disabilities need to be addressed. The presence of an obvious physical limitation (e.g., using crutches to walk or using a wheelchair to get around) necessitates further investigation. The initial cause or onset of the disability, as well as the impact on functional ability, should be established. Chart 4-4 presents specific issues that the nurse should consider

when obtaining health histories and conducting physical assessments of patients with disability.

Veterans Considerations

When conducting a health assessment, a key part of the nurse's role is to ask all adult patients if they have served in the U.S. military, and, if so, their branch of service, length of service, and assigned duty stations (i.e., geographic locations and type of assignments). Patients who are veterans should be specifically asked about their experiences with violence and war, regardless of their ages, genders, lengths of service, and assignments. Asking about violent experiences works best when it is viewed as a normal and natural part of the nursing assessment. The nurse's approach to gathering this information should be similar to that used when asking patients about sleep or activity difficulties or dietary or sexual concerns. It is important to try to establish a connection with the patient first. Taking time to listen in a nonjudgmental, nondirective way and noting that confidentiality of responses will be ensured helps create a safe, supportive atmosphere. Traumatic experiences from witnessing violence are common for combat veterans and veterans who have experienced other forms of violence, placing them at risk for posttraumatic stress disorder (PTSD), alcohol abuse (Possemato, Maisto, Wade, et al., 2015), pain (Flynn, Cook, Kallen, et al., 2017), and increased suicide risk compared with nonveterans (Kang, Bullman, Smolenski, et al., 2015). Pain is a leading cause of disability among active duty service members and veterans (Flynn et al., 2017) (see Chapter 9 for further discussion).

Veterans may be eligible for Veterans Administration (VA) benefits, including access to VA financial aid services and health care through the Veterans Health Administration (VHA), the largest integrated health care system in the United States. The VHA provides care to veterans at more than 1200 health care facilities, including 170 medical centers and 1000 outpatient sites that provide health care services of varying complexity. In addition, benefits-eligible veterans who reside in rural areas may opt to receive some VHA services through mobile vans and telehealth services. Less than half of the 20 million benefits-eligible U.S. veterans are enrolled in VA benefits services (Chokshi & Sommers, 2015).

Self-Concept

Self-concept, a person's view of themself/themselves, is an image that develops over many years. To assess self-concept, the interviewer might ask how a person views life, using a question such as "How do you feel about your life in general?" A person's self-concept can be threatened very easily by changes in physical function, appearance, or other threats to health. The impact of certain medical conditions or surgical interventions, such as a colostomy or a mastectomy, can threaten body image. In addition, patients with implantable

devices may have body image concerns, particularly those with implantable cardioverter defibrillators (ICDs) and ventricular assist devices (VADs) (Alonso, Mollard, Zimmerman, et al., 2019; Frydensberg, Skovbakke, Pedersen, et al., 2018). The question, "Do you have any particular concerns about your body?" may elicit useful information about self-image.

Chart 4-4 **ASSESSMENT**

Assessing the Health of People with Disability

Overview

People with disability are entitled to the same level of health assessment and physical examination as people without disability. Physical and mental disability should be explained in the health history. Patients with mental disability are often marginalized from mainstream health care services because of the complexities of their disability. It is appropriate to ask the patient, or caregiver when necessary, what assistance they need rather than assuming that help is needed for all activities or that, if assistance is needed, the patient will ask for it.

Health History

Communication between the nurse and the patient is essential. To ensure that the patient is able to respond to assessment questions and provide needed information, interpreters, assistive listening devices, or other alternative formats (e.g., Braille, large-print forms) may be required.

When interpreters are needed, interpretation services should be arranged. Health care facilities have a responsibility to provide these services without charge to the patient. Family members (especially children) should *not* be used as interpreters, because doing so violates the patient's right to privacy and confidentiality.

The nurse should speak directly to the patient and not to family members or others who have accompanied the patient. If patients have impaired hearing, they should be encouraged to use their hearing aids or hearing assistance technology during the assessment. The patient should be able to see the nurse's face clearly during the health history so that speech reading and nonverbal clues can be used to aid communication.

The health history should address general health issues that are important to all patients, including sexual history and risk for abuse, including intimate partner violence. It should also address the impact of the patient's disability on health issues and access to care, as well as the effect of the patient's current health problem on their disability. An assessment of whether the patient's quality of life meets their expectations should be included in the health history.

The nurse should verify what the patient has said; if the patient has difficulty communicating verbally, the nurse should ask for clarification rather than assume that it is too difficult for the patient to do so. Most people would rather be asked to explain again than run the risk of being misunderstood.

Physical Examination

Inaccessible facilities remain a major barrier to health care for people with disability. Barriers include lack of ramps and grab bars, inaccessible restrooms, small examination rooms, and examination tables that cannot be lowered to allow the patient to move himself or herself onto, or be transferred easily and safely to, the examination table. The patient may need help getting undressed for the physical examination (and dressed again), moving on and

off the examination table, and maintaining positions usually required during physical examination maneuvers. It is important to ask the patient what assistance is needed.

If the patient has impaired sensory function (e.g., lack of sensation, hearing or vision loss), it is important to inform the patient that you will be touching them. Furthermore, it is important to explain all procedures and maneuvers.

Gynecologic examinations should *not* be deferred because a patient has a disability or is assumed to be sexually inactive. Explanations of the examination are important for all women, and even more so for women with disability, because they may have had previous negative experiences. Slow, gentle moving and positioning of the patient for the gynecologic examination and warming the speculum before attempting insertion often minimize spasticity in women with neurologically related disability.

Health Screenings and Testing

Many people with disability report that they have not been weighed for years or even decades because they are unable to stand for this measurement. Alternative methods (e.g., use of wheelchair scales) are needed to monitor weight and body mass index. This is particularly important because of the increased incidence of obesity and its effects on health status and transfer of people with disabilities.

Patients with disability may require special assistance if urine specimens are to be obtained as part of the visit. They are often able to suggest strategies to obtain urine specimens based on previous experience.

If it is necessary for the nurse to wear a mask during a procedure or if the patient is unable to see the face of the nurse during a procedure, it is important to explain the procedure and the expected role of the patient ahead of time. If the patient is unable to hear or communicate with the nurse or other health care provider verbally during an examination or diagnostic test, a method of communication (e.g., signaling the patient by tapping the arm, signaling the nurse by using a bell) should be established beforehand.

People with disability experience difficulties related to obtaining care, challenges accessing health care facilities, perceptions that health professionals are insensitive to their needs, and concerns about the quality of care they receive. Therefore, it is important to ask about health screening and recommendations for screening. In addition, people with disability should be asked about their participation in health promotion activities, because inaccessible environments and other barriers may limit their participation in exercise, health programs, and other health promotion efforts such as health screenings.

Adapted from Amieva, H., Ouvrard, C., Meillon, C., et al. (2018). Death, depression, disability, and dementia associated with self-reported hearing problems: A 25-year study. *Journals of Gerontology Series A: Biological Sciences & Medical Sciences, 73*(10), 1383–1389; Axmon, A., Björkman, M., & Ahlström, G. (2019). Hospital readmissions among older people with intellectual disability in comparison with the general population. *Journal of Intellectual Disability Research, 63*(6), 593–602; Mitra, M., Akobirshoev, I., Moring, N. S., et al. (2017). Access to and satisfaction with prenatal care

among pregnant women with physical disabilities: Findings from a national survey. *Journal of Women's Health, 26*(12), 1356–1363; Zetterlund, C., Lundqvist, L., Richter, H. O., et al. (2019). Visual, musculoskeletal and balance symptoms in individuals with visual impairment. *Clinical & Experimental Optometry, 102*(1), 63–69.

Sexuality

The sexual history is an extremely personal area of assessment. Interviewers are frequently uncomfortable with such questions and ignore this area of the patient profile or conduct a very cursory interview about this subject. It is the nurse's professional and clinical responsibility to discuss issues of sexuality with patients.

Sexual function may be affected negatively by disease (or treatment), surgery, or aging. In order for the patient to maintain sexual function and optimize quality of life, sexual issues must be addressed. In addition, the interviewer should project a positive attitude related to sexual orientation or toward those who may be lesbian, gay, bisexual, transgender, or queer (LGBTQ). In addition, if a patient's sexual orientation and gender identity is not yet known, use of neutral language will help put the patient at ease and enhance the therapeutic relationship (see Chapter 54, Table 54-1, for examples of gender neutral language and assessment questions).

Sexual assessment can be approached at the end of the interview or at the time interpersonal or lifestyle factors are assessed; otherwise, it may be easier to discuss sexuality as a part of the genitourinary history within the review of systems. In cisgender female patients, a discussion of sexuality could follow questions about menstruation. In cisgender male patients, a similar discussion could follow questions about the urinary system.

Obtaining the sexual history provides an opportunity to discuss sexual matters openly and gives the person permission to express sexual concerns to an informed professional. The assessment begins with an orienting sentence such as "Next, I would like to ask about your sexual health and practices." This type of opening may lead to a discussion of concerns related to sexual expression or the quality of a relationship, or to questions about contraception, risky sexual behaviors, and safer sex practices. Examples of other questions include "Do you have one or more sexual partners?" and "Are you satisfied with your sexual relationships?"

Determining whether a person is sexually active should precede any attempts to explore issues related to sexuality and sexual function. Care should be taken to initiate conversations about sexuality with older adult patients and patients with disability and not to treat them as asexual people. Questions should be worded in such a way that the person feels free to discuss sexuality regardless of marital status or sexual orientation. Direct questions are usually less threatening when prefaced with such statements as "Some people feel that…" or "Many people worry about…." This suggests the normalcy of such feelings or behavior

and encourages the person to share information that might otherwise be omitted because of fear of seeming "different."

If a person answers abruptly or does not wish to carry the discussion any further, then the interviewer should move to the next topic. However, introducing the subject of sexuality indicates to the person that a discussion of sexual concerns is acceptable and can be approached again in the future if so desired (further discussion of the sexual history is presented in Chapters 50, 53, and 54).

Gerontologic Considerations

Effective health care for older adults requires assessment of sexual health (Weber & Kelley, 2018). Older adults may be stereotyped by misconceptions that they are sick and disabled, have dementia, have lower intelligence and are resistant to change, are not able to have sexual intercourse, or are not interested in sex (Eliopoulos, 2018); however, sexual activity continues in later life, and sexual satisfaction depends on age-related changes (Skałacka & Gerymski, 2019). Literature supports that people not only remain sexually active for a long time into their old age, but also that various forms of sexual activity is associated with their global life satisfaction (Lee, Vanhoutte, Nazroo, et al., 2016; Skałacka & Gerymski, 2019). Many older adults prefer to engage in more subtle forms of sexual activity (e.g., kissing, cuddling) rather than having intercourse. The frequency of intercourse may diminish because of body changes and health issues that may result from the aging process and/or sexual dysfunction in one or both partners (Skałacka & Gerymski, 2019).

Risk for Intimate Partner Violence

Physical, sexual, and psychological violence affects people of both genders and those who identify as gender fluid or nonbinary, as well as people of all ages and from all socioeconomic and ethnic groups. IPV, also called domestic violence, is common in the United States. One in four women in the United States experiences IPV (Smith, Chen, Basile, et al., 2017). IPV includes physical, sexual, or emotional abuse, as well as sexual coercion and stalking by a current or former intimate partner (HHS, 2019c). Patients rarely discuss this topic unless specifically asked about it. Therefore, it is important to ask direct questions, such as:

- Is anyone physically hurting you or forcing you to engage in sexual activities?
- Has anyone ever hurt you physically or threatened to do so?
- Are you ever afraid of anyone close to you (your partner, caregiver, or other family members)?

Patients who are older or have disability are at increased risk for IPV and should be asked about it as a routine part of assessment (Truong, Burnes, Alaggia, et al., 2019). However, when older patients are questioned directly,

they rarely admit to abuse. Health care professionals should assess for risk factors, such as high levels of stress or alcoholism in caregivers, or evidence of violence, emotional outbursts, or financial, emotional, or physical dependency in patients.

Two additional questions have been found to be effective in uncovering specific types of IPV that may occur only in people with disability:

- Does anyone prevent you from using a wheelchair, cane, respirator, or other assistive device?
- Does anyone you depend on refuse to help you with an important personal need, such as taking your medicine, getting to the bathroom, getting in or out of bed, bathing, dressing, or getting food or drink?

If a person's response indicates that IPV is a risk, further assessment is warranted, and efforts are made to ensure the patient's safety and provide access to appropriate community and professional resources and support systems (further discussion of IPV is presented in Chapters 50 and 67).

Stress and Coping Responses

Each person handles stress differently. How well people adapt to stress depends on their ability to cope. During a health history, past coping patterns and perceptions of current stresses and anticipated outcomes are explored to identify the person's overall ability to handle stress. It is especially important to identify the expectations that a person may have related to family, friends, and caregivers in terms of providing financial, emotional, or physical support (further discussion of stress and coping is presented in Chapter 5).

Physical Assessment

Physical assessment, or the physical examination (collection of objective data about the patient's health status), is an integral part of nursing assessment. The basic techniques and tools used in performing a physical examination are described in general in this chapter. The examinations of specific systems, including special maneuvers, are described in the respective system assessment chapters throughout the book.

Examination Considerations

The physical examination is usually performed after the health history is obtained. It is carried out in a well-lighted, warm area. The patient is asked to (or helped to) undress and is draped appropriately so that only the area to be examined is exposed. The patient's physical and psychological comfort are considered at all times. It is necessary to describe procedures to the patient and explain what sensations to expect before each part of the examination. The

examiner washes his or her hands before and immediately after the examination. Fingernails are kept short to avoid injuring the patient. If there is a possibility of coming into contact with blood or other body secretions during the physical examination, gloves should be worn.

An organized and systematic examination is the key to obtaining appropriate data in the shortest time. Such an approach encourages cooperation and trust on the part of the patient. The patient's health history provides the examiner with a health profile that guides all aspects of the physical examination.

A "complete" physical examination is not routine. Many of the body systems are selectively assessed on the basis of the presenting problem. For example, if a healthy 20-year-old college student requires an examination to study abroad and reports no history of neurologic abnormality, the neurologic assessment is brief. Conversely, a history of transient numbness and diplopia (double vision) usually necessitates a complete neurologic investigation. Similarly, a patient with chest pain receives a much more intensive examination of the chest and the heart than one with an earache. In general, the health history guides the examiner in obtaining additional data for a complete picture of the patient's health.

The process of learning to perform a physical examination requires repetition and reinforcement in a simulated or clinical setting. Only after basic physical assessment techniques are mastered can the examiner tailor the routine examination to include thorough assessments of particular systems, including special maneuvers (Hogan-Quigley et al., 2017; Weber & Kelley, 2018).

Components of the Physical Examination

The components of a physical examination include general observations and then a more focused assessment of the pertinent body systems. The tools of the physical examination are the human senses of vision, hearing, touch, and smell. These may be augmented by special tools (e.g., stethoscope, ophthalmoscope, reflex hammer) that are extensions of the human senses; they are simple tools that anyone can learn to use well. Expertise comes with practice, and sophistication comes with the interpretation of what is seen and heard.

Initial Observations

General inspection begins with the first contact with the patient. Introducing oneself and shaking hands provide opportunities for making initial observations: Is the person old or young? How old? How young? Does the person appear to be their stated age? Is the person thin or obese? Does the person appear anxious or depressed? Is the person's body structure normal or abnormal—in what way and how different from normal? It is essential to pay attention to the details in observation. Vague, general statements are not a substitute for specific descriptions based on careful observation. Consider the following examples:

- "The patient appears sick." In what way do they appear sick? Is the skin clammy, pale, jaundiced, or cyanotic? Is the patient grimacing in pain or having difficulty breathing? Do they have edema? What specific physical features or behavioral manifestations indicate that the patient is "sick?"
- "The patient appears chronically ill." In what way do they appear chronically ill? Does the patient appear to have lost weight? Patients who lose weight secondary to muscle-wasting diseases (e.g., AIDS, malignancy) have a different appearance than those who are merely thin, and weight loss may be accompanied by loss of muscle mass or atrophy. Does the skin have the appearance of chronic illness (i.e., is it pale, or does it give the appearance of dehydration or loss of subcutaneous tissue)?

These important specific observations are documented in the patient's chart or health record. Among general observations that should be noted in the initial examination of the patient are posture, body movements, nutritional status, speech pattern, and vital signs.

Posture

The posture that a patient assumes often provides valuable information. Patients who have dyspnea (breathing difficulties) secondary to cardiac disease prefer to sit and may report feeling short of breath when lying flat for even a brief time. Patients with abdominal pain owing to peritonitis prefer to lie perfectly still; even slight jarring of the bed or examination table causes agonizing pain. In contrast, patients with abdominal pain owing to renal or biliary colic are often restless and may pace the room.

Body Movements

There are two kinds of abnormalities of body movement: generalized disruption of voluntary or involuntary movement and asymmetry of movement. The first category includes various tremors; some tremors may occur at rest (Parkinson's disease), whereas others occur only on voluntary movement (cerebellar ataxia). Other tremors may exist during both rest and activity (alcohol withdrawal syndrome, thyrotoxicosis). Some voluntary or involuntary movements are fine and others are quite coarse. Extreme examples include the convulsive movements of generalized seizures and the choreiform (involuntary and irregular) movements of patients with rheumatic fever or Huntington disease.

Asymmetry of movement, in which only one side of the body is affected, may occur with disorders of the central nervous system (CNS), primarily in those patients who have had a stroke. Patients may have drooping of one side of the face, weakness or paralysis of the extremities on one side of the body, or a foot-dragging gait.

Nutritional Status

Nutritional status is important to note. Obesity may be generalized as a result of excessive intake of calories, or it may be specifically localized to the trunk in patients who have an endocrine disorder (Cushing's disease) or who have been taking corticosteroids for long periods. Loss of weight may be generalized as a result of inadequate caloric intake, or it may be seen in loss of muscle mass with disorders that affect protein synthesis. Nutritional assessment is discussed in more detail later in this chapter.

Speech Pattern

Speech may be slurred because of CNS disease or because of damage to cranial nerves. Recurrent damage to the laryngeal nerve results in hoarseness, as do disorders that produce edema or swelling of the vocal cords. Speech may be halting, slurred, or interrupted in flow in patients with some CNS disorders (e.g., multiple sclerosis, stroke).

Vital Signs and Pain Assessment

The recording of vital signs is a part of every physical examination (Hogan-Quigley et al., 2017). Blood pressure, pulse rate, respiratory rate, and body temperature measurements are obtained and recorded. Acute changes and trends over time are documented, and unexpected changes and values that deviate significantly from a patient's normal values are brought to the attention of the patient's primary provider. Pain is also assessed and documented, if indicated (see Chapter 9 for further discussion).

Focused Assessment

Following the general inspection, a more focused assessment is conducted. Although the sequence of physical examination depends on the circumstances and the patient's reason for seeking health care, the complete examination usually proceeds as follows:

- Skin
- Head and neck
- Thorax and lungs
- Breasts
- Cardiovascular system
- Abdomen
- Rectum
- Genitalia
- Neurologic system
- Musculoskeletal system

In clinical practice, all relevant body systems are tested throughout the physical examination, not necessarily in the sequence described (Weber & Kelley, 2018). For example, when the face is examined, it is appropriate to check for facial asymmetry and, thus, for the integrity of the fifth and seventh cranial nerves; the examiner does not need to repeat this as part of a neurologic examination. When systems are combined in this manner, the patient does not need to change positions repeatedly, which can be exhausting and time-consuming.

The traditional sequence in the focused portion of the examination is inspection, palpation, percussion, and then auscultation, except in the case of an abdominal examination (in which auscultation precedes palpation and percussion).

Inspection

The first fundamental technique is **inspection**, or observation of each relevant body system in more detail as indicated from the health history or the general inspection. Characteristics such as skin color, presence and size of lesions, edema, erythema, symmetry, and pulsations are noted. Specific body movements that are noted on inspection include spasticity, muscle spasms, and an abnormal gait (Norris, 2019).

Palpation

Palpation, which utilizes the sense of touch, is a vital part of the physical examination. Many structures of the body, although not visible, may be assessed through the techniques of light and deep palpation (Fig. 4-3). Examples include the superficial blood vessels, lymph nodes, thyroid gland, organs of the abdomen and the pelvis, and rectum. When the abdomen is examined, auscultation is performed before palpation and percussion to avoid altering bowel sounds (Hogan-Quigley et al., 2017; Weber & Kelley, 2018).

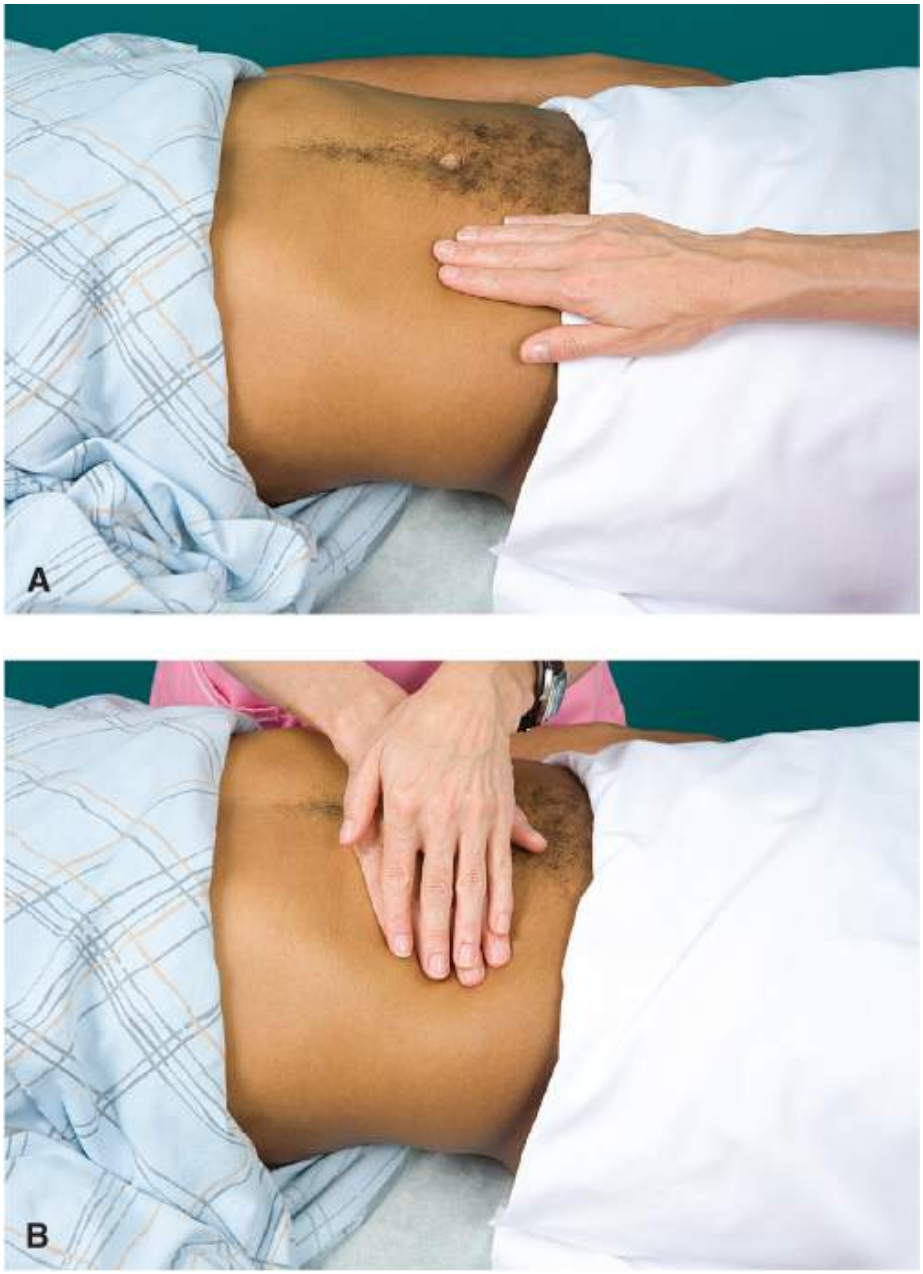


Figure 4-3 • **A.** Light palpation. **B.** Deep palpation.

Some sounds generated within the body, if within specified frequency ranges, may also be detected through touch. For example, turbulent flow in the heart or within blood vessels (thrills) may be detected. Thrills cause a sensation to the hand much like the purring of a cat. Voice sounds are transmitted along the bronchi to the periphery of the lung. These may be perceived by touch and may be altered by disorders affecting the lungs. The phenomenon is called *tactile fremitus* and is useful in assessing diseases of the chest. The significance of these findings is discussed in Chapters 17 and 21.

Percussion

The technique of **percussion** translates the application of physical force into sound. It is a skill requiring practice that yields much information about disease processes in the chest and the abdomen (Hogan-Quigley et al., 2017; Weber & Kelley, 2018). The principle is to set the chest wall or abdominal wall into vibration by striking it with a firm object. The sound produced reflects the density of the underlying structure. Certain densities produce sounds as percussion notes. These sounds, listed in a sequence that proceeds from the least to the densest, are tympany, hyperresonance, resonance, dullness, and flatness. Tympany is the drumlike sound produced by percussing the air-filled stomach. Hyperresonance is audible when one percusses over inflated lung tissue in a person with emphysema. Resonance is the sound elicited over air-filled lungs. Percussion of the liver produces a dull sound, whereas percussion of the thigh produces a flat sound.

Percussion allows the examiner to assess such normal anatomic details as the borders of the heart and the movement of the diaphragm during inspiration. It is also possible to determine the level of a pleural effusion (fluid in the pleural cavity) and the location of a consolidated area caused by pneumonia or atelectasis (collapse of alveoli). The use of percussion is described further with disorders of the thorax and the abdomen (see Chapters 17 and 38).

Concept Mastery Alert

Whereas auscultation involves listening to sounds produced within the body by the movement of air, percussion involves applying physical force to the body in order to discern what sounds are made, thereby assessing internal organs. Hyperresonance is audible when one percusses over inflated lung tissue in a person with emphysema.

Auscultation

Auscultation is the skill of listening to sounds produced within the body created by the movement of air or fluid (Fig. 4-4). A stethoscope is typically used to enhance this technique. Examples include breath sounds, the spoken voice, bowel sounds, heart sounds, and cardiac murmurs. Physiologic sounds may be normal (e.g., first and second heart sounds) or pathologic (e.g., heart murmurs in diastole, crackles in the lung). Some normal sounds may be distorted by abnormalities of structures through which the sound must travel (e.g., changes in the character of breath sounds as they travel through the consolidated lung of a patient with lobar pneumonia).

Figure 4-4 • Auscultation of the heart in forward sitting position.

Sound produced within the body, if of sufficient amplitude, may be detected with the stethoscope, which functions as an extension of the human ear and channels sound. The nurse must avoid touching the tubing or rubbing other surfaces (hair, clothing) during auscultation to minimize extraneous noises. Sounds detected by auscultation are classified according to their intensity (loud or soft), pitch (high or low), duration (length), and quality (musical, raspy, crackling) (Hogan-Quigley et al., 2017; Weber & Kelley, 2018).

Nutritional Assessment

Nutrition is important to maintain health and to prevent disease and premature death. When illness or injury occurs, optimal nutrition is essential for recovery, healing, and for resisting infection and other complications. An in-depth nutritional assessment is often integrated into the health history and physical examination. Assessment of a patient's nutritional status provides information about obesity, undernutrition, and malnutrition.

Certain signs that suggest possible nutritional deficiency, such as muscle wasting, poor skin integrity, loss of subcutaneous tissue, and obesity, are easy to note because they are evident and objective. Other physical signs may be subtle, or the patient may report subjective symptoms, which must be carefully assessed. It is important to note that some signs and symptoms that appear to

indicate nutritional deficiency may actually reflect other systemic conditions (e.g., endocrine disorders, infectious disease). Others may result from impaired digestion, absorption, excretion, or storage of nutrients in the body (Norris, 2019; Weber & Kelley, 2018). Disorders caused by nutritional deficiency, overeating, or eating unhealthy foods are among the leading causes of illness and death in the United States today. Examples of health problems associated with poor nutrition include obesity, osteoporosis, cirrhosis, diverticulitis, and eating disorders.

Obesity is a major concern for children, adolescents, and adults in the United States and globally. The World Health Organization (WHO) defines obesity as abnormal or excessive fat accumulation that may impair health. Obesity and being overweight are leading risk factors for global deaths; most of the world's population lives in countries where overweight and obesity kill more people than underweight. In addition, coronary artery disease, diabetes, musculoskeletal disorders, and certain cancers can be attributable to obesity (WHO, 2019) (see Chapter 42 for a detailed discussion of obesity).

Lifespan Considerations

When the nurse conducts a nutritional assessment, two age groups merit special consideration: adolescents and older adults. Key considerations for each group are highlighted below.

Adolescents

Adolescence is a time of critical growth and when lifelong eating and exercise habits are established. Nutritional assessment is particularly important during this time period. In general, adolescents gain 40% of their adult weight and 15% of their adult height during this developmental stage of life (Lassi, Moin, & Bhutta, 2017). It is vital to assess for obesity in adolescents to prevent complications from obesity as they grow and develop, as well as when they enter adulthood.

Adolescent girls should consume approximately 1400 to 2400 calories daily; whereas, adolescent boys require between 1600 to 3200 calories each day to support their greater growth needs in terms of both overall size and muscle mass. Athletes of either gender may need to consume up to 5000 calories daily to support their metabolic demands. In adolescents of both genders, sufficient micronutrients such as calcium, B-complex vitamins, iron, and folate are necessary to support increased metabolic activity during this time of growth. Adolescent girls are at particular nutritional risk, because they are thought to be exposed to expectations to diet and maintain a thin body. As a consequence, many adolescent girls are purposely deficient in their intake of dairy products, because they are caloric-rich. However, dairy products provide an important

source of calcium that is necessary in order to build bone mass. Adolescents of both genders are at risk for behavioral eating disorders, such as anorexia, bulimia, and binge-eating disorders, although girls are at greater risk (Lassi et al., 2017).

Older Adults

Older adults are also at risk for altered nutrition. Nutritional assessment in the older adult should include inquiry about the patient's current dietary practices as well as a nutritional screening to assess for adequate nutrition. The Mini Nutritional Assessment is a commonly used, well-validated tool developed specifically for this purpose (Chart 4-5). Many older adults adhere to specific diets, such as those low in saturated fat or sodium, for improving or maintaining health. Proper nutrition for an older adult meets daily requirements, maintains ideal body weight, and addresses specific health concerns such as cardiovascular or renal disease (Eliopoulos, 2018).

Older adults are particularly at high risk for poor nutrition due to factors that may include social isolation, frailty, cognitive impairment, polypharmacy (i.e., use of multiple prescription and OTC medications), reduced functional status, and financial instability (Astrup & O'Connor, 2018). Disorders affecting any part of the gastrointestinal tract can alter nutritional requirements and health status in people of any age; however, such disorders are likely to occur more quickly and more frequently in older adults. Acute and chronic diseases may affect the metabolism and utilization of nutrients, which already are altered by the aging process. Even well older adults may be nutritionally at risk because of decreased odor perception, poor dental health, limited ability to shop and cook, financial hardship, and the fact that they often eat alone (Eliopoulos, 2018).

Polypharmacy also may place older adults at risk nutritionally. The number of adverse reactions increases proportionately with the number of medications taken. Age-related physiologic and pathophysiologic changes may alter the metabolism and elimination of many medications (Eliopoulos, 2018). Medications can influence food intake by producing side effects such as nausea, vomiting, decreased appetite, and changes in cognition. They may also interfere with the distribution, utilization, and storage of nutrients.

Components of Nutritional Assessment

The sequence of the assessment may vary; however, evaluation of a patient's nutritional status includes the use of one or more of the following methods: measurement of body mass index (BMI) and waist circumference, biochemical assessment, clinical examination findings, and dietary data. Measurement of BMI and waist circumference is recommended to determine whether a patient has obesity (CDC, 2019a).

Body Mass Index, Ideal Weight, and Waist Circumference

Body mass index (BMI) is a ratio based on body weight and height (Table 4-1). The obtained value is compared to established standards; however, trends or changes in values over time are considered more useful than isolated or one-time measurements. BMI is highly correlated with body fat, although increased lean body mass or a large body frame can also increase the BMI. People who have a BMI lower than 18.5 (or who are 80% or less of their desirable body weight for height) are at increased risk for problems associated with poor nutritional status. In addition, a low BMI is associated with a higher mortality rate among hospitalized patients and community-dwelling older adults. Those who have a BMI between 25 and 29.9 are considered overweight. Obesity is defined as a BMI of greater than 30 (WHO, 2019). Although there are no current standard recommendations for BMI based on race or ethnicity, there is literature to support that BMI and body fat percentages can vary between genders and among people of different ages and from different ethnic groups (McConnell-Nzunga, Naylor, Macdonald, et al., 2018). In analyzing BMI, the nurse must be aware that there may be weight variance that could be dependent upon age, gender, and ethnicity.

TABLE 4-1 How Is BMI Calculated?[a]

Measurement Units	Formula and Calculation
Kilograms and meters (or centimeters)	Formula: weight (kg)/[height (m)]^2 With the metric system, the formula for BMI is weight in kilograms divided by height in meters squared. Because height is commonly measured in centimeters, divide height in centimeters by 100 to obtain height in meters. Example: Weight = 68 kg, Height = 165 cm (1.65 m) Calculation: 68/(1.65)^2 = 24.98
Pounds and inches	Formula: weight (lb)/[height (in)]^2 × 703 Calculate BMI by dividing weight in pounds (lb) by height in inches (in) squared and multiplying by a conversion factor of 703. Example: Weight = 150 lb, Height = 65 in Calculation: [150/(65)^2] × 703 = 24.96

[a]BMI is calculated the same way for both adults and children. The calculation is based on formulas within this table.

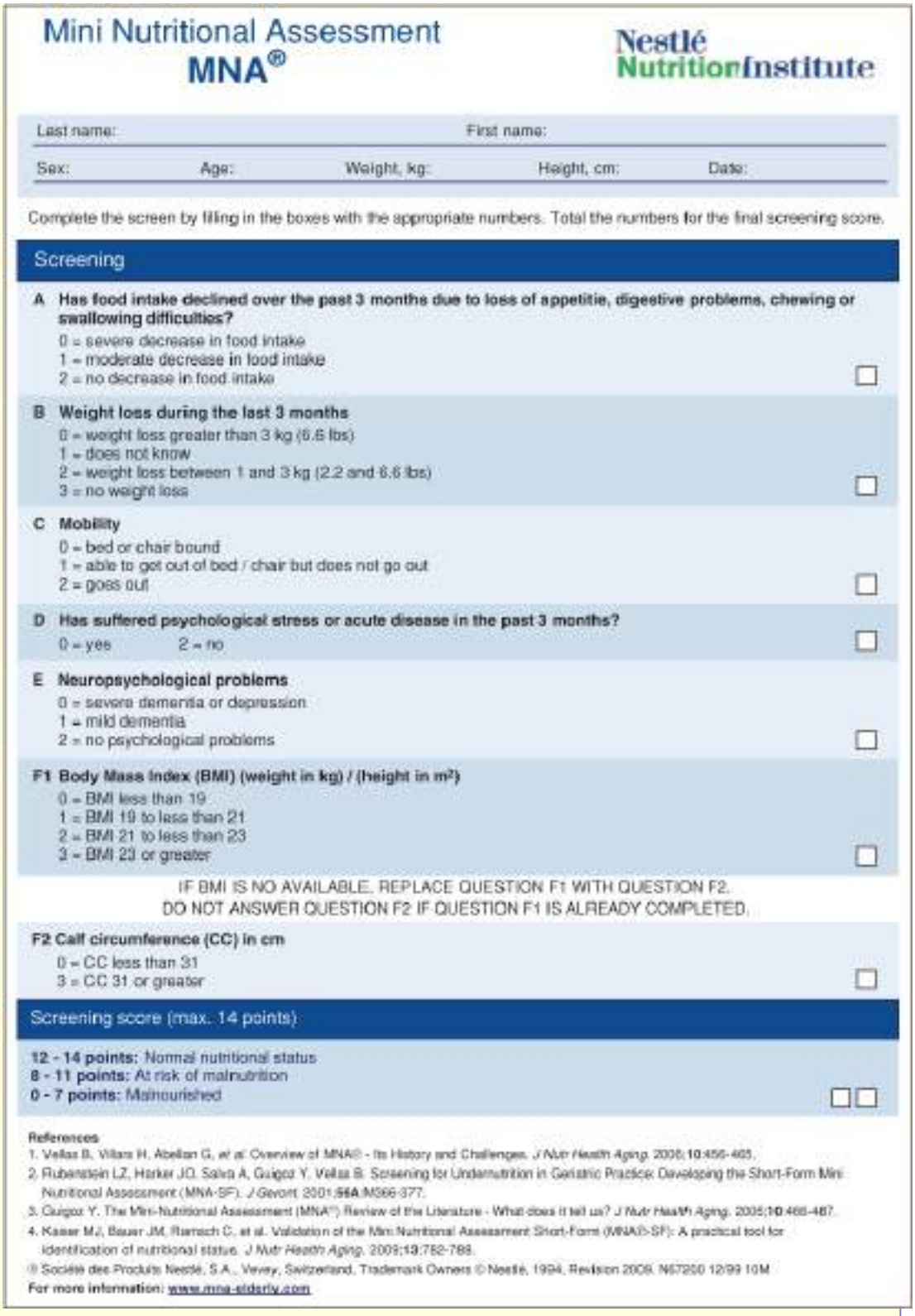
BMI, body mass index.

Adapted from the Centers for Disease Control and Prevention (CDC). (2019b). About body mass index (BMI). Retrieved on 6/9/2019 at: www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html

Chart 4-5

Mini Nutritional Assessment

The Mini Nutritional Assessment (MNA) is a six-item tool designed to identify adults aged 65 y and older who are either malnourished or at risk for becoming malnourished. It is available in several languages and there are several methods of delivery, including self-assessment as well as an electronic health record (EHR) version. It provides a more sensitive measure than body mass index (BMI) in identifying older adults in long-term care facilities at risk for malnutrition (Nestlé Nutrition Institute, 2011).



Mini Nutritional Assessment
MNA®

Nestlé Nutrition Institute

Last name: First name:

Sex: Age: Weight, kg: Height, cm: Date:

Complete the screen by filling in the boxes with the appropriate numbers. Total the numbers for the final screening score.

Screening

A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
0 = severe decrease in food intake
1 = moderate decrease in food intake
2 = no decrease in food intake

B Weight loss during the last 3 months
0 = weight loss greater than 3 kg (6.6 lbs)
1 = does not know
2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs)
3 = no weight loss

C Mobility
0 = bed or chair bound
1 = able to get out of bed / chair but does not go out
2 = goes out

D Has suffered psychological stress or acute disease in the past 3 months?
0 = yes 2 = no

E Neuropsychological problems
0 = severe dementia or depression
1 = mild dementia
2 = no psychological problems

F1 Body Mass Index (BMI) (weight in kg) / (height in m²)
0 = BMI less than 19
1 = BMI 19 to less than 21
2 = BMI 21 to less than 23
3 = BMI 23 or greater

IF BMI IS NO AVAILABLE, REPLACE QUESTION F1 WITH QUESTION F2.
DO NOT ANSWER QUESTION F2 IF QUESTION F1 IS ALREADY COMPLETED.

F2 Calf circumference (CC) in cm
0 = CC less than 31
3 = CC 31 or greater

Screening score (max. 14 points)

12 - 14 points: Normal nutritional status
8 - 11 points: At risk of malnutrition
0 - 7 points: Malnourished

References
1. Vellas B, Villars H, Abellan G, et al. Overview of MNA® - Its History and Challenges. J Nutr Health Aging. 2006;10:456-465.
2. Rubenstein LZ, Harker JO, Salva A, Guigoz Y, Vellas B. Screening for Undernutrition in Geriatric Practice: Developing the Short-Form Mini Nutritional Assessment (MNA-SF). J Geront. 2001;56A:M366-377.
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4. Kaiser MJ, Bauer JM, Ramsch C, et al. Validation of the Mini Nutritional Assessment Short-Form (MNA®-SF): A practical tool for identification of nutritional status. J Nutr Health Aging. 2009;13:782-788.

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For more information: www.mna-elderly.com

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It is important to assess for usual body weight and height and to compare these values with ideal weight (see Chapter 42, Fig. 42-3). Current weight does

not provide information about recent changes in weight; therefore, patients are asked about their usual body weight and any recent weight loss or gain. Loss of height may be attributable to osteoporosis—an important problem related to nutrition, especially in postmenopausal women (Hogan-Quigley et al., 2017; Weber & Kelley, 2018).

In addition to the calculation of BMI, waist circumference measurement is a useful assessment tool. To measure waist circumference, a tape measure is placed in a horizontal plane around the abdomen at the level of the iliac crest. A waist circumference greater than 40 inches for men or 35 inches for women indicates excess abdominal fat. Those with a high waist circumference are at an increased risk for diabetes, dyslipidemias, hypertension, heart attack, and stroke (Hogan-Quigley et al., 2017; Weber & Kelley, 2018).

Biochemical Assessment

Biochemical measurements are applicable to a patient's nutritional assessment as they can test the level of a given nutrient and reflect abnormalities of metabolism in relation to the utilization of nutrients. Tests of serum and urine are done to determine whether the values are within an acceptable range. Some of these tests, while reflecting recent intake of the elements detected, can also identify a long-term deficiency (below-normal levels) even when there are no clinical symptoms of deficiency.

Low serum albumin and prealbumin levels are most often used as measures of protein deficit in adults. Albumin synthesis depends on normal liver function and an adequate supply of amino acids. Because the body stores a large amount of albumin, the serum albumin level may not decrease until malnutrition is severe; therefore, its usefulness in detecting recent protein depletion is limited. Decreased albumin levels may be caused by overhydration, liver or renal disease, or excessive protein loss due to burns, major surgery, infection, or cancer. Serial measurements of prealbumin levels are used to assess the effectiveness of nutritional therapy.

Additional laboratory data, such as levels of transferrin and retinol-binding protein, and complete blood and electrolyte counts, are used in many institutions. Transferrin is a protein that binds and carries iron from the intestine through the serum. Because of its short half-life, transferrin levels decrease more quickly than albumin levels in response to protein depletion. Low levels of transferrin can also lead to a deficiency in iron; low availability of iron in the body limits the synthesis of functioning hemoglobin causing anemia. Although measurement of retinol-binding protein is not available from many laboratories, it may be a useful means of monitoring acute, short-term changes in protein status. The total lymphocyte count may be reduced in people who are acutely malnourished as a result of stress and low-calorie feeding, as well as in those with impaired cellular immunity. Anergy, or the absence of an immune response to injection of small concentrations of recall antigen under the skin, may also

indicate malnutrition because of delayed antibody synthesis and response. Serum electrolyte levels provide information about fluid and electrolyte balance and kidney function.

A 24-hour urine collection can be utilized to calculate the creatinine/height index that assesses metabolically active tissue and indicates the degree of protein depletion. The amount of creatinine is measured and the index is calculated on the basis of the patient's height and gender. The patient's creatinine/height index is then compared to normal ranges based on the expected body weight by height. Values lower than normal may indicate loss of lean body mass and protein malnutrition (Fischbach & Fischbach, 2018).

Clinical Examination

The state of nutrition is often reflected in a person's appearance. Although the most obvious physical sign of good nutrition is a normal body weight with respect to height, body frame, and age, other tissues can serve as indicators of general nutritional status and adequate intake of specific nutrients; these include the hair, skin, teeth, gums, mucous membranes, mouth and tongue, skeletal muscles, abdomen, lower extremities, and thyroid gland (Table 4-2).

Dietary Data

Commonly used methods of determining individual eating patterns include the food record, the 24-hour food recall, and a dietary interview. Each of these methods helps estimate whether food intake is adequate and appropriate. If these methods are used to obtain the dietary history, instructions must be given to the patient about measuring and recording food intake.

Methods of Collecting Data

The nurse may employ multiple methods to collect a patient's dietary data. Two common methods described here include the food record and the 24-hour recall.

Food Record

The food record, also called the food diary, is used most often in nutritional status studies. A person is instructed to keep a record of food consumed over a period of time, varying from 3 to 7 days, and to accurately estimate and describe the specific foods consumed. Food records are fairly accurate if the person is willing to provide factual information and is able to estimate food quantities.

TABLE 4-2 Physical Indicators of Nutritional Status

Indicator	Signs of Good Nutrition	Signs of Poor Nutrition
General appearance	Alert, responsive	Listless, appears acutely or chronically ill
Hair	Shiny, lustrous; firm, healthy scalp	Dull and dry, brittle, dyspigmentation, alopecia (hair loss)
Face	Skin color uniform; healthy appearance	Skin dark over cheeks and under eyes, skin flaky, face swollen or hollow/sunken cheeks, moon face, pallor
Eyes	Bright, clear, moist	Xerophthalmia (pale conjunctiva, dry mucosa), increased vascularity, xanthelasma (yellow subdermal fat deposits around the lids)
Lips	Good color (pink), smooth	Swollen and puffy, angular stomatitis (cracks at corners), cheilosis (angular lesion at corners of mouth)
Tongue	Deep red in appearance; surface papillae present	Glossitis (smooth appearance, swollen, beefy-red or magenta), sores, atrophic papillae
Teeth	Straight, no crowding, no dental caries, bright	Delayed eruption, dental caries, fluorosis (mottled appearance), malpositioned
Gums	Firm, good color (pink)	Spongy, scorbutic (bleeding), marginal redness, recession
Thyroid	No enlargement of the thyroid	Simple goiter (thyroid enlargement)
Skin	Smooth, good color, moist	Rough, dry, flaky, swollen, pale, pigmented; lack of fat under skin
Nails	Firm, pink	Spoon shaped, ridged, brittle
Skeleton	Good posture, no malformation	Stunted growth, poor posture, rachitic rosary (beading of ribs), bowed legs (rickets), narrow chest (pigeon breast), loss of fat, muscle wasting
Muscles	Well developed, firm	Flaccid, poor tone, wasted, underdeveloped
Extremities	No tenderness	Weak and tender, loss of fat, muscle wasting, edematous
Abdomen	Flat	Swollen
Nervous system	Normal reflexes	Decreased or absent ankle and knee reflexes, confusion, neuropathy, tetany
Weight	Normal for height, age, and body build	Overweight or underweight

Adapted from Fenske, C., Watkins, K., Saunders, T., et al. (2020). *Health & physical assessment in nursing* (4th ed.). Hoboken, NJ: Pearson Education, Inc.

24-Hour Recall

As the name implies, the 24-hour recall method is a recall of food intake over a 24-hour period. A person is asked to recall all foods eaten during the previous day and to estimate the quantities of each food consumed. Because information does not always represent usual intake, at the end of the interview the patient is asked whether the previous day's food intake was typical. To obtain supplementary information about the typical diet, it is also necessary to ask how frequently the person eats foods from the major food groups.

Dietary Interview

The success of the interviewer in obtaining information for dietary assessment depends on effective communication, which requires that good rapport be established to promote respect and trust. The interview is conducted in a nondirective and exploratory way, allowing the respondent to express feelings and thoughts while encouraging them to answer specific questions. The manner in which questions are asked influences the respondent's cooperation. The interviewer must be nonjudgmental and avoid expressing disapproval by verbal comments or facial expression.

Several questions may be necessary to elicit the information needed. When attempting to elicit information about the type and quantity of food eaten at a particular time, open-ended questions should be utilized. In addition, assumptions should not be made about the size of servings; instead, questions are phrased to clearly determine the quantities. For example, to help determine the size of one hamburger, the patient may be asked, "How many servings were prepared with the pound of meat you bought?" Another approach to determining quantities is to use food models of known sizes in estimating portions of meat, cake, or pie, or to record quantities in common measurements, such as cups or spoonfuls (or the size of containers when discussing intake of bottled beverages).

In recording a particular combination dish, such as a casserole, it is useful to ask about the ingredients, recording the largest quantities first. When recording quantities of ingredients, the interviewer notes whether the food item was raw or cooked and the number of servings provided by the recipe. When a patient lists the foods for the recall questionnaire, it may help read back the list of foods and ask whether anything was forgotten, such as condiments, fruit, cake, candy, between-meal snacks, or alcoholic beverages.

Cultural, Ethnic, and Religious Considerations

Individuals' culture, ethnicity, or personal beliefs determine to a large extent which foods are eaten and how they are prepared and served. Cultural and religious practices can determine whether certain foods are prohibited (Chart 4-

6) and whether certain foods and spices are eaten on holidays or at specific family gatherings. Because of the value of food pattern choices to many individuals, the nurse must be sensitive to these choices when obtaining a dietary history. Equally important, the nurse must not stereotype individuals and assume that because they are from a certain culture or religious group, they adhere to specific dietary customs. Specific eating patterns, such as vegan or vegetarian, should be explored so that appropriate dietary recommendations can be offered (U.S. Department of Agriculture [USDA] & HHS, 2019). Deficiencies in certain diets may cause disorders such as anemia (see Chapter 29 for further discussion).

Chart 4-6

Prohibited Foods and Beverages of Select Religious Groups

Hinduism

All meats
Animal shortenings/fats

Islam

Pork
Alcoholic products and beverages (including extracts, such as vanilla and lemon)
Animal shortenings
Gelatin made from pork, marshmallow, and other confections made with gelatin
Note: Halal is lawful food that may be consumed according to tenets of the Koran, whereas *Haram* is food that is unlawful to consume.

Judaism

Pork
Predatory fowl
Shellfish and scavenger fish (e.g., shrimp, crab, lobster, escargot, catfish). Fish with fins and scales are permissible.
Mixing milk and meat dishes at same meal
Blood by ingestion (e.g., blood sausage, raw meat).
Note: Packaged foods will contain labels identifying kosher ("properly preserved" or "fitting") and pareve (made without meat or milk) items.

Church of Jesus Christ of Latter-Day Saints (formerly known as Mormonism)

Alcohol
Beverages containing caffeine stimulants (coffee, tea, colas, and selected carbonated soft drinks)

Seventh-Day Adventism

Alcohol
Beverages containing caffeine stimulants (coffee, tea, colas, and selected carbonated soft drinks)
Pork
Certain seafood, including shellfish
Fermented beverages
Note: Optional vegetarianism is encouraged.

Adapted from Giger, J. (2016). *Transcultural nursing: Assessment and intervention* (7th ed.). St. Louis, MO: Elsevier; Holland, K. (2018). *Cultural awareness in nursing and healthcare: An introductory text* (3rd ed.). New York: Taylor & Francis.

The cultural context of food varies widely but usually includes one or more of the following: relief of hunger; promotion of health and healing; prevention

of disease or illness; expression of caring for another; promotion of interpersonal closeness among individual people, families, groups, communities, or nations; and promotion of kinship and family alliances. Food is also associated with strengthening of social ties; observance of life events (e.g., birthdays, marriages, funerals); expression of gratitude or appreciation; recognition of achievement or accomplishment; validation of social, cultural, or religious ceremonial functions; facilitation of business negotiations; and expression of affluence, wealth, or social status.

Culture influences which foods are served and when they are served, the number and frequency of meals, who eats with whom, and who receives the choicest portions. Culture also may influence how foods are prepared and served, how they are eaten (with chopsticks, hands, or fork, knife, and spoon), and where people shop (e.g., ethnic grocery stores, specialty food markets). Culture also determines the impact of excess weight and obesity on self-esteem and social standing. In some cultures, physical bulk is viewed as a sign of affluence and health (e.g., a chubby baby is a healthy baby).

Religious practices may include fasting (e.g., Catholics, Buddhists, Jews, Muslims) and abstaining from selected foods at particular times (e.g., Catholics abstain from meat on Ash Wednesday and on Fridays during Lent). Practices may also include the ritualistic use of food and beverages (e.g., Passover dinner, consumption of bread and wine during religious ceremonies; see Chart 4-6).

Most groups feast, often in the company of family and friends, on selected holidays. For example, many Christians eat large dinners on Christmas and Easter and consume other traditional high-calorie, high-fat foods, such as seasonal cookies, pastries, and candies. These culturally based dietary practices are especially significant in the care of patients with diabetes, hypertension, gastrointestinal disorders, obesity, and other conditions in which diet plays a key role in the treatment and health maintenance regimen.

Evaluating Dietary Information

After obtaining basic dietary information, the nurse evaluates the patient's dietary intake and communicates the information to the dietitian and the rest of the health care team for more detailed assessment and clinical nutrition intervention. If the goal is to determine whether the patient generally eats a healthful diet, their food intake may be compared with the dietary guidelines outlined in the USDA's Center for Nutrition Policy & Promotion's MyPlate (Fig. 4-5). Foods are divided into five major groups (fruits, vegetables, grains, protein foods, and dairy), plus oils. Recommendations are provided related to variety in the diet, proportion of food from each food group, and moderation in eating fats, oils, and sweets. A patient's food intake is compared with recommendations based on various food groups for different age groups and activity levels (Weber & Kelley, 2018).

If nurses or dietitians are interested in knowing about the intake of specific nutrients, such as vitamin A, iron, or calcium, the patient's food intake is

analyzed by consulting a list of foods and their composition and nutrient content. The diet is analyzed in terms of grams and milligrams of specific nutrients. The total nutritive value is then compared with the recommended dietary allowances specific for the patient's age category, gender, and special circumstances such as pregnancy or lactation.

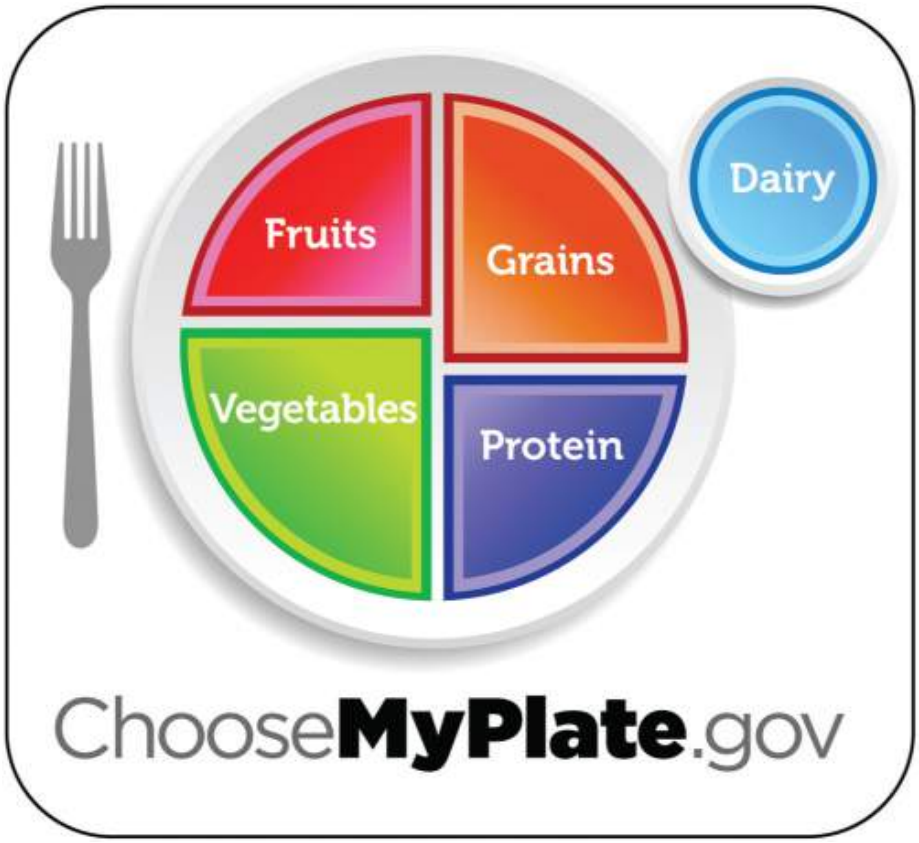

Figure 4-5 • MyPlate, a simple reminder for healthy eating. From the U.S. Department of Agriculture's Center for Nutrition Policy & Promotion. Retrieved on 7/24/2019 at: www.choosemyplate.gov

Fat intake and cholesterol levels are additional aspects of the nutritional assessment. Trans fats are produced when hydrogen atoms are added to monounsaturated or polyunsaturated fats to produce a semisolid product, such as margarine. Partially hydrogenated oils (PHOs), the primary source of industrially produced trans fats, are found in many popular processed foods, such as baked goods and frozen foods. This is a concern because increased amounts of trans fats have been associated with increased risk for heart disease and stroke. In 2015, the FDA released its final determination that PHOs were not *Generally Recognized as Safe (GRAS)*.

At that time, the FDA announced that manufacturers must stop adding PHOs to processed food, providing a 3-year compliance period so that food manufacturers could gradually phase out the use of PHOs. However, to allow

for an orderly transition in the marketplace, FDA extended the compliance date for these foods (FDA, 2019).

Factors Influencing Nutritional Status in Various Situations

Patients who are hospitalized may have an inadequate dietary intake because of the illness or disorder that necessitated the hospital stay. Patients who are at home may feel too sick or fatigued to shop and prepare food, or they may be unable to eat because of other physical problems or limitations. Limited or fixed incomes or the high costs of medications may result in insufficient money to buy nutritious foods. Culturally influenced food patterns can also affect nutritional status. Because complex treatments (e.g., mechanical ventilation, intravenous infusions, chemotherapy) once used only in the hospital setting are now being provided in the home and outpatient settings, nutritional assessment of patients in these settings is an important aspect of home and community-based care. Many of the factors that contribute to poor nutritional status are identified in Table 4-3.

Analysis of Nutritional Status

Physical measurements (BMI, waist circumference) and biochemical and dietary data are used in combination to determine a patient's nutritional status. Often, these data provide more information about the patient's nutritional status than the clinical examination, which may not detect subclinical deficiencies unless they become so advanced that overt signs develop. A low intake of nutrients over a long period may lead to low biochemical levels and, without nutritional intervention, may result in characteristic and observable signs and symptoms. A plan of action for nutritional intervention is based on the results of the dietary assessment and the patient's clinical examination. To be effective, the plan should include a healthy diet, maintenance (or control) of weight, and compensation for increased nutritional needs.

Cultural Assessment

Cultural assessment refers to a systematic appraisal or examination of individuals, families, groups, and communities in terms of their cultural beliefs, values, and practices. Nurses need to ensure that patients of all cultures understand what the nurse is trying to accomplish by gathering cultural data during the assessment process in order to avoid misunderstanding (Holland, 2018). In an effort to establish a database for determining a patient's cultural background, nurses have developed cultural assessment tools or modified existing assessment tools (Leininger, 2002) to ensure that transcultural

considerations are included in the plan of care. Giger and Davidhizar's Transcultural Assessment Model can be used to help nurses perform cultural assessments. Questions derived from this model may be used to direct nursing assessment of a person's ethnic, cultural, or religious beliefs and its relationship to their personal and health care traditions (Chart 4-7) (Giger, 2016). In addition, nurses should gather data on patients' cultural perceptions and family ancestry throughout the assessment process. Nurses should recognize that advancing knowledge about culturally congruent care is important for promoting care that is consistent with the cultural needs of each patient's heritage (Jakub, Turk, Fapohunda, et al., 2018) (see Chart 4-8 for a Nursing Research Profile).

Culturally Mediated Considerations

Nurses should be aware that patients act and behave in various ways, in part because of the influence of culture on behaviors and attitudes. However, although certain attributes and attitudes are frequently associated with particular cultural groups, it is important to remember that not all people from the same cultural background share the same behaviors and views. Although nurses who fail to consider patients' cultural preferences and beliefs are considered insensitive and possibly indifferent, nurses who assume that all members of any one culture act and behave in the same way run the risk of stereotyping people. As stated previously, the best way to avoid stereotyping is to view each patient as a person and to assess the patient's cultural preferences. A thorough cultural assessment using a culture assessment tool or questionnaire can be beneficial.

TABLE 4-3 Factors Associated with Potential Nutritional Deficits

Factor	Possible Consequences
Dental and oral problems (missing teeth, ill-fitting dentures, impaired swallowing or chewing)	Inadequate intake of high-fiber foods
Nothing by mouth (NPO) for diagnostic testing	Inadequate caloric and protein intake; dehydration
Prolonged use of glucose and saline intravenous fluids	Inadequate caloric and protein intake
Nausea and vomiting	Inadequate caloric and protein intake; loss of fluid, electrolytes, and minerals
Diarrhea	Loss of fluid, electrolytes, and minerals; malabsorption of nutrients
Stress of illness, surgery, and/or hospitalization	Increased protein and caloric requirement; increased catabolism
Wound drainage	Loss of protein, fluid, electrolytes, and minerals
Pain	Loss of appetite; inability to shop, cook, eat
Fever	Increased caloric and fluid requirement; increased catabolism
Gastrointestinal intubation	Loss of protein, fluid, and minerals
Tube feedings	Inadequate amounts; variation of nutrients in each formula
Gastrointestinal disease	Inadequate intake and malabsorption of nutrients
Alcoholism	Inadequate intake of nutrients; increased consumption of calories without other nutrients; vitamin deficiencies
Depression	Loss of appetite; inability to shop, cook, eat
Eating disorders (anorexia, bulimia)	Inadequate caloric and protein intake; loss of fluid, electrolytes, and minerals
Medications	Inadequate intake due to medication side effects, such as dry mouth, loss of appetite, decreased taste perception, difficulty swallowing, nausea and vomiting, malabsorption of nutrients
Restricted ambulation or disability	Limited ability to shop, cook, or help self to food, liquids, other nutrients

Chart 4-7 ASSESSMENT

Assessing for Patients' Cultural Beliefs

Communication

- Do you like communicating with friends, family, and acquaintances?
- When asked a question, do you usually respond?
- If you have something important to discuss with your family, how would you approach them?

Space

- When you talk with family members, how close do you stand?
- When you talk with acquaintances, how close do you stand?
- If a stranger touches you, how do you react or feel?
- If a loved one touches you, how do you react or feel?
- Are you comfortable with the distance between us now?

Social Organization

- What are some activities that you enjoy?
- What are your hobbies, or what do you do when you have free time?
- Do you believe in a Supreme Being?
- How do you worship that Supreme Being?
- What is your role in your family/unit system?

Time

- Do you wear a timepiece daily?
- If a nurse tells you that you will receive a medication "in about a half hour," how much time will you allow before calling the nurse?

Environmental Control

- Is it acceptable for you to have visitors drop in unexpectedly?
- Do you use home remedies? Which home remedies worked? Will you use them in the future?
- What is your definition of "good health"?
- What is your definition of illness or "poor health"?

Biologic Variations

- What diseases or illnesses are common in your family?
- Who usually helps you to cope during a difficult time?
- What foods do you and your family like to eat? What foods are family favorites or are considered traditional?

Nursing Process Utilization

- Note whether the patient has become culturally assimilated or observes own cultural practices.
- Incorporate data into the plan of nursing care.

Adapted from Giger, J. (2016). *Transcultural nursing: Assessment and intervention* (6th ed.). St. Louis, MO: Elsevier.

Chart 4-8 NURSING RESEARCH PROFILE

Cultural Beliefs, Perceptions, and Practices of Adult Children of African Immigrants

Jakub, K. E., Turk, M. T., Fapohunda, A., et al. (2018). Cultural beliefs, perceptions, and practices of young adult offspring of African immigrants regarding healthy eating and activity. *Journal of Transcultural Nursing, 29*(6), 548–554.

Purpose

The purpose of this study was to understand and explore the beliefs, perceptions, and practices of young adult offspring of African immigrants regarding healthy eating and activities in the context of their environment and culture. The researchers also examined what influences the beliefs, perceptions, and practices of the study population.

Design

Using a focused ethnography design, five small group interviews consisting of two to six participants were conducted yielding a total of 20 college-age students who were offspring of African immigrants. Focused group semistructured interviews were digitally recorded during the data collection. Data collection was completed upon determination of data saturation. Leininger's four phases of qualitative data analysis were used to analyze the data.

Findings

The 20 participants, between the ages of 18 and 23, reported parental ancestry from eight different countries of the African continent: 11 from Nigeria, 3 from Ghana, and 1 participant each from Ethiopia, Cameroon, Egypt, Sudan, Liberia, and Eritrea. Seventeen categories, six patterns, and four themes emerged from the data. The four themes included (1) family, community, and religious ties to traditional African foods; (2) traditional African cuisine as healthy and American foods as nonhealthy; (3) eating patterns vary according to availability and resources; and (4) exercise patterns have familial, peer-driven, and generational influences significant to this college-age group. Participants also reported balancing acculturation into a university setting. Food choices were influenced by living arrangements, availability, financial resources, and time constraints.

Nursing Implications

Nurses should assess cultural perceptions and family ancestry that may affect a patient's perceptions of health and activity levels. Advancing knowledge about culturally congruent care is important and may promote healthy behaviors that include better eating habits and activity for college-age offspring of immigrants. Efforts should be made to identify the country of origin of patients and develop educational or health promoting programs to manage wellness specific to each patient's heritage.

Information Disclosure

Many aspects of care may be influenced by the diverse cultural perspectives held by health care providers, patients, families, or significant others. One example is the issue of communication and full disclosure. In general, nurses may argue that patients have the right to full disclosure concerning their disease and prognosis and may believe that advocacy means working to provide that disclosure. However, family members in some cultural backgrounds may believe that it is their responsibility to protect and spare the patient (their loved one) knowledge about a terminal illness. In some cultures, the head of the family group, older adult, or husband is expected to receive all information and make decisions. Patients may in fact not want to know about their condition and may expect their family members to "take the burden" of that knowledge and related decision making. Nurses should not decide that a family or patient is simply wrong or that a patient must know all of the details of their illness regardless of the patient's preference. Similar concerns may be noted when patients refuse pain medication or treatment because of cultural beliefs regarding pain or beliefs in divine intervention or faith healing.

Determining the most appropriate and ethical approach to patient care requires an exploration of the cultural aspects of these situations. Self-examination and recognition of one's own cultural bias and worldview play a major part in helping the nurse resolve cultural and ethical conflicts. Nurses must promote open dialogue and work with patients, families, primary providers, and other health care providers to reach the culturally appropriate solution for the individual patient.

Space and Distance

Personal space is the area that surrounds a person's body and includes the space and the objects within the space (Giger, 2016). People tend to regard the space in their immediate vicinity as an extension of themselves. The amount of space that they need between themselves and others to feel comfortable is a culturally determined phenomenon.

Because nurses and patients usually are not consciously aware of their personal space requirements, they frequently have difficulty understanding different behaviors. For example, one patient may perceive the nurse sitting close to them as an expression of warmth and care; another patient may perceive the nurse's act as a threatening invasion of personal space. Research reveals that people from the United States, Canada, and Great Britain require the most personal space between themselves and others, whereas those from Latin America, Japan, and the Middle East need the least amount of space and feel comfortable standing close to others (Giger, 2016).

If the patient appears to position himself or herself too close or too far away, the nurse should consider cultural preferences for space and distance. Ideally, the patient should be permitted to assume a position that is comfortable to them

in terms of personal space and distance. The nurse should be aware that the wheelchair of a person with a disability is considered an extension of the person; therefore, the nurse should ask the person's permission before moving or touching the wheelchair. Because a significant amount of communication during nursing care requires close physical contact, the nurse should be aware that having personal space promotes self-identity by allowing opportunities for patient self-expression (Giger, 2016).

Eye Contact

Eye contact is also a culturally determined behavior. Although most nurses have been taught to maintain eye contact when speaking with patients, some people from certain cultural backgrounds may interpret this behavior differently. For example, some Asians, Native Americans, Indo-Chinese, Arabs, and Appalachians may consider direct eye contact impolite or aggressive, and they may avert their own eyes when talking with nurses and others whom they perceive to be in positions of authority. Some Native Americans stare at the floor during conversations—a cultural behavior conveying respect and indicating that the listener is paying close attention to the speaker. Some Hispanic patients maintain downcast eyes as a sign of culturally appropriate deferential behavior toward others on the basis of age, gender, social position, economic status, and position of authority (Giger, 2016). Eye contact is an important tool in a transcultural assessment and is used for both observation and to initiate interaction (Giger, 2016). The nurse who is aware that eye contact may be culturally determined can better understand the patient's behavior and provide an atmosphere in which the patient can feel comfortable.

Time

Attitudes about time vary widely among cultures and can be a barrier to effective communication between nurses and patients. Views about punctuality and the use of time are culturally determined, as is the concept of waiting. Symbols of time, such as watches, sunrises, and sunsets, represent methods for measuring the duration and passage of time (Giger, 2016).

For most health care providers, time and promptness are extremely important. For example, nurses frequently expect patients to arrive at an exact time for an appointment, although patients may be kept waiting by health care providers who are running late. Health care providers are likely to function according to an appointment system in which there are short intervals. However, for patients from some cultures, time is a relative phenomenon, with little attention paid to the exact hour or minute. Time may also be determined according to traditional times for meals, sleep, and other activities or events. For people from some cultures, the present is of the greatest importance, and time is viewed in broad ranges rather than in terms of a fixed hour. Being flexible in regard to schedules is the best way to accommodate these differences.

Value differences also may influence a person's sense of priority when it comes to time. For example, responding to a family matter may be more important to a patient than meeting a scheduled health care appointment. Allowing for these different views is essential in maintaining an effective nurse–patient relationship. Scolding or acting annoyed at patients for being late undermines their confidence and may result in further missed appointments or indifference to health care suggestions.

Touch

Touch is the most personal of all sensations, is central to the human communication process, and is often used as a method of communication (Giger, 2016). The meaning that people associate with touching is culturally determined to a great degree. In some cultures (e.g., Hispanic, Arab), male health care providers may be prohibited from touching or examining certain parts of the female body. Similarly, it may be inappropriate for females to care for males. Among many Asians, it is impolite to touch a person's head because the spirit is believed to reside there. Therefore, assessment of the head or evaluation of a head injury requires permission of the patient or a family member, if the patient is not able to give permission.

The patient's culturally defined sense of modesty must also be considered when providing nursing care. For example, some Jewish and Muslim women believe that modesty requires covering their head, arms, and legs with clothing. It is important for the nurse to recognize cultural variances and to understand that touch can be perceived as intrusive to some patients.

Observance of Holidays

People from all cultures observe certain civil and religious holidays. Nurses should familiarize themselves with major observances for members of the cultural groups they serve. Information about these observances is available from various sources, including religious organizations, hospital chaplains, and patients themselves. Routine health appointments, diagnostic tests, surgery, and other major procedures should be scheduled to avoid observances that patients identify as significant. If not contraindicated, efforts should also be made to accommodate patients and families or significant others who wish to perform cultural and religious rituals in the health care setting.

CRITICAL THINKING EXERCISES

1 pq You are conducting an admission assessment on a 66-year-old Vietnamese woman who was recently discharged from the hospital with a diagnosis of congestive heart failure. The patient's blood pressure is elevated, and the patient has a productive cough. The patient speaks very little English, but the patient's son is able to interpret. What types of assessments are necessary to complete a comprehensive admission assessment? What are the priorities in this patient's care? What interventions should you incorporate into the plan of care for this patient?

2 ebp A 28-year-old woman is admitted to the hospital with diverticulitis. She is visibly undernourished with poor skin turgor and loss of subcutaneous tissue. After calculating her ideal body weight, you note that her weight is well below average for her height. What standardized assessment tools would you use to determine her health risk? Identify her health risks, given her decreased weight, based on the most recent evidence. Evaluate the strength of the evidence for these risks.

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Alcoholics Anonymous, www.aa.org
Al-Anon Family Groups, www.al-anon.org
American Heart Association, heart.org
Center on Addiction and the Family, www.phoenixhouse.org
Co-Anon Family Groups, www.co-anon.org
Cocaine Anonymous, www.ca.org
Council on Nursing and Anthropology (CONAA), www.conaa.org
Dual Recovery Anonymous World Network Central Office, www.draonline.org
Genetic Alliance, www.geneticalliance.org
Healthcare Information and Management Systems Society, Inc. (HIMSS), www.himss.org
LanguageLine Solutions, www.languageline.com
Narcotics Anonymous World Services, www.na.org
National Cancer Institute, Cancer Information Service, www.cancer.gov
National Center for Complementary and Integrative Heath, nccih.nih.gov
National Center for Cultural Competence (NCCC), Georgetown University Center for Child and Human Development, nccc.georgetown.edu
National Institute on Drug Abuse, www.drugabuse.gov
Office of Minority Health (OMH), minorityhealth.hhs.gov
Substance Abuse and Mental Health Services Administration (SAMHSA), www.samhsa.gov
Transcultural Nursing Society, www.tcns.org

5 Stress and Inflammatory Responses

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the significance of the principles of internal constancy, homeostasis, stress, and adaptation in promoting and maintaining steady state in the body.
2. Describe the General Adaptation Syndrome and the sympathetic–adrenal–medullary and hypothalamic-pituitary responses to stress.
3. Identify ways in which maladaptive responses to stress can increase the risk of illness and cause disease.
4. Compare the adaptive processes of atrophy, hypertrophy, hyperplasia, metaplasia, and dysplasia within the body's inflammatory and reparative processes.
5. Assess the health patterns of individuals and families, identifying strategies that are useful in reducing stress.

NURSING CONCEPTS

Anxiety
Cellular Regulation
Communication
Family
Immunity
Inflammation
Stress and Coping

GLOSSARY

adaptation: a change or alteration designed to assist in adjusting to a new situation or environment

adrenocorticotropic hormone (ACTH): a hormone produced by the anterior lobe of the pituitary gland that stimulates the secretion of cortisol and other hormones by the adrenal cortex

antidiuretic hormone (ADH): a hormone secreted by the posterior lobe of the pituitary gland that constricts blood vessels, elevates blood pressure, and reduces the excretion of urine

catecholamines: any of the group of amines (such as epinephrine, norepinephrine, or dopamine) that serve as neurotransmitters

coping: the cognitive and behavioral strategies used to manage the stressors that tax a person's resources

corticosteroids: the group of steroid hormones, such as cortisol, that are produced by the adrenal cortex; they are involved in carbohydrate, protein, and fat metabolism and have anti-inflammatory properties

disease: an abnormal variation in the structure or function of any part of the body

dysplasia: bizarre cell growth resulting in cells that differ in size, shape, or arrangement from other cells of the same tissue type

family: a group whose members are related by reciprocal caring, mutual responsibilities, and loyalties

fight-or-flight response: the alarm stage in the General Adaptation Syndrome described by Selye

gluconeogenesis: the formation of glucose by the liver from noncarbohydrate sources, such as amino acids and the glycerol portion of fats

guided imagery: the mindful use of a word, phrase, or visual image to achieve relaxation or direct attention away from uncomfortable sensations or situations

homeostasis: a steady state within the body; the stability of the internal environment

hyperplasia: an increase in the number of new cells in an organ or tissue

hypoxia: inadequate supply of oxygen to the cell

inflammation: a localized reaction of tissue to injury, irritation, or infection that is manifested by five cardinal signs of redness, warmth, swelling, pain, and loss of function

metaplasia: a cell transformation in which one type of mature cell is converted into another type of cell

negative feedback: mechanisms that monitor the internal environment and restore homeostasis when conditions shift out of the normal range

positive feedback: mechanisms that perpetuate a chain of events

steady state: a stable condition that does not change over time, or when change in one direction is balanced by change in an opposite direction

stress: a disruptive condition that occurs in response to adverse influences from the internal or external environments

stressor: an internal or external event or situation that creates the potential for physiologic, emotional, cognitive, or behavioral changes

When the body is threatened or suffers an injury, its response may involve functional and structural changes; these changes may be adaptive (having a positive effect) or maladaptive (having a negative effect). The defense mechanisms that the body uses determine the difference between adaptation and maladaptation—health and disease. This chapter addresses individual homeostasis, stress, adaptation, health problems associated with maladaptation, and ways that nurses intervene with patients and families to reduce stress and its health-related effects.

Fundamental Concepts

Each body system performs specific functions to sustain optimal life for an organism. Compensatory mechanisms for adjusting internal conditions promote the steady state of the organism, ensure its survival, and restore balance in the body. Pathophysiologic processes result when cellular injury occurs at such a rapid rate that the body's compensatory mechanisms cannot make the adaptive changes necessary to remain healthy.

Physiologic mechanisms must be understood in the context of the body as a whole. Each person has both an internal and external environment, between which information and matter are continuously exchanged. Within the internal environment, each organ, tissue, and cell is also a system or subsystem of the whole, each with its own internal and external environment, each exchanging information and matter (Fig. 5-1). The goal of the interaction of the body's subsystems is to produce a dynamic balance or **steady state** (even in the presence of change) so that all subsystems are in harmony with each other. Four concepts—constancy, homeostasis, stress, and adaptation—are key to the understanding of steady state.

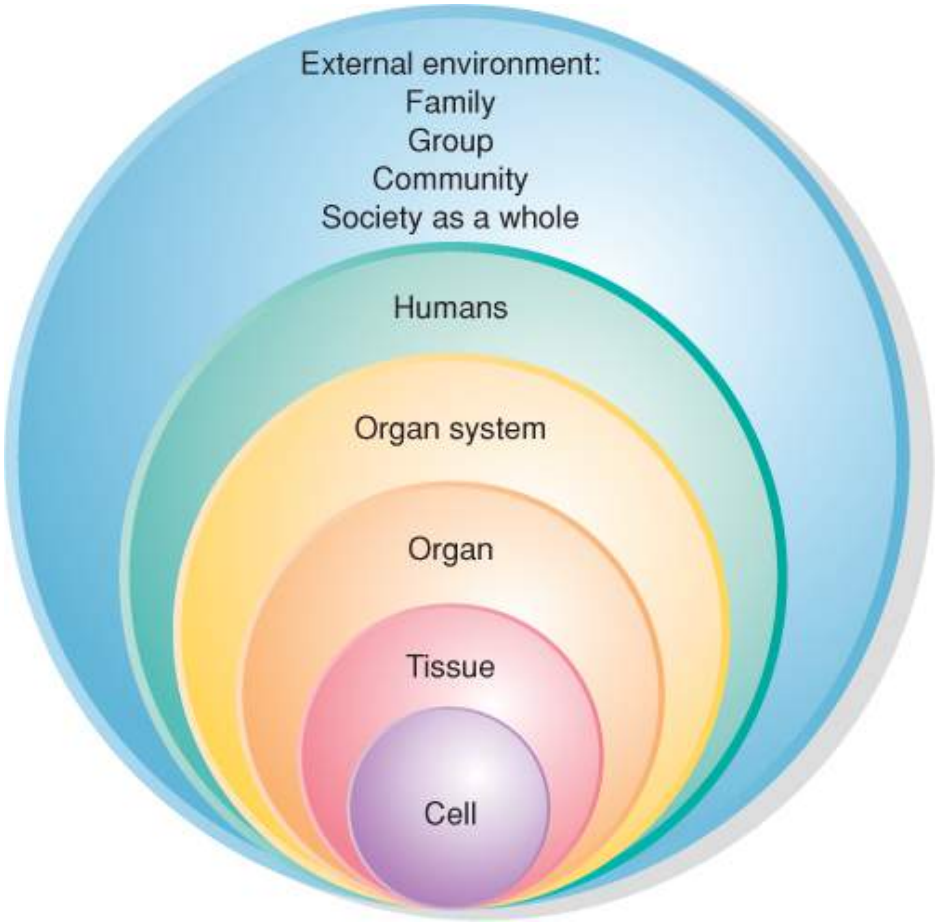

Figure 5-1 • Constellation of systems. Each system is a subsystem of the larger system (suprasystem) of which it is a part. The cells represent the smallest system and are a subsystem of all other systems.

Constancy and Homeostasis

Claude Bernard, a 19th-century French physiologist, first developed the biologic principle that for life there must be a constancy or "fixity of the internal milieu" despite changes in the external environment. The internal milieu is the fluid that bathed the cells, and the constancy the balanced internal state maintained by physiologic and biochemical processes. His principle implies a static process.

Bernard's principle of "constancy" underpins the concept of **homeostasis,** which refers to a steady state within the body. When a change or stress occurs that causes a body function to deviate from its stable range, processes are initiated to restore and maintain dynamic balance. An example of this restorative effort is the development of hyperpnea (rapid breathing) after intense exercise in an attempt to compensate for an oxygen deficit and excess lactic acid accumulated in the muscle tissue. When these adjustment processes or compensatory mechanisms are not adequate, steady state is threatened,

function becomes disordered, and dysfunctional responses occur. For example, in heart failure, the body reacts by retaining sodium and water and increasing venous pressure, which worsens the condition. Dysfunctional responses can lead to **disease** (an abnormal variation in the structure or function of any part of the body), which is a threat to steady state.

Stress and Adaptation

Stress is a disruptive condition produced by a change in the environment that is perceived as challenging, threatening, or damaging to a person's dynamic balance or equilibrium. The person may feel unable to meet the demands of the new situation. The change or stimulus that evokes this state is the stressor. A person appraises and copes with changing situations. The desired goal is **adaptation** or adjustment to the change so that the person is again in equilibrium and has the energy and ability to meet new demands. This is the process of coping with the stress, a compensatory process that uses cognitive and behavioral strategies.

Because both stress and adaptation may exist at different levels of a system, it is possible to study these reactions at the cellular, tissue, and organ levels. Biologists are concerned mainly with subcellular components or with subsystems of the total body. Behavioral scientists, including many nurse researchers, study stress and adaptation in individuals, families, groups, and societies; they focus on how a group's organizational features are modified to meet the requirements of the social and physical environment in which the group exists. In any system, the desired goals of adaptation are survival, growth, and reproduction.

Overview of Stress

Each person operates at a certain level of adaptation and regularly encounters a certain amount of change. Such change is expected; it contributes to growth and enhances life. A stressor can upset this equilibrium. A **stressor** may be defined as an internal or external event or situation that creates the potential for physiologic, emotional, cognitive, or behavioral changes.

Types of Stressors

Stressors exist in many forms and categories. They may be described as physical, physiologic, or psychosocial. Physical stressors include cold, heat, and chemical agents; physiologic stressors include pain and fatigue. An example of a psychosocial stressor is fear (e.g., fear of failing an examination, losing a job, waiting for a diagnostic test result). Stressors can also occur as

normal life transitions that require some adjustment, such as going from childhood into puberty, getting married, or giving birth.

Stressors have also been classified as day-to-day frustrations or hassles, major complex occurrences involving large groups, and stressors that occur less frequently and involve fewer people. Day-to-day stressors include common occurrences as getting caught in a traffic jam, experiencing computer downtime, and having an argument with a spouse or roommate. These experiences vary in effect. For example, encountering a rainstorm while you are vacationing at the beach will most likely evoke a more negative response than it might at another time. These daily hassles have been shown to have a greater health impact than major life events because of the cumulative effect they have over time. They can lead to high blood pressure, palpitations, or other physiologic problems (Sarid, Slonim-Nevo, Sergienko, et al., 2018; Terrill & Molton, 2019).

Major stressors influence larger groups of individuals, families, and sometimes even entire nations. These include events of history, such as terrorism and war, experienced either directly in the war zone or indirectly through live news coverage. The demographic, economic, and technologic changes occurring in society also serve as stressors. The tension produced by any stressor is sometimes a result not only of the change itself, but also of the speed with which the change occurs.

Stressors concerning relatively infrequent situations that directly affect people have been studied extensively. This category includes the influence of life events such as death, birth, military service, marriage, divorce, and retirement. It also includes the psychosocial crises that occur in the life cycle stages of the human experience. More enduring chronic stressors may include having a permanent disability or coping with the need to provide long-term care for a child who has a developmental disability or for an older parent who is frail.

Duration may also be used to categorize stressors, as in the following:

- An acute, time-limited stressor, such as studying for final examinations
- A stressor sequence—a series of stressful events that result from an initial event such as job loss or divorce
- A chronic intermittent stressor, such as daily hassles
- A chronic enduring stressor that persists over time, such as chronic illness, a disability, or poverty

Stress as a Stimulus for Disease

Relating life events to illness (the theoretical approach that defines stress as a stimulus) has been a major focus of psychosocial studies. Research suggests

that people under constant stress have a high incidence of disease (Kalinowski, Taylor, & Spruill, 2019; Kibler, Ma, Tursich, et al., 2018).

Holmes and Rahe (1967) developed life events scales that assign numerical values, called *life-change units,* to typical life events. Because the items in the scales reflect events that require a change in a person's life pattern, and stress is viewed as an accumulation of changes in one's life that require psychological adaptation, one can theoretically predict the likelihood of illness by checking off the number of recent events and deriving a total score. The Recent Life Changes Questionnaire (RLCQ) (Tausig, 1982) contains 118 items such as death, birth, marriage, divorce, promotions, serious arguments, and vacations. The items include both desirable and undesirable events. Both the life events scale and the RLCQ have formed the basis for the development of two additional scales: the Positive–Negative Relationship Quality Scale (PNRQS) (Fincham & Rogge, 2010), which measures stress related to relationship quality, and the Stress Overload Scale (SOS) (Amirkhan, 2012; Amirkhan, Urizar, & Clark, 2015), which measures excessive stress. A tool developed by Vohra and colleagues (2019) called the Stressometer® (SOM) was designed to measure stress and mental health. This instrument is composed of subscales related to a person's individual nature, personal circumstances, clinical symptoms, home life and work life. The underlying premise of the PNRQS, SOS, and SOM instruments is that sources of stress, such as stressful life events and a person's personal vulnerabilities, can influence and even undermine engaging in adaptive processes.

Sources of stress for people have been well researched (Anniko, Boersma, & Tillfors, 2019; Pitt, Oprescu, Tapia, et al., 2018). People typically experience distress related to alterations in their physical and emotional health status, changes in their level of daily functioning, and decreased social support or the loss of significant others (Albdour, Hong, Lewin, et al., 2019; Benham & Charak, 2019; Reblin, Stanley, Galligan, et al., 2019; Sikes & Hall, 2017). Fears of immobilization, isolation, loneliness, sensory changes, financial problems, and death or disability increase a person's anxiety level. Loss of one's role or perceived purpose in life can cause intense discomfort. Any of these identified variables, plus a myriad of other conditions or demands, are likely to cause ineffective coping, and a lack of effective coping skills is often a source of additional distress for the person. When a person endures prolonged or unrelenting suffering, the outcome is frequently the development of a stress-related illness. Nurses have the skills to assist people to alter their distressing circumstances and manage their responses to stress, as discussed later in the chapter.

Psychological Responses to Stress

After recognizing a stressor, a person consciously or unconsciously reacts to manage the situation. This is termed the *mediating process*. A theory developed by Lazarus (1991) emphasizes cognitive appraisal and coping as important mediators of stress. Appraisal and coping are influenced by antecedent variables, including the internal and external resources of the individual person.

Appraisal of the Stressful Event

Cognitive appraisal (Lazarus, 1991; Lazarus & Folkman, 1984) is a process by which an event is evaluated with respect to what is at stake (primary appraisal) and what might and can be done (secondary appraisal). What a person sees as being at stake is influenced by their personal goals, commitments, or motivations. Important factors include how important or relevant the event is to the person, whether the event conflicts with what the person wants or desires, and whether the situation threatens the person's own sense of strength and ego identity.

Primary appraisal results in the situation being identified as either nonstressful or stressful. Secondary appraisal is an evaluation of what might and can be done about the situation. Reappraisal—a change of opinion based on new information—may occur. The appraisal process is not necessarily sequential; primary and secondary appraisal and reappraisal may occur simultaneously.

The appraisal process contributes to the development of an emotion. Negative emotions such as fear and anger accompany harm/loss appraisals, and positive emotions accompany challenge. In addition to the subjective component or feeling that accompanies a particular emotion, each emotion also includes a tendency to act in a certain way. For example, unprepared students may view an unexpected quiz as threatening. They might feel fear, anger, and resentment and might express these emotions through hostile behavior or comments.

Lazarus (1991) expanded his initial ideas about stress, appraisal, and coping into a more complex model relating emotion to adaptation. He called this model a "cognitive–motivational–relational theory," with the term *relational* "standing for a focus on negotiation with a physical and social world" (p. 13). A theory of emotion was proposed as the bridge to connect psychology, physiology, and sociology: "More than any other arena of psychological thought, emotion is an integrative, organismic concept that subsumes psychological stress and coping within itself and unites motivation, cognition, and adaptation in a complex configuration" (p. 40).

Coping with the Stressful Event

Coping consists of the cognitive and behavioral efforts made to manage the specific external or internal demands that tax a person's resources and may be emotion focused or problem focused. Emotion-focused coping seeks to make the person feel better by lessening the emotional distress. Problem-focused coping aims to make direct changes in the environment so that the situation can be managed more effectively. Both types of coping usually occur in a stressful situation. Even if the situation is viewed as challenging or beneficial, coping efforts may be required to develop and sustain the challenge—that is, to maintain the positive benefits of the challenge and to ward off any threats. In harmful or threatening situations, successful coping reduces or eliminates the source of stress and relieves the emotion generated.

Appraisal and coping are affected by internal characteristics such as health, energy, personal belief systems, commitments, or life goals, self-esteem, control, mastery, knowledge, problem-solving skills, and social skills. The characteristics that have been studied in nursing research are health-promoting lifestyles and resilience (Callaghan, Fellin, & Alexander, 2019; Marques, Perolta, Santos, et al., 2019; Shen, 2019; Sima, Yu, Marwitz, et al., 2019). Resilience is considered both a personal trait and a process. Researchers have defined resilience as the ability of a person to function well in stressful situations such as traumatic events and other types of adverse situations (Kim, Lin, Kim, et al., 2019). A resilient person maintains flexibility even in difficult circumstances and controls strong emotional reactions using appropriate communication and problem-solving skills. Factors that play a role in building a person's resilience are having strong, supportive relationships with family members and other individuals and being exposed to positive role models. A resilient person knows when to act, when to step back and rely on others, and when to stop to re-energize and nurture the self. Researchers have found positive support for resilience as a significant variable that positively influences rehabilitation and overall improvement after a challenging or traumatic experience (Kok, Reed, Wickham, et al., 2019; Liu, Zhou, Zhang, et al., 2019; McNeil, Bartram, Cregan, et al., 2019; Vaughan, Koczwara, Kemp, et al., 2019).

A health-promoting lifestyle buffers the effect of stressors. From a nursing practice standpoint, this outcome—buffering the effect of stressors—supports nursing's goal of promoting health. In many circumstances, promoting a healthy lifestyle is more achievable than altering the stressors.

Physiologic Response to Stress

The physiologic response to a stressor, whether it is physical, psychological, or psychosocial, is a protective and adaptive mechanism to maintain the body's homeostatic balance. When a stress response occurs, it activates a series of

neurologic and hormonal processes within the brain and body systems. The duration and intensity of the stress can cause both short- and long-term effects.

Selye's Theory of Adaptation

Selye (1976) developed a theory of adaptation to biologic stress that profoundly influenced the scientific study of stress.

General Adaptation Syndrome

Selye's theory, called the *General Adaptation Syndrome* (GAS), has three phases: alarm, resistance, and exhaustion. During the alarm phase, the sympathetic **fight-or-flight response** is activated with release of **catecholamines** (i.e., epinephrine, norepinephrine, and dopamine), that serve as neurotransmitters and the onset of the **adrenocorticotropic hormone (ACTH)**–adrenal cortical response. ACTH is produced by the anterior lobe of the pituitary gland and stimulates the secretion of cortisol as well as other hormones by the adrenal cortex. The alarm reaction is defensive and anti-inflammatory but self-limited. Because living in a continuous state of alarm would result in death, people move into the second stage—resistance. During the resistance stage, adaptation to the noxious stressor occurs, and cortisol activity is still increased. If exposure to the stressor is prolonged, the third stage—exhaustion—occurs. During the exhaustion stage, endocrine activity increases, and this has negative effects on the body systems (i.e., the circulatory, digestive, and immune systems) that can lead to death. The first two stages of this syndrome are repeated, in different degrees, throughout life as the person encounters stressors.

Selye compared the GAS with the life process. During childhood, too few encounters with stress occur to promote the development of adaptive functioning, and children are vulnerable. During adulthood, numerous stressful events occur, and people develop resistance or adaptation. During the later years, the accumulation of life's stressors and wear and tear on the organism again decrease people's ability to adapt, resistance falls, and eventually death occurs.

Local Adaptation Syndrome

According to Selye, a *Local Adaptation Syndrome* also occurs. This syndrome includes the inflammatory response and repair processes that occur at the local site of tissue injury. This syndrome occurs in small, topical injuries, such as contact dermatitis. If the local injury is severe enough, the GAS is activated as well.

Selye emphasized that stress is the nonspecific response common to all stressors, regardless of whether they are physiologic, psychological, or psychosocial. The many conditioning factors in each person's environment account for why different demands are experienced by different people as

stressors. Conditioning factors also account for differences in the tolerance of different people for stress: Some people may develop diseases of adaptation, such as hypertension and migraine headaches, whereas others are unaffected.

Interpretation of Stressful Stimuli by the Brain

Physiologic responses to stress are mediated by the brain through a complex network of chemical and electrical messages. The neural and hormonal actions that maintain homeostatic balance are integrated by the hypothalamus, which is located in the center of the brain, surrounded by the limbic system and the cerebral hemispheres. The hypothalamus is made up of a number of nuclei and integrates autonomic nervous system mechanisms that maintain the chemical constancy of the internal environment of the body. Together with the limbic system, which contains the amygdala, hippocampus, and septal nuclei, along with other structures, the hypothalamus regulates emotions and many visceral behaviors necessary for survival (e.g., eating, drinking, temperature control, reproduction, defense, aggression).

Each of the brain structures responds differently to stimuli. The cerebral hemispheres are concerned with the cognitive functions of thought processes, learning, and memory. The limbic system has connections with both the cerebral hemispheres and the brain stem. In addition, the reticular activating system, a network of cells that forms a two-way communication system, extends from the brain stem into the midbrain and limbic system. This network controls the alert or waking state of the body.

In the stress response, afferent impulses are carried from sensory organs (eye, ear, nose, skin) and internal sensors (baroreceptors, chemoreceptors) to nerve centers in the brain. The response to the perception of stress is integrated in the hypothalamus, which coordinates the adjustments necessary to return to homeostatic balance. The degree and duration of the response vary; initially, there is a sympathetic nervous system discharge, followed by a sympathetic–adrenal–medullary discharge. If the stress persists, the hypothalamic-pituitary system is activated (Fig. 5-2).

Sympathetic Nervous System Response

The sympathetic nervous system response is rapid and short-lived. Norepinephrine is released at nerve endings that are in direct contact with their respective end organs to cause an increase in function of the vital organs and a state of general body arousal (Norris, 2019). Heart rate increases and peripheral vasoconstriction occurs, raising the blood pressure. Blood is also shunted away from abdominal organs. The purpose of these responses is to provide better perfusion of vital organs (brain, heart, skeletal muscles). Blood glucose is increased, supplying more readily available energy. The pupils dilate, and mental activity increases; a greater sense of awareness exists. Constriction of the blood vessels of the skin limits bleeding in the event of

trauma. The person is likely to experience cold feet, clammy skin and hands, chills, palpitations, and "knots" in the stomach. Typically, the person appears tense, with the muscles of the neck, upper back, and shoulders tightened; respirations may be rapid and shallow, with the diaphragm tense.

Sympathetic–Adrenal–Medullary Response

In addition to directly affecting major end organs, the sympathetic nervous system stimulates the adrenal medulla to release the hormones epinephrine and norepinephrine into the bloodstream. These hormones act similarly to the sympathetic nervous system, sustaining and prolonging its actions. Because these hormones are catecholamines, they stimulate the nervous system and produce metabolic effects that increase the blood glucose level and metabolic rate. The effect of the sympathetic–adrenal–medullary responses is summarized in Table 5-1. This effect is called the *fight-or-flight response* (Norris, 2019).

Hypothalamic-Pituitary Response

The longest-acting phase of the physiologic response, which is more likely to occur in persistent stress, involves the hypothalamic-pituitary pathway. The hypothalamus secretes corticotropin-releasing factor, which stimulates the anterior pituitary to produce ACTH, which in turn stimulates the adrenal cortex to produce **corticosteroids,** primarily cortisol (Norris, 2019). Cortisol stimulates protein catabolism, releasing amino acids; stimulates liver uptake of amino acids and their conversion to glucose (**gluconeogenesis**); and inhibits glucose uptake (anti-insulin action) by many body cells but not those of the brain and the heart (Norris, 2019). These cortisol-induced metabolic effects provide the body with a ready source of energy during a stressful situation. This effect has some important implications. For example, a person with diabetes who is under stress, such as that caused by an infection, needs more insulin than usual. Any patient who is under stress (e.g., illness, surgery, trauma, prolonged psychological stress) catabolizes body protein and needs supplements.

The actions of the catecholamines (epinephrine and norepinephrine) and cortisol are the most important in the general response to stress. Other hormones that play a role are **antidiuretic hormone (ADH)** released from the posterior pituitary and aldosterone released from the adrenal cortex. ADH and aldosterone promote sodium and water retention, which is an adaptive mechanism in the event of hemorrhage or loss of fluids through excessive perspiration. ADH constricts blood vessels, elevates blood pressure, and reduces the excretion of urine. ADH has also been shown to influence learning and may thus facilitate coping in new and threatening situations. Secretion of growth hormone and glucagon stimulates the uptake of amino acids by cells, helping to mobilize energy resources. Endorphins, which are endogenous

opioids, increase during stress and enhance the threshold for tolerance of painful stimuli. They may also affect mood and have been implicated in the so-called high that long-distance runners experience. The secretion of other hormones is also affected; however, their adaptive function is less clear.

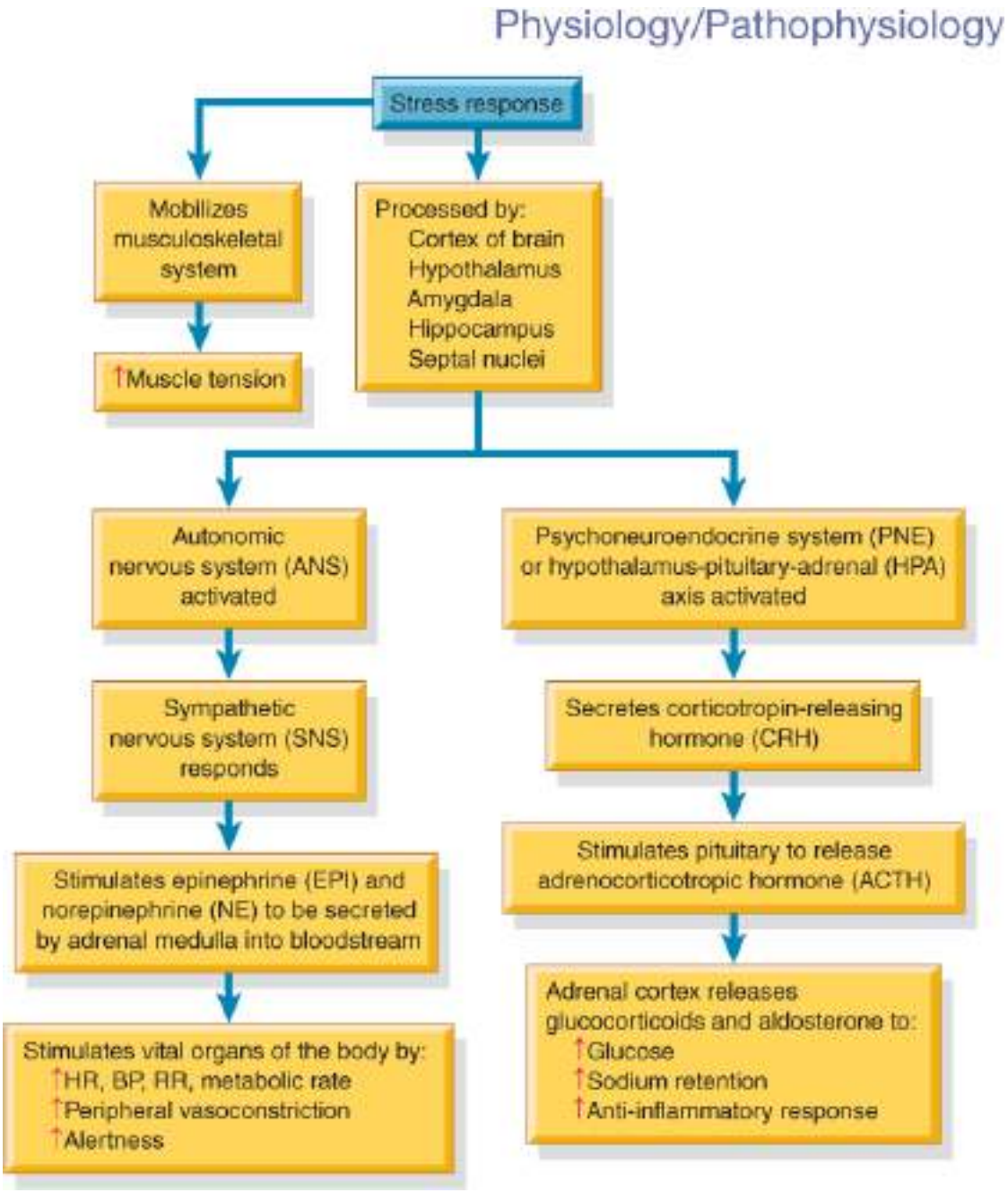

Figure 5-2 • The physiologic response to stress. The body is prepared through brain activation of the autonomic nervous system and psychoneuroendocrine system commonly referred to as the hypothalamus–pituitary–adrenal axis to cope with stress.

TABLE 5-1 Sympathetic–Adrenal–Medullary Reaction to Stress or Fight-or-Flight Response

Effect	Purpose	Mechanism
Increased heart rate and blood pressure	More perfusion to vital organs	Increased cardiac output owing to increased myocardial contractility and heart rate; increased venous return (peripheral vasoconstriction)
Increased blood glucose level	Increased available energy	Increased liver and muscle glycogen breakdown; increased breakdown of adipose tissue triglycerides
Mental acuity	Alert state	Increase in amount of blood shunted to the brain from the abdominal viscera and skin
Dilated pupils	Increased awareness	Contraction of radial muscle of iris
Increased tension of skeletal muscles	Preparedness for activity, decreased fatigue	Excitation of muscles; increase in amount of blood shunted to the muscles from the abdominal viscera and skin
Increased ventilation (may be rapid and shallow)	Provision of oxygen for energy	Stimulation of respiratory center in medulla; bronchodilation
Increased coagulability of blood	Prevention of hemorrhage in event of trauma	Vasoconstriction of surface vessels

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health status* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Immunologic Response

The immune system is connected to the neuroendocrine and autonomic systems. Lymphoid tissue is richly supplied by autonomic nerves capable of releasing a number of different neuropeptides that can have a direct effect on leukocyte regulation and the inflammatory response. Neuroendocrine hormones released by the central nervous system and endocrine tissues can inhibit or stimulate leukocyte function. The various stressors a person experiences may result in different alterations in autonomic activity and subtle variations in neurohormone and neuropeptide synthesis. All of these possible autonomic and neuroendocrine responses can interact to initiate, weaken, enhance, or terminate an immune response.

The study of the relationships among the neuroendocrine system, the central and autonomic nervous systems, and the immune system and the effects of these relationships on overall health outcomes are called *psychoneuroimmunology.* Because one's perception of events and one's coping styles determine whether, and to what extent, an event activates the stress

response system, and because the stress response affects immune activity, one's perceptions, ideas, and thoughts can have profound neurochemical and immunologic consequences. Some studies have demonstrated altered immune function in people who are under stress (Atkinson, Rodman, Thuras, et al., 2019; Christensen, Flensborg-Madsen, Garde, et al., 2019; Frishman, 2019; Ubel & Rosenthal, 2019). Other studies have identified certain personality traits, such as decisiveness, assertiveness, compassion, helpfulness, and conscientiousness, as having positive effects on health (Antoni & Dhabhar, 2019; Champagne, 2019; Wilson, Woody, Padin, et al., 2019). As research continues, this field of study will likely uncover to what extent and by what mechanisms people can consciously influence their immunity.

Maladaptive Responses to Stress

The stress response, as indicated earlier, facilitates adaptation to threatening situations and is retained from humans' evolutionary past. The fight-or-flight response, for example, is an anticipatory response that mobilized the bodily resources of our ancestors to deal with predators and other harsh factors in their environment. This same mobilization comes into play in response to emotional stimuli unrelated to danger. For example, a person may get an "adrenaline rush" when competing over a decisive point in a ball game or when excited about attending a party.

When responses to stress are ineffective, they are referred to as *maladaptive.* Maladaptive responses are chronic, recurrent responses or patterns of response that do not promote the goals of adaptation. The goals of adaptation are somatic or physical health (optimal wellness); psychological health or having a sense of well-being (happiness, satisfaction with life, morale); and enhanced social functioning, which includes work, social life, and family (positive relationships). Maladaptive responses that threaten these goals include faulty appraisals and inappropriate coping (Lazarus, 1991).

The frequency, intensity, and duration of stressful situations contribute to the development of emotions and subsequent patterns of neurochemical discharge. By appraising situations adequately and coping appropriately, it is possible to anticipate and defuse some of these situations. For example, frequent stressful encounters (e.g., marital discord) might be avoided with better communication and problem solving, or a pattern of procrastination (e.g., delaying work on tasks) could be corrected to reduce stress when deadlines approach.

Coping processes that include the use of alcohol or drugs to reduce stress increase the risk of illness. Other inappropriate coping patterns may increase the risk of illness less directly. For example, people who demonstrate "type A" behaviors, including impatience, competitiveness, and achievement orientation, have an underlying aggressive approach to life. Type A behaviors

increase the output of catecholamines, the adrenal–medullary hormones, with their attendant effects on the body. Additional forms of inappropriate coping include denial, avoidance, and distancing.

Models of illness frequently include stress and maladaptation as precursors to disease. A general model of illness, based on Selye's theory, suggests that any stressor elicits a state of disturbed physiologic equilibrium. If this state is prolonged or the response is excessive, it increases the susceptibility of the person to illness. This susceptibility, coupled with a predisposition in the person (from genetic traits, health, or age), leads to illness. If the sympathetic–adrenal–medullary response is prolonged or excessive, a state of chronic arousal develops that may lead to high blood pressure, arteriosclerotic changes, and cardiovascular disease. If the production of ACTH is prolonged or excessive, behavior patterns of withdrawal and depression are seen. In addition, the immune response is decreased, and infections and tumors may develop.

Selye (1976) proposed a list of disorders known as diseases of maladaptation: high blood pressure (including hypertension of pregnancy), diseases of the heart and blood vessels, diseases of the kidney, rheumatic diseases and inflammatory diseases of the skin and eyes, infections, allergic and hypersensitivity diseases, nervous and mental diseases, sexual dysfunction, digestive diseases, metabolic diseases, and cancer. Research continues on the complex interconnections between stress, coping (adaptive and maladaptive), and disease (Torkzadeh, Danesh, Mirbagher, et al., 2019; Tormohlen, Tobin, & Latkin, 2019).

Indicators of Stress

Indicators of stress and the stress response include both subjective and objective measures. Chart 5-1 lists signs and symptoms that may be observed directly or reported by a person. They are psychological, physiologic, or behavioral and reflect social behaviors and thought processes. Some of these reactions may be coping behaviors. Over time, each person tends to develop a characteristic pattern of behavior during stress to warn that the system is out of balance.

Chart 5-1 **ASSESSMENT**

Assessing for Stress

Be alert for the following:

Bruxism (grinding of teeth)
Changes in menstrual cycle
Change in appetite
Concentration difficulties
Diarrhea
Difficulty sleeping
Dry mouth
Emotional lability
Excessive perspiration
Fatigue
Feeling weak or dizzy
Gastrointestinal distress
Headaches
Hyperactivity
Increased substance use or misuse
Increased use of tobacco products or electronic nicotine delivery systems (ENDS) including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars
Increased body tension
Intense or increased anxiety
Impulsive behaviors
Loss of interest in life activities
Nausea or vomiting
Nervous habits
Nervous laughter
Overpowering urge to act out
Pain in back, neck, or other parts of the body
Palpitations
Prone to injury
Restlessness
Strong startle response
Tremors
Unintentional weight loss or gain
Urinary frequency

Adapted from Rice, V. H. (Ed.). (2012). *Handbook of stress, coping, and health: Implications for theory, research, and practice* (2nd ed.). Thousand Oaks, CA: Sage; Selye, H. (1976). *The stress of life, Rev. ed.* New York: McGraw-Hill.

Laboratory measurements of indicators of stress have helped in understanding this complex process. Blood and urine analyses can be used to demonstrate changes in hormonal levels and hormonal breakdown products.

Blood levels of catecholamines, corticosteroids, ACTH, and eosinophils are reliable measures of stress. Serum cholesterol and free fatty acid levels can be used to measure stress. Distress can cause an increase in adrenal hormones, including cortisol and aldosterone, which can lead to high serum cholesterol levels. Both physical and psychological distress can trigger an elevated cholesterol level. In addition, the results of immunoglobulin assays are increased when a person is exposed to various stressors, especially infections and immune deficiency conditions.

In addition to using laboratory tests, researchers have developed questionnaires to identify and assess stressors, stress, and coping strategies. The work of Rice (2012) includes a compilation of information gained from research on stress, coping, and health, and includes some of these questionnaires.

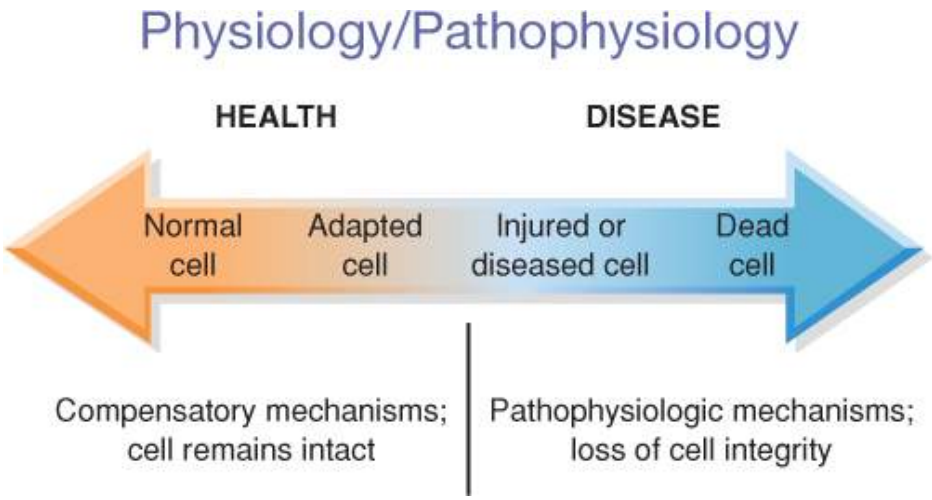

Figure 5-3 • The cell on a continuum of function and structure. Changes in the cell are not as easily discerned as the diagram depicts, and the point at which compensation subsides and pathophysiology begins is not clearly defined.

Stress at the Cellular Level

The cell exists on a continuum of function and structure, ranging from the normal cell, to the adapted cell, to the injured or diseased cell, to the dead cell (Fig. 5-3). Changes from one state to another may occur rapidly and may not be readily detectable, because each state does not have discrete boundaries, and disease represents disruption of normal processes. The earliest changes occur at the molecular or subcellular level and are not perceptible until steady-state functions or structures are altered. With cell injury, some changes may be reversible; in other instances, the injuries are lethal. For example, tanning of the skin is an adaptive, morphologic response to exposure to the rays of the

sun. However, if the exposure is continued, sunburn and injury occur, and some cells may die, as evidenced by desquamation ("peeling").

Different cells and tissues respond to stimuli with different patterns and rates of response, and some cells are more vulnerable to one type of stimulus or stressor than others. The cell involved, its ability to adapt, and its physiologic state are determinants of the response. For example, cardiac muscle cells respond to **hypoxia** (inadequate cellular oxygenation) more quickly than do smooth muscle cells.

Other determinants of cellular response are the type or nature of the stimulus, its duration, and its severity. For example, neurons that control respiration can develop a tolerance to regular, small amounts of a barbiturate; however, one large dose may result in respiratory depression and death.

Control of the Steady State

The concept of the cell as existing on a continuum of function and structure includes the relationship of the cell to compensatory mechanisms, which occur continuously in the body to maintain the steady state. Compensatory processes are regulated primarily by the autonomic nervous system and the endocrine system, with control achieved through negative feedback.

Negative Feedback

Negative feedback mechanisms throughout the body monitor the internal environment and restore homeostasis when conditions shift out of the normal range. These mechanisms sense deviations from a predetermined set point or range of adaptability and trigger a response to offset the deviation. Functions regulated through such compensatory mechanisms include blood pressure, acid–base balance, blood glucose level, body temperature, and fluid and electrolyte balance.

Most of the human body's control systems are integrated by the brain with feedback from the nervous and endocrine systems. Control activities involve detecting deviations from the predetermined reference point and stimulating compensatory responses in the muscles and glands of the body. The major organs affected are the heart, lungs, kidneys, liver, gastrointestinal tract, and skin. When stimulated, these organs alter their rate of activity or the amount of secretions they produce. Because of this, these major organs are considered the "*organs of homeostasis or adjustment*" (Norris, 2019).

In addition to the responses influenced by the nervous and endocrine systems, local responses consisting of small feedback loops in a group of cells or tissues occur. The cells detect a change in their immediate environment and initiate an action to counteract its effect. For example, the accumulation of lactic acid in an exercised muscle stimulates dilation of blood vessels in the

area to increase blood flow and improve the delivery of oxygen and removal of waste products.

The net result of negative feedback loops is homeostasis. A steady state is achieved by the continuous, variable action of the organs involved in making the adjustments and by the continuous exchange of chemical substances among cells, interstitial fluid, and blood. For example, an increase in the carbon dioxide (CO_2) concentration of the extracellular fluid leads to increased pulmonary ventilation, which decreases the CO_2 level. On a cellular level, increased CO_2 raises the hydrogen ion concentration of the blood. This is detected by chemosensitive receptors in the brain's medullary respiratory control center. The chemoreceptors then stimulate an increase in the rate of discharge of the neurons that innervate the diaphragm and intercostal muscles, which increases the respiratory rate. Excess CO_2 is exhaled, the hydrogen ion concentration returns to normal, and the chemically sensitive neurons are no longer stimulated (Norris, 2019).

Positive Feedback

Another type of feedback, **positive feedback,** perpetuates the chain of events set in motion by the original disturbance instead of compensating for it. As the system becomes more unbalanced, disorder and disintegration occur. There are some exceptions to this; blood clotting in humans, for example, is an important positive feedback mechanism.

Cellular Adaptation

Cells are complex units that dynamically respond to the changing demands and stresses of daily life. They possess a maintenance function and a specialized function. The maintenance function refers to the activities that the cell performs with respect to itself; specialized functions are those that the cell performs in relation to the tissues and organs of which it is a part. Individual cells may cease to function without posing a threat to the organism. However, as the number of dead cells increases, the specialized functions of the tissues are altered and health is threatened.

Cells can adapt to environmental stress through structural and functional changes. Some of these adaptations include cellular atrophy, hypertrophy, hyperplasia, metaplasia, and dysplasia. Such adaptations reflect changes in the normal cell in response to stress (Fig. 5-4A). If the stress is unrelenting, cellular injury and death may occur.

Atrophy can be the consequence of disease, decreased use, decreased blood supply, loss of nerve supply, or inadequate nutrition. Disuse of a body part is often associated with the aging process and immobilization. Cell size and

organ size decrease (Fig. 5-4B), and the structures principally affected are the skeletal muscles, the secondary sex organs, the heart, and the brain.

Atrophy and **hypertrophy** lead to changes in the size of cells (Fig. 5-4C) and hence the size of the organs they form. Compensatory hypertrophy is the result of an enlarged muscle mass and commonly occurs in skeletal and cardiac muscle that experiences a prolonged, increased workload. One example is the bulging muscles of an athlete.

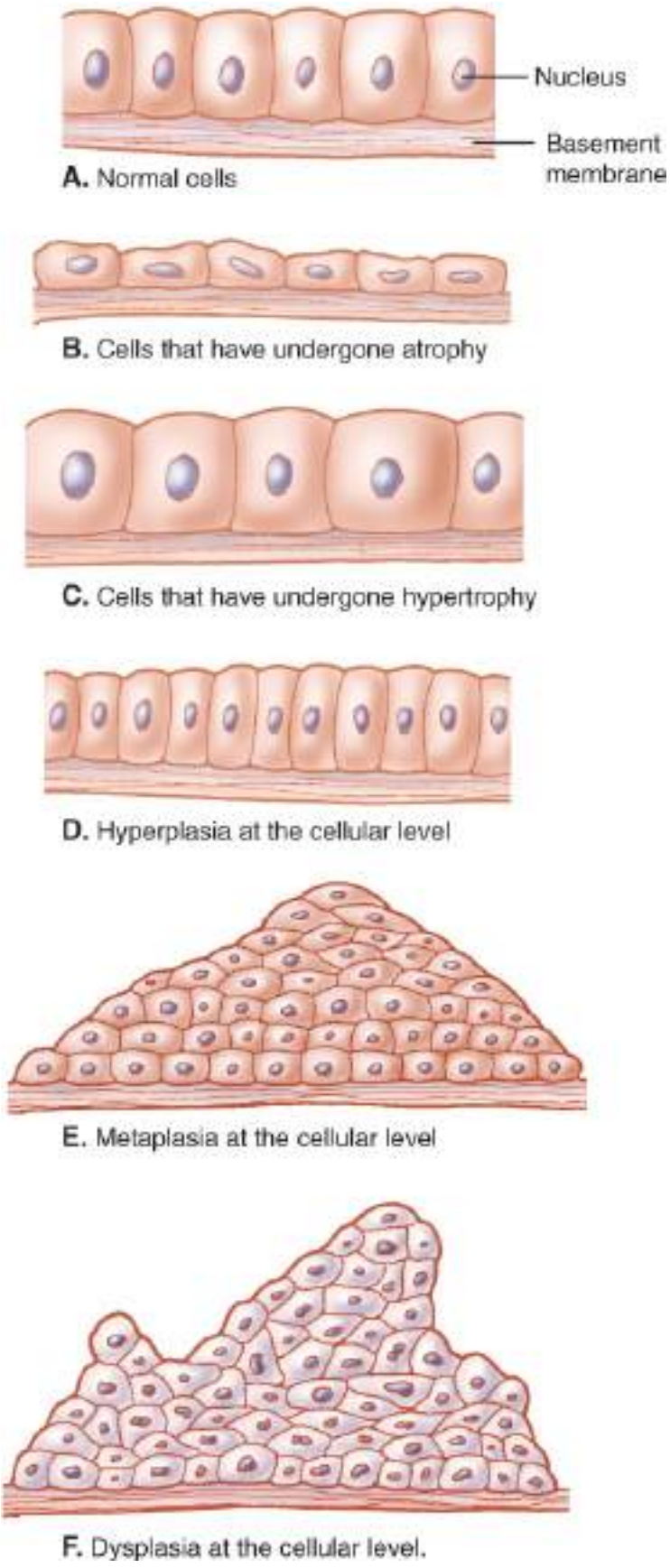

Figure 5-4 • Adaptation at the cellular level. Adapted with permission from Stewart J, Anatomical Chart Company. *Atlas of*

pathophysiology (4th ed., p. 5). Wolters Kluwer Health, Inc., 2017.

Hyperplasia is an increase in the number of new cells in an organ or tissue (Fig. 5-4D). As cells multiply and are subjected to increased stimulation, the tissue mass enlarges. This mitotic response (a change occurring with mitosis) is reversible when the stimulus is removed. This distinguishes hyperplasia from neoplasia or malignant growth, which continues after the stimulus is removed. Hyperplasia may be hormonally induced. An example is the increased size of the thyroid gland caused by thyroid-stimulating hormone (secreted from the pituitary gland) when a deficit in thyroid hormone occurs.

Metaplasia is a cell transformation in which one type of mature cell is converted into another type of cell (Fig. 5-4E). This serves a protective function, because less-transformed cells are more resistant to the stress that stimulated the change. For example, the ciliated columnar epithelium lining the bronchi of people who smoke is replaced by squamous epithelium. The squamous cells can survive; loss of the cilia and protective mucus, however, can have damaging consequences.

Dysplasia is bizarre cell growth resulting in cells that differ in size, shape, or arrangement from other cells of the same tissue type (Fig. 5-4F). Dysplastic cells have a tendency to become malignant; dysplasia is seen commonly in epithelial cells in the bronchi of people who smoke or use electronic nicotine delivery systems (ENDS) including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars.

Cellular Injury

Injury is defined as a disorder in steady-state regulation. Any stressor that alters the ability of the cell or system to maintain optimal balance of its adjustment processes leads to injury. Structural and functional damage then occurs, which may be reversible (permitting recovery) or irreversible (leading to disability or death). Homeostatic adjustments are concerned with the small changes within the body's systems. With adaptive changes, compensation occurs, and a new steady state may be achieved. With injury, steady-state regulation is lost and changes in functioning ensue.

Causes of disorder and injury in the system (cell, tissue, organ, body) may arise from the external or internal environment (Fig. 5-5) and include hypoxia, nutritional imbalance, physical agents, chemical agents, infectious agents, immune mechanisms, and genetic defects. The most common causes are hypoxia (oxygen deficiency), chemical injury, and infectious agents. In addition, the presence of one injury makes the system more susceptible to another injury. For example, inadequate oxygenation and nutritional deficiencies make the system vulnerable to infectious agents. These agents

damage or destroy the integrity of the cell membrane (necessary for ionic balance) as well as the cell's ability to do the following:

- Transform energy (aerobic respiration, production of adenosine triphosphate)
- Synthesize enzymes and other necessary proteins
- Grow and reproduce (genetic integrity)

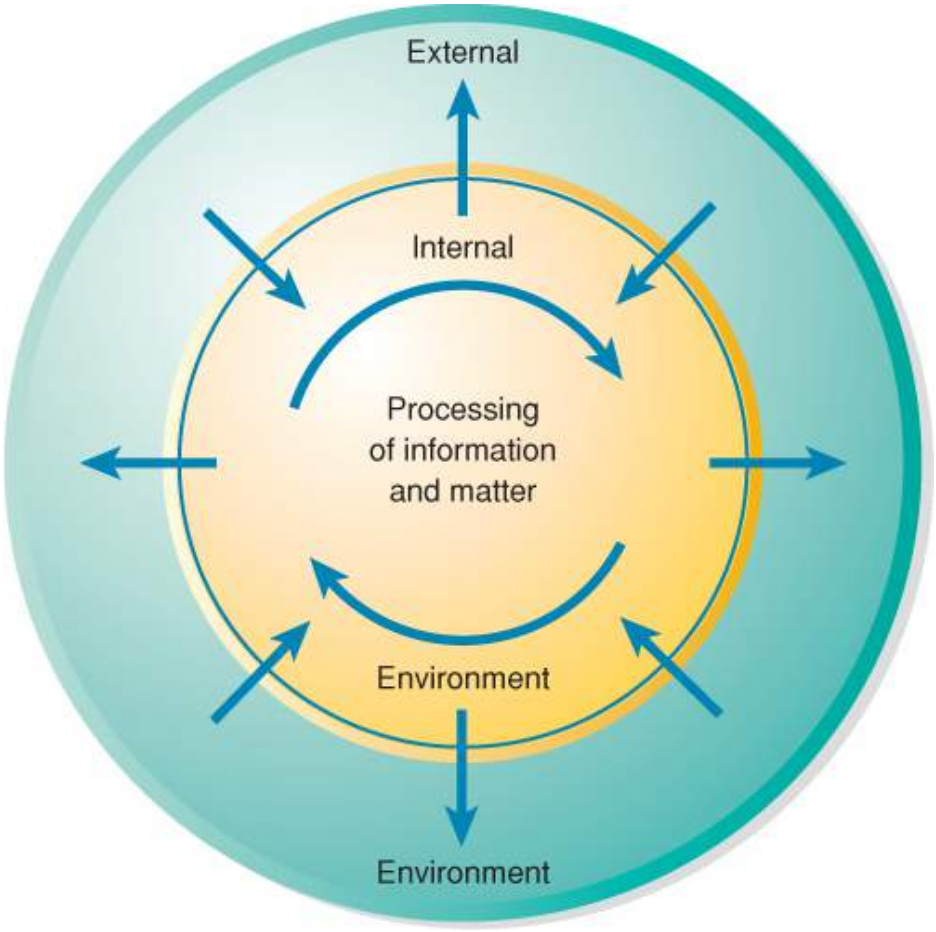

Figure 5-5 • Influences leading to disorder may arise from the internal and external environments of the system. Excesses or deficits of information and matter may occur, or there may be faulty regulation of processing.

Hypoxia

Hypoxia interferes with the cell's ability to transform energy. Hypoxia may be caused by a decrease in blood supply to an area, a decrease in the oxygen-carrying capacity of the blood (decreased hemoglobin), a ventilation–perfusion or respiratory problem that reduces the amount of arterial oxygen available, or a problem in the cell's enzyme system that makes it unable to use oxygen.

The usual cause of hypoxia is ischemia or deficient blood supply. Ischemia is commonly seen in myocardial cell injury in which arterial blood flow is

decreased because of atherosclerotic narrowing of blood vessels. Ischemia also results from intravascular clots (thrombi or emboli) that may form and interfere with blood supply. Thromboemboli are common causes of cerebrovascular disease (strokes). The length of time in which different tissues can survive without oxygen varies. For example, brain cells most often succumb in 3 to 6 minutes. If the condition leading to hypoxia is slow and progressive, collateral circulation may develop, whereby blood is supplied by other blood vessels in the area. However, this mechanism is not highly reliable.

Nutritional Imbalance

Nutritional imbalance refers to a relative or absolute deficiency or excess of one or more essential nutrients. This may be manifested as undernutrition (inadequate consumption of food or calories) or overnutrition (caloric excess). Caloric excess to the point of obesity overloads cells in the body with lipids. By requiring more energy to maintain the extra tissue, obesity places a strain on the body and has been associated with the development of disease, especially pulmonary and cardiovascular disease as well as several types of cancer. (See Chapter 42 for further discussion of obesity.)

Specific deficiencies arise when an essential nutrient is deficient or when a nutrient imbalance exists. Protein deficiencies and avitaminosis (deficiency of vitamins) are typical examples. An energy deficit leading to cell injury can occur if there is insufficient glucose or insufficient oxygen to transform the glucose into energy. A lack of insulin, or the inability to use insulin, may also prevent glucose from entering the cell from the blood. This occurs in diabetes, a metabolic disorder that can lead to nutritional deficiency, as well as a host of short- and long-term life-threatening complications. (See Chapter 46 for further discussion of diabetes.)

Physical Agents

Physical agents, including temperature extremes, radiation, electrical shock, and mechanical trauma, can cause injury to the cells or to the entire body. The duration of exposure and the intensity of the stressor determine the severity of damage.

Temperature

When a person's temperature is elevated, hypermetabolism occurs and the respiratory rate, heart rate, and basal metabolic rate increase. With fever induced by infections, the hypothalamic thermostat may be reset at a higher temperature and then return to normal when the fever abates. The increase in body temperature is achieved through physiologic mechanisms. Body temperatures greater than 41°C (106°F) indicate hyperthermia, because the physiologic function of the thermoregulatory center breaks down and the

temperature soars (Norris, 2019). This physiologic condition occurs in people who have heatstroke. Eventually, the high temperature causes coagulation of cell proteins, and cells die.

The local response to burn injury is similar. Increased metabolic activity occurs, and, as heat increases, proteins coagulate and enzyme systems are destroyed. In extreme situations, charring or carbonization occurs. See Chapter 57 for more information about burn injuries.

Extreme low environmental temperature (cold) causes vasoconstriction. Blood flow becomes sluggish and clots form, leading to ischemic damage in the involved tissues. With still lower temperatures, ice crystals may form and cells may burst.

Radiation and Electrical Shock

Radiation is used for diagnosis and treatment of diseases. Ionizing forms of radiation may cause injury by their destructive action. Radiation decreases the protective inflammatory response of the cell, creating a favorable environment for opportunistic infections. Electrical shock produces burns as a result of the heat generated when electrical current travels through the body. It may also abnormally stimulate nerves, leading, for example, to fibrillation of the heart.

Mechanical Trauma

Mechanical trauma can result in wounds that disrupt the cells and tissues of the body. The severity of the wound, amount of blood loss, and extent of nerve damage are significant factors in determining the extent of injury.

Chemical Agents

Chemical injuries are caused by poisons, such as lye, that have a corrosive action on epithelial tissue, or by heavy metals, such as mercury, arsenic, and lead, each of which has its own specific destructive action. Many other chemicals are toxic in certain amounts, in certain people, and in specific tissues. For example, excessive secretion of hydrochloric acid can damage the stomach lining; large amounts of glucose can cause osmotic shifts, affecting the fluid and electrolyte balance; and too much insulin can cause subnormal levels of glucose in the blood (hypoglycemia) and can lead to coma.

Drugs, including prescribed medications, can also cause chemical poisoning. Some people are less tolerant of medications than others and manifest toxic reactions at the usual or customary dosages. Aging tends to decrease tolerance to medications. Polypharmacy (taking many medications at one time) occurs frequently in older adults, and the unpredictable effects of the resulting medication interactions can cause injury.

Alcohol (ethanol) is also a chemical irritant. In the body, alcohol is broken down into acetaldehyde, which has a direct toxic effect on liver cells that leads to various liver abnormalities, including cirrhosis in susceptible people.

Disordered liver cell function leads to complications in other organs of the body.

Infectious Agents

Biologic agents known to cause disease in humans are viruses, bacteria, rickettsiae, mycoplasmas, fungi, protozoa, and nematodes. The severity of the infectious disease depends on the number of microorganisms entering the body, their virulence, and the host's defenses (e.g., health, age, immune responses; see Chapter 66 for further discussion of infectious diseases).

An infection exists when the infectious agent is living, growing, and multiplying in the tissues and is able to overcome the body's normal defenses. Some bacteria, such as those that cause tetanus and diphtheria, produce exotoxins that circulate and create cell damage. Others, such as gram-negative bacteria, produce endotoxins when they die. Tubercle bacilli induce an immune reaction.

Viruses are among the smallest living organisms known and survive as parasites of the living cells they invade. Viruses infect specific cells. Through a complex mechanism, viruses replicate within cells and then invade other cells, where they continue to replicate. As the body mounts an immune response to eliminate the viruses, cells harboring the viruses can be injured in the process. Typically, an inflammatory response and immune reaction are the body's physiologic responses to viral infection.

Disordered Immune Responses

The immune system is an exceedingly complex system, the purpose of which is to defend the body from invasion by any foreign object or foreign cell type, such as cancerous cells. This is a steady-state mechanism; however, like other adjustment processes, it can become disordered and cellular injury results. The immune response detects foreign bodies by distinguishing non-self substances from self substances and destroying the non-self entities. The entrance of an antigen (foreign substance) into the body evokes the production of antibodies that attack and destroy the antigen (antigen–antibody reaction).

The immune system may function normally, or it may be hypoactive or hyperactive. When it is hypoactive, immune deficiency diseases occur; when it is hyperactive, hypersensitivity disorders occur. A disorder of the immune system can result in damage to the body's own tissues. Such disorders are labeled autoimmune diseases (see Unit 7).

Genetic Disorders

There is intense interest in genetic defects as causes of disease and modifiers of genetic structure. Many of these defects produce mutations that have no recognizable effect, such as lack of a single enzyme; others contribute to more

obvious congenital abnormalities, such as Down syndrome. (For further information on genetics, see Chapter 6.)

Cellular Response to Injury: Inflammation

Cells or tissues of the body may be injured or killed by any of the agents (physical, chemical, infectious) described earlier. When this happens, an inflammatory response (or inflammation) naturally occurs in the healthy tissues adjacent to the site of injury. **Inflammation** is a localized reaction intended to neutralize, control, or eliminate the offending agent to prepare the site for repair. It is a nonspecific response (not dependent on a particular cause) that is meant to serve a protective function. For example, inflammation may be observed at the site of a bee sting, in a sore throat, in a surgical incision, and at the site of a burn. Inflammation also occurs in cell injury events, such as stroke, deep vein thrombosis, and myocardial infarction.

Inflammation is not the same as infection. An infectious agent is only one of several agents that may trigger an inflammatory response. Regardless of the cause, a general sequence of events occurs in the local inflammatory response. This sequence involves changes in the microcirculation, including vasodilation, increased vascular permeability, and leukocytic cellular infiltration (Fig. 5-6). As these changes take place, five cardinal signs of inflammation are produced: redness, warmth, swelling, pain, and loss of function (Norris, 2019).

The transient vasoconstriction that occurs immediately after injury is followed by vasodilation and an increased rate of blood flow through the microcirculation to the area of tissue damage. Local warmth and redness result. Next, the structure of the microvascular system changes to accommodate the movement of plasma protein from the blood into the tissues. Following this increase in vascular permeability, plasma fluids (including proteins and solutes) leak into the inflamed tissues, producing swelling. Leukocytes migrate through the endothelium and accumulate in the tissue at the site of the injury. The pain that occurs is attributed to the pressure of fluids or swelling on nerve endings and to the irritation of nerve endings by chemical mediators released at the site. Bradykinin is one of the chemical mediators suspected of causing pain. Loss of function is most likely related to the pain and swelling; however, the exact mechanism is not completely known.

As blood flow increases and fluid leaks into the surrounding tissues, the formed elements (red blood cells, white blood cells, and platelets) remain in the blood, causing it to become more viscous. Leukocytes (white blood cells) collect in the vessels, exit, and migrate to the site of injury to engulf offending organisms and to remove cellular debris in a process called *phagocytosis*. Fibrinogen in the leaked plasma fluid coagulates, forming fibrin for clot

formation, which serves to wall off the injured area and prevent the spread of infection.

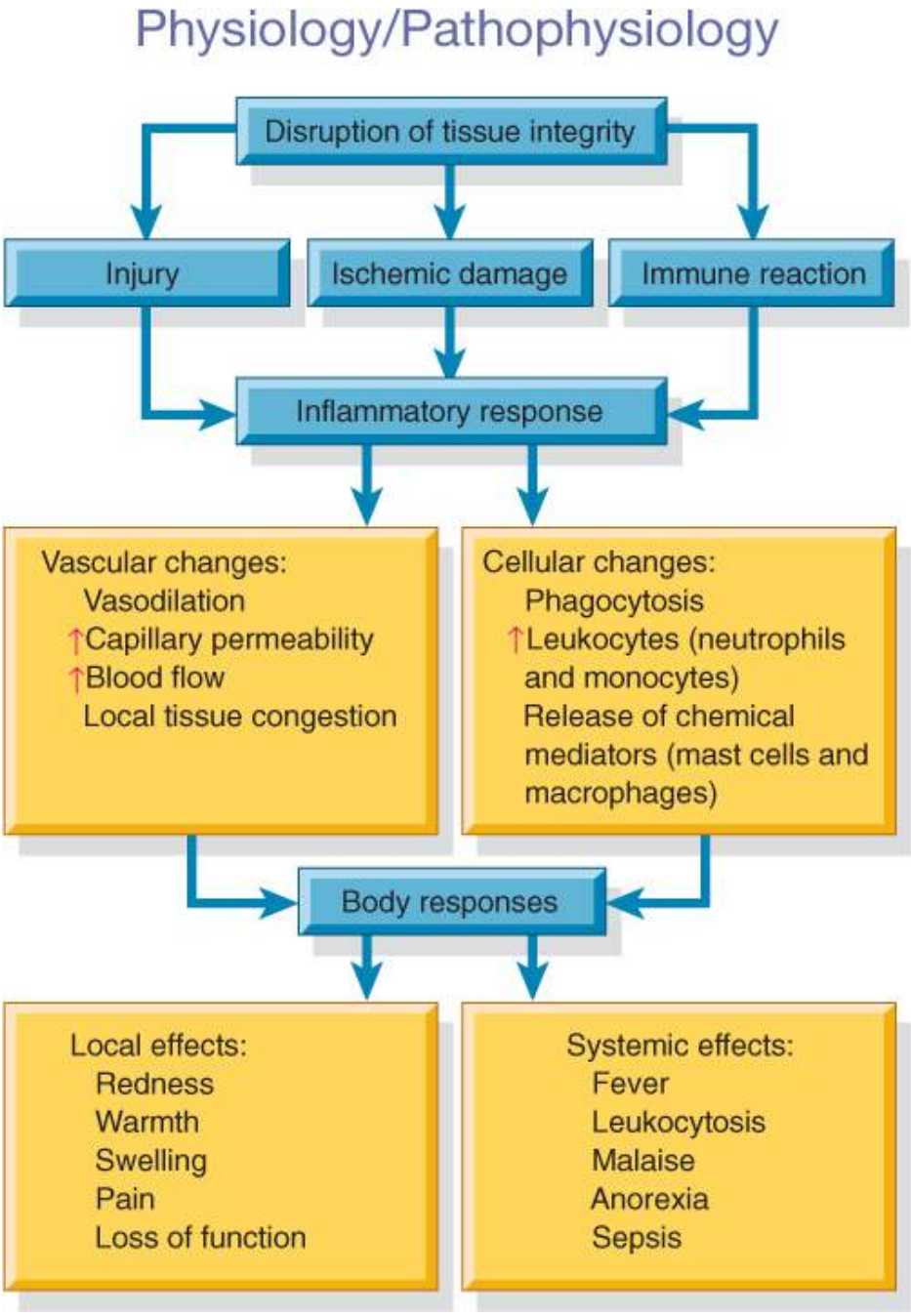

Figure 5-6 • Inflammatory response. Source: Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health status* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Chemical Mediators of Inflammation

Injury initiates the inflammatory response; however, chemical substances released at the site induce vascular changes. Foremost among these chemicals are histamine and kinins. Histamine is present in many tissues of the body but

is concentrated in the mast cells. It is released when injury occurs and is responsible for the early changes in vasodilation and vascular permeability. Kinins cause vasodilation and increased vascular permeability, and they attract neutrophils to the area. Prostaglandins—another group of chemical substances—are also suspected of causing increased vascular permeability (Norris, 2019).

Systemic Response to Inflammation

The inflammatory response is often confined to the site, causing only local signs and symptoms. However, systemic responses can also occur. Fever is the most common sign of a systemic response to injury, and it is most likely caused by endogenous pyrogens (internal substances that cause fever) released from neutrophils and macrophages (specialized forms of leukocytes). These substances reset the hypothalamic thermostat, which controls body temperature, and produce fever. Leukocytosis, an increase in the synthesis and release of neutrophils from bone marrow, may occur, enhancing the body's ability to fight infection. During this process, general, nonspecific symptoms develop, including malaise, loss of appetite, aching, and weakness.

Types of Inflammation

Inflammation is categorized primarily by its duration and the type of exudate produced. It is most often acute or chronic. Acute inflammation is characterized by the local vascular and exudative changes described previously and usually lasts less than 2 weeks. An acute inflammatory response is immediate and serves a protective function. After the causative agent is removed, the inflammation subsides and healing takes place with the return of normal or near-normal structure and function.

Chronic inflammation develops if the injurious agent persists and the acute response is perpetuated. Symptoms are present for many months or years. Chronic inflammation may also begin insidiously and never have an acute phase. The chronic response does not serve a beneficial and protective function; on the contrary, it is debilitating and can produce long-lasting effects. As the inflammation becomes chronic, changes occur at the site of injury, and the nature of the exudate becomes proliferative. A cycle of cellular infiltration, necrosis, and fibrosis begins, with repair and breakdown occurring simultaneously. Considerable scarring may occur, resulting in permanent tissue damage.

Cellular Healing

The reparative process begins at approximately the same time as the injury. Healing proceeds after the inflammatory debris has been removed. Healing

may occur by regeneration, in which the defect is gradually repaired by proliferation of the same type of cells as those destroyed, or by replacement, in which cells of another type, usually connective tissue, fill in the tissue defect and result in scar formation.

Regeneration

The ability of cells to regenerate depends on whether they are labile, permanent, or stable. Labile cells multiply constantly to replace cells worn out by normal physiologic processes; these include epithelial cells of the skin and those lining the gastrointestinal tract. Permanent cells include neurons—the nerve cell bodies, not their axons. Destruction of neurons is permanent; however, axons may regenerate. If normal activity is to return, tissue regeneration must occur in a functional pattern, especially in the growth of several axons. Stable cells in some organ systems have a latent ability to regenerate. Under normal physiologic processes, they are not shed and do not need replacement; if they are damaged or destroyed, they are able to regenerate. Examples include functional cells of the kidney, liver, and pancreas. Cells in other organs, such as the brain, do not regenerate.

Replacement

The condition of the host, the environment, and the nature and severity of the injury affect the processes of inflammation, repair, and replacement. Depending on the extent of damage, repair and replacement may occur by primary or secondary intention. In primary intention healing, the wound edges are approximated, as in a surgical wound (see Chapter 16). Little scar formation occurs, and the wound healing occurs without granulation. In secondary intention healing, there is tissue loss so the edges are not approximated and the wound fills with granulation tissue (Norris, 2019). The process of repair takes longer and may result in scar formation, with loss of specialized function. For example, people who have recovered from myocardial infarction have abnormal electrocardiographic tracings because the electrical signal cannot be conducted through the connective tissue that has replaced the infarcted area.

Nursing Management

Stress or the potential for stress is ubiquitous—that is, it is both everywhere and anywhere. It is essential for all people, particularly student nurses, to engage in strategies for stress relief. Nursing students experience stressors that can negatively affect their academic and clinical performance (Kinchen & Loerzel, 2019). See the Nursing Research Profile in Chart 5-2. Anxiety, frustration, anger, and feelings of inadequacy, helplessness, or powerlessness

are emotions often associated with stress. In the presence of these emotions, the customary activities of daily living may be disrupted—for example, a sleep disturbance may occur, eating and activity patterns may be altered, and family processes or role performance may be disrupted.

The optimal point of intervention to promote health is during the stage when a person's own compensatory processes are still functioning effectively. A major role of nurses is the early identification of both physiologic and psychological stressors. Nurses should be able to relate the presenting signs and symptoms of distress to the physiology they represent and identify a person's position on the continuum of function, from health and compensation to pathophysiology and disease.

In the assessment of people who seek health care, both objective signs and subjective symptoms are the primary indicators of existing physiologic processes. The following questions are addressed:

- Are the heart rate, respiratory rate, and temperature normal?
- What emotional distress may be contributing to the patient's health problems?
- Are there other indicators of steady-state deviation?
- What are the patient's blood pressure, height, and weight?
- Are there any problems in movement or sensation?
- Are there any problems with affect, behavior, speech, cognitive ability, orientation, or memory?
- Are there obvious impairments, lesions, or deformities?

Objective evidence can be obtained from laboratory data, such as electrolytes, blood urea nitrogen, blood glucose, and urinalysis results. Further signs of injury are seen in diagnostic studies such as computed tomography (CT) scanning, magnetic resonance imaging (MRI), and positron emission tomography (PET). Further information on diagnostic evaluation can be found in assessment chapters of each unit of this book. Many nursing diagnoses are possible for patients suffering from stress. One nursing diagnosis associated with stress is anxiety, which is defined as a vague, uneasy feeling, the source of which may be nonspecific or not known to the person. Stress may also be manifested as difficulty coping patterns, decisional conflict, or relationship problem. These human responses are reflected in the nursing diagnoses of anxiety, difficulty coping, and denial, all of which indicate poor adaptive responses. Other possible nursing diagnoses include social isolation, risk for spiritual distress, readiness for positive family processes, decisional conflict, lack of resilience, and risk for powerlessness, among others. Because human responses to stress are varied, as are the sources of stress, arriving at an accurate diagnosis allows interventions and goals to be more specific and leads to improved outcomes.

Chart 5-2 NURSING RESEARCH PROFILE

Nursing Students' Attitudes and Use of Holistic Therapies for Stress Relief

Kinchen, E. V., & Loerzel, V. (2019). Nursing students' attitudes and use of holistic therapies for stress relief. *Journal of Holistic Nursing, 37*(1), 6–17.

Purpose

The purpose of this mixed methods research study was to determine nursing students' openness to using or making recommendations to use holistic strategies to manage school or work stress, along with their perceptions of engaging in the use of holistic therapies for their own personal health.

Design

In this quasi-experimental, mixed methods study, a convenience sample of nursing students was recruited from a senior undergraduate class and provided an email to obtain information about the study, the consent form, and the survey link. Participants completed the quantitative electronic survey and answered the accompanying three open-ended questions. The questions asked the participants about their personal use or recommendation to use holistic therapies for stress relief, the strategies they utilized for managing their stress, and their perceptions of the influence that holistic therapies have on personal health. Students who participated in the study were given two extra credit points; nonparticipants who desired to obtain the extra credit points were permitted to write a one-page essay as an alternative assignment on the holistic therapy of their choice.

Findings

The reported findings were only from the qualitative portion of the study. Of the 116 participants, 81 (70%) were very open or open to using or recommending holistic therapies, while 32 (28%) were somewhat open, and 3 (2%) were not open to using or recommending holistic modalities. From the data, eight categories of stress management activities were obtained: physical activity, prayer and meditation, time management, distraction, socialization, artistic/creative pursuits, interactions with animals, and other behaviors such as napping, taking a day off, stress eating, and crying. It was noted that 62% of the identified stress management actions are designated as holistic therapies. Overall, 85 of the participants (73%) held the view that holistic therapies had a positive influence on personal health, while 25 participants (22%) believed that holistic therapies had a potential influence on their health, and the remaining 6 (5%) perceived that holistic therapies had no effect on personal health. Four recurring themes were extracted from the data: wholeness, self-empowerment, relaxation/restoration, and alternative/complement to traditional medicine. The student participants were open to recommending these strategies to others. There also were barriers identified, such as a lack of knowledge and a lack of time, which interfered with using holistic methods for managing stress.

Nursing Implications

Information from this study supports that, in addition to the traditional behavioral health and pharmacologic interventions used for managing stress, many nursing students found holistic strategies useful for managing stress in their daily lives. This study lends support to the recommendations from many nursing organizations, such as the American Holistic Nurses Association (AHNA) and the American Nurses Association (ANA), to promote self-care and stress-relief strategies while providing students with the knowledge necessary to educate their patients about the use of holistic therapies. It is important for nursing education programs to establish and implement curriculum content and practical experiences related to holistic therapies.

Stress management is directed toward reducing and controlling stress and improving coping. The need to prevent illness, improve the quality of life, and decrease the cost of health care makes efforts to promote health essential, and stress control a significant health promotion goal. Stress reduction methods and coping enhancements can derive from either internal or external sources. For example, healthy eating habits and relaxation techniques are internal resources that help reduce stress, and a broad social network is an external resource that helps reduce stress. Goods and services that can be purchased are also external resources for stress management. It may be easier for people with adequate financial resources to cope with constraints in the environment, because their sense of vulnerability to threat is decreased compared to those without adequate financial resources.

Promoting a Healthy Lifestyle

A health-promoting lifestyle provides internal resources that aid in coping, and it buffers or cushions the impact of stressors. Lifestyles or habits that contribute to the risk of illness can be identified through a health risk appraisal, which is an assessment method designed to promote health by examining a person's habits and recommending changes when a health risk is identified.

Health risk appraisals involve the use of health risk questionnaires to estimate the likelihood that people with a given set of characteristics will become ill. People who receive this information may be influenced to adopt healthy behaviors (e.g., stop smoking, have periodic screening examinations) to improve their health. Questionnaires typically address the information presented in Chart 5-3.

The personal information is compared with average population risk data, and the risk factors are identified and weighted. From this analysis, a person's risks and major health hazards are identified. Further comparisons with population data can estimate how many years will be added to a person's lifespan if the suggested changes are made. However, research has not yet

demonstrated that providing people with such information ensures that they will change their behaviors. The single most important factor for determining health status is social class, and within a social class, research suggests that the major factor influencing health is level of education (Bastable, Gramet, Jacobs, et al., 2019).

Chart 5-3

Information Addressed in Health Risk Questionnaires

Demographic data such as age, gender, race/ethnic background
Personal and family history of diseases and health problems
Lifestyle choices:

- Eating, sleeping, exercise, smoking, drinking, use of illicit drugs, sexual activity, recreation activity, and driving habits
- Stressors at home and on the job
- Roles, role relationships, and associated stressors
- Living and family situation
- Family and social supports

Physical measurements:

- Blood pressure
- Height, weight, body mass index
- Laboratory analyses of blood and urine

Participation in high-risk behaviors (e.g., engaging in unprotected sexual activity, not using seat belts while riding in a motor vehicle, using illicit drugs)

Enhancing Coping Strategies

Bulechek, Butcher, Dochterman, and colleagues (2018) identified coping enhancement as a nursing intervention and defined it as handling perceived and actual stressors, changes, or threats that affect how one meets daily life demands and roles (Chart 5-4). The nurse can build on the patient's existing coping strategies, as identified in the health appraisal, or provide education about new strategies for coping if necessary.

Chart 5-4

Coping Enhancement: Nursing Interventions

Definition

Facilitation of cognitive and behavioral efforts to manage perceived stressors, changes, or threats that interfere with meeting life's demands and roles.

Select Activities

Assist the patient in identifying appropriate short- and long-term goals.
Assist the patient to solve problems in a constructive manner.
Provide information concerning diagnosis, treatment, and prognosis.
Encourage an attitude of realistic hope as a way of dealing with feelings of helplessness.
Acknowledge the patient's spiritual/cultural background and encourage the use of spiritual resources if desired.
Foster constructive outlets for anger and hostility.
Assist the patient in examining available resources to meet goals.
Appraise the needs and desires for social support, and assist the patient to identify available support systems.
Assist the patient to identify positive strategies to deal with limitations, manage needed lifestyle or role changes, and work through the losses of chronic illness and/or disability if appropriate.

Adapted from Bulechek, G. M., Butcher, H. K., Dochterman, J. M., et al. (Eds.). (2018). *Nursing interventions classification (NIC)* (7th ed.). St. Louis, MO: Mosby-Elsevier.

The five predominant ways of coping with illness identified in a review of 57 nursing research studies were as follows (Jalowiec, 1993):

- Trying to be optimistic about the outcome
- Using social support
- Using spiritual resources
- Trying to maintain control either over the situation or over feelings
- Trying to accept the situation

Other ways of coping included seeking information, reprioritizing needs and roles, lowering expectations, making compromises, comparing oneself to others, planning activities to conserve energy, taking things one step at a time, listening to one's body, and using self-talk for encouragement.

Unfolding Patient Stories: Skyler Hansen • Part 1

Skyler Hansen is an 18-year-old male recently diagnosed with type 1 diabetes. He lives with his parents and two younger siblings and is active in high school sports. He now requires insulin injections, glucose monitoring, and a diabetic diet. Examine how the psychological, physical, and educational needs for managing a new diagnosis can be a great source of stress to the patient and the family. How can the nurse enhance his ability to cope with and adapt to diabetes management? (Skyler Hansen's story continues in Chapter 46.)

Care for Skyler and other patients in a realistic virtual environment: *vSim* (**thepoint.lww.com/vSimMedicalSurgical**). Practice documenting these patients' care in DocuCare (**thepoint.lww.com/DocuCareEHR**).

Educating About Relaxation Techniques

Relaxation techniques are a major method used to relieve stress. The goal of using relaxation techniques is to produce a response that counters the stress response. When this goal is achieved, the action of the hypothalamus adjusts, decreasing sympathetic and parasympathetic nervous system activity. The sequence of physiologic effects and their signs and symptoms are then interrupted, thus reducing psychological stress. This is a learned response and requires practice to achieve. Commonly used techniques include progressive muscle relaxation, the Benson relaxation response, and relaxation with guided imagery (all discussed later). Other relaxation techniques include meditation, breathing techniques, massage, Reiki, music therapy, biofeedback, and the use of humor.

The different relaxation techniques share four similar elements: (1) a quiet environment, (2) a comfortable position, (3) a passive attitude, and (4) a mental device (something on which to focus one's attention, such as a word, phrase, or sound).

Chart 5-5

The Benson Relaxation Response

1. Pick a brief phrase or word that reflects your basic belief system.
2. Choose a comfortable position.
3. Close your eyes.
4. Relax your muscles.
5. Become aware of your breathing and start using your selected focus word.
6. Maintain a passive demeanor.
7. Continue for a set period of time.
8. Practice the technique twice daily.

Adapted from Benson, H. (1993). The relaxation response. In D. Goleman, & J. Gurin. (Eds.). *Mind-body medicine: How to use your mind for better health*. Yonkers, NY: Consumer Reports Books.

Progressive Muscle Relaxation

Progressive muscle relaxation involves tensing and releasing the muscles of the body in sequence and sensing the difference in feeling. It is best if the person lies on a soft cushion in a quiet room, breathing easily. Someone usually reads the instructions in a low tone in a slow and relaxed manner, or a recording of the instructions may be played. The person tenses the muscles in the entire body (one muscle group at a time), holds, senses the tension, and then relaxes. As each muscle group is tensed, the person keeps the rest of the body relaxed. Each time the focus is on feeling the tension and relaxation. When the exercise is completed, the entire body should be relaxed (Benson, 1993; Benson & Stark, 1996).

The Benson Relaxation Response

The Benson relaxation response (Chart 5-5) combines meditation with relaxation. Along with the repeated word or phrase, a passive demeanor is essential. If other thoughts or distractions (noises, pain) occur, Benson recommends not fighting the distraction but simply continuing to repeat the focus phrase. Time of day is not important; however, the exercise works best on an empty stomach (Benson, 1993; Benson & Proctor, 1984; Benson & Stark, 1996).

Guided Imagery

Simple **guided imagery** is the mindful use of a word, phrase, or visual image for the purpose of distracting oneself from distressing situations or consciously taking time to relax or re-energize. A nurse can help a person select a pleasant scene or experience, such as watching the ocean or dabbling the feet in a cool stream. The image serves as the mental device in this technique. As the person

sits comfortably and quietly, the nurse guides the person to review the scene, trying to feel and relive the imagery with all of the senses. A recording may be made of the description of the image, or commercial recordings for guided imagery and relaxation can be used.

Educating About Stress Management

Two commonly prescribed nursing educational interventions—providing sensory information and providing procedural information (e.g., preoperative education)—aim to reduce stress and improve the patient's coping ability. This preparatory education includes giving structured content, such as a lesson in childbirth preparation to expectant parents, a review of how an implantable cardioverter defibrillator works to a patient with heart disease, or a description of sensations a patient will experience during cardiac catheterization. These techniques may alter the person–environment relationship such that something that might have been viewed as harmful or a threat will now be perceived more positively. Giving patients information also reduces the emotional response so that they can concentrate and solve problems more effectively (Kittleson, 2019; Miller & Stoeckel, 2017; Rhee, Marottoli, Van Ness, et al., 2018).

Veterans Considerations

Veterans have similar educational needs to nonveterans. Yet one study revealed that, in a postsecondary education setting, women service members and veterans received less health information compared to women who were not service members or veterans (Albright, Thomas, McDaniel, et al., 2019). In this cross-sectional study, women service members and veterans received less education about alcohol and illicit drug use, depression and anxiety, sexual assault and relational violence prevention, and stress reduction. Nurses who work on college campuses should be attuned to the educational needs of women veterans.

Promoting Family Health

In addition to individual concepts of homeostasis, stress, adaptation, and health problems associated with maladaptation, the concept of family is also important. Nurses can intervene with both individuals and families to reduce stress and its health-related effects. The **family** (group whose members are related by reciprocal caring, mutual responsibilities, and loyalties) plays a central role in the life of the patient and is a major part of the context of the patient's life. It is within families that people grow, are nurtured, acquire a sense of self, develop beliefs and values about life, and progress through life's

developmental stages (Fig. 5-7). Families are also the first source for socialization and education about health and illness.

Ideally, the health care team conducts a careful and comprehensive family assessment (including coping style), develops interventions tailored to handle the stressors, implements the specified treatment protocols, and facilitates the construction of social support systems. The use of existing family strengths, resources, and education is augmented by therapeutic family interventions. The nurse's primary goals are to maintain and improve the patient's present level of health and to prevent physical and emotional deterioration. Next, the nurse intervenes in the cycle that the illness creates: patient illness, stress for other family members, new illness in other family members, and additional patient stress.

Figure 5-7 • Within families, individuals progress through life's developmental stages.

Helping the family members manage the myriad stressors that bombard them daily involves working with family members to develop coping skills. Seven traits that enhance coping of family members under stress have been identified (Burr, Klein, Burr, et al., 1994). Communication skills and spirituality were frequently useful traits. Cognitive abilities, emotional strengths, relationship capabilities, willingness to use community resources, and individual strengths and talents were also associated with effective coping. As nurses work with families, they must not underestimate the impact of their therapeutic interactions, educational information, positive role modeling, provision of direct care, and education on promoting health. Maladaptive coping may result if health care team members are not perceived as actively supporting family members. Often, denial and blaming of others occur.

Sometimes, physiologic illness, emotional withdrawal, and physical distancing are the results of severe family conflict, violent behavior, or addiction to drugs and alcohol. Substance abuse may develop in family members who feel unable to cope or solve problems. People may engage in these dysfunctional behaviors when faced with difficult or problematic situations.

Enhancing Social Support

The nature of social support and its influence on coping have been studied extensively. Social support has been demonstrated to be an effective moderator of life stress. Such support has been found to provide people with several different types of emotional information (Nicks, Wray, Peavler, et al., 2019; Warner, Roberts, Jeanblanc, et al., 2017). The first type of information leads people to believe that they are cared for and loved. This emotional support appears most often in a relationship between two people in which mutual trust and attachment are expressed by helping each other to meet their emotional needs. The second type of information leads people to believe that they are esteemed and valued. This is most effective when others in a group recognize a person's favorable position within that group, demonstrating the person's value. Known as esteem support, this elevates the person's sense of self-worth. The third type of information leads people to feel that they belong to a network of communication and mutual obligation. Members of this network share information and make goods and services available to the members as needed.

Social support also facilitates a person's coping behaviors; however, this depends on the nature of the social support. People can have extensive relationships and interact frequently; however, the necessary support comes only when people feel a deep level of involvement and concern, not when they merely touch the surface of each other's lives.

The critical qualities within a social network are the exchange of intimate communications and the presence of solidarity and trust.

Emotional support from family and significant others provides love and a sense of sharing the burden. The emotions that accompany stress are unpleasant and often increase in a spiraling fashion if relief is not provided. Being able to talk with someone and express feelings openly may help a person gain mastery of the situation. Nurses can provide this support but also must identify the person's social support system and encourage its use. People who are "loners," who are isolated, or who withdraw in times of stress have a high risk of coping failure.

Because anxiety can also distort a person's ability to process information, it helps to seek information and advice from others who can assist with analyzing the threat and developing a strategy to manage it. Again, this use of others helps people maintain mastery of a situation and self-esteem.

Thus, social networks assist with management of stress by providing people with:

- A positive social identity
- Emotional support
- Material aid and tangible services
- Access to information
- Access to new social contacts and new social roles

Recommending Support and Therapy Groups

Support groups exist especially for people in similar stressful situations. Groups have been formed by people with ostomies; women who have had mastectomies; and people with cancer or other serious diseases, chronic illness and disability. There are groups for single parents, substance abusers and their family members, homicide bereavement, and victims of child abuse. Professional, civic, and religious support groups are active in many communities (Mavandadi, Wray, & Toseland, 2019; Supiano & Overfelt, 2018). Encounter groups, assertiveness training programs, and consciousness-raising groups help people modify their usual behaviors in their transactions with their environment. Many find that being a member of a group with similar problems or goals has a releasing effect that promotes freedom of expression and exchange of ideas.

Veterans Considerations

Due to the loss of their military community and associated support systems, veterans are at higher risk compared to civilians of experiencing psychiatric symptoms (such as posttraumatic stress disorder [PTSD]) and interpersonal distress. One group of researchers reported that in a study of 117 veterans, group psychotherapy helped to reduce the symptoms of PTSD and interpersonal distress, mainly by increasing social support among the veterans (Cox, Owen, & Ogrodniczuk, 2017).

The Role of Stress in Health Patterns

As noted previously, a person's psychological and biologic health, internal and external sources of stress management, and relationships with the environment are predictors of health outcomes. These factors are directly related to the person's health patterns. The nurse has a significant role and responsibility in identifying the health patterns of patients receiving care as well as those of their families. If those patterns are not achieving physiologic, psychological,

and social balance, the nurse is obligated, with the assistance and agreement of the patient, to seek ways to promote individual and family balance.

This chapter has presented some physiologic mechanisms and perspectives on health and disease, the way that one copes with stress. Nurses should keep in mind that the way that one relates to others and the values and goals held are also interwoven into those physiologic patterns. To evaluate a patient's health patterns and to intervene if a disorder exists requires a total assessment of the person. Specific disorders and their nursing management are addressed in greater depth in other chapters.

CRITICAL THINKING EXERCISES

1 ebp You are the nurse in a student health center, and a female veteran comes in after experiencing 1 week of persistent discomfort in her shoulder after spiking a ball during a volleyball game. During the appointment, the student tells you, "I play hard as this is the only form of exercise that I get during the week. I have been putting ice on it at night, but that has stopped helping. I'm very stressed-out about this injury, and I am afraid that I may have torn my rotator cuff. How serious do you think this is?" What is the evidence base for offering guidelines for managing this student's health situation and her high level of stress? What educational information can you share to assist her to make appropriate health decisions and establish positive health behaviors? Identify the criteria used to evaluate the strength of the evidence for this practice.

2 pci An 82-year-old man recently moved out of his daughter's home into an assisted living program where you are working. His reason for coming to see you is "because I haven't been feeling well and sometimes my chest is sore." During his interview, he states, "I am a stomach cancer survivor and I have heart disease. I chose to move into assisted living rather than being with my daughter and her crazy family. Those people make me upset and anxious. They raise my blood pressure and make me sick." Identify this older man's health priorities and state the next steps you will take to meet his identified needs and other health promotion needs.

3 ipc You are the nurse working in an outpatient clinic. You tell a 30-year-old woman that during her routine physical examination a thyroid nodule was found. How will you educate this patient about this finding? What referrals do you anticipate will be made? What steps will the interdisciplinary team take to address the patient's health care needs?

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

American Holistic Nurses Association (AHNA), www.ahna.org
Anxiety and Depression Association of America (ADAA), www.adaa.org
Grief Recovery Institute, www.griefrecoverymethod.com
Help Guide: A Nonprofit Guide to Mental Health and Well Being, www.helpguide.org
Institute of HeartMath: Connecting Hearts and Minds, www.heartmath.org
National Hospice and Palliative Care Organization (NHPCO), www.nhpco.org
Physiological Stress Response: Its Effects on the Body, www.stressfocus.com/stress_focus_article/stress-removal.htm
Psych Central: Tips to Decrease Stress, www.psychcentral.com/lib/20-tips-to-tame-your-stress
Stress: The Silent Killer, www.holisticonline.com/Stress/stress_home.htm
The Compassionate Friends, www.compassionatefriends.org
The Psychology of "Stress," www.guidetopsychology.com/stress.htm
Widowed Persons Service, 3950 Ferrara Dr., Silver Spring, MD; 1-301-949-7398; www.wpsgr.org

Women's Health Network, www.womentowomen.com/inflammation/default.aspx

6 Genetics and Genomics in Nursing

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the role of the nurse in integrating genetics and genomics in nursing care.
2. Identify the common patterns of inheritance of genetic disorders.
3. Conduct a comprehensive genetic- and genomic-based assessment.
4. Apply the principles, concepts, and theories of genetics and genomics to individuals, families, groups, and communities.
5. Identify ethical, legal, and social issues in nursing related to genetics and genomics.

NURSING CONCEPTS

Legal Issues
Reproduction

GLOSSARY

carrier: a person who is heterozygous; possessing two different alleles of a gene pair, with one allele typically altered/mutated; therefore, the expression of the altered gene may not be expressed

chromosome: microscopic structures in the cell nucleus that contain genetic information; humans have 46 chromosomes in all somatic cells

deoxyribonucleic acid (DNA): the primary genetic material in humans consisting of nitrogenous bases, a sugar group, and phosphate combined into a double helix

dominant: a genetic trait that is normally expressed when a person has a gene mutation on one of a pair of chromosomes and the "normal" form of the gene is on the other chromosome

epigenetics: the study of changes in gene expression that are not directly related to changes in the DNA genetic code

genetics: the scientific study of heredity; how specific traits or predispositions are transmitted from parents to offspring

genome: the total genetic complement of an individual genotype

genomics: the study of the human genome, including gene sequencing, mapping, and function

genotype: the genetic structure and the variations therein that a person inherits from their parents

mutation: a heritable alteration in a DNA sequence

nondisjunction: the failure of a chromosome pair to separate appropriately during cell division, resulting in abnormal chromosome numbers in daughter cells

pedigree: a diagrammatic representation of a family history

pharmacogenetics: the study of the safety and efficacy of medication administration based on a person's genotype

phenotype: a person's entire physical, biochemical, and physiologic genetic makeup that generates the physical presentation of the person

preimplantation genetic testing: a testing procedure used to identify genetic alterations in embryos

prenatal screening: testing that is used to identify whether a fetus is at risk for a birth defect (e.g., Down syndrome or spina bifida)

presymptomatic testing: genetic testing that is used to determine whether a person with a family history of a disorder, but no

current symptoms, has the gene mutation (e.g., testing for Huntington disease)

recessive: a genetic trait that is expressed only when a person has two copies of a mutant autosomal gene or a single copy of a mutant X-linked gene in the absence of another X chromosome

variable expression: variation in the degree to which a trait is manifested; clinical severity

X-linked: located on the X chromosome

The completion of the Human Genome Project, which was an international research project focused on identifying and characterizing the DNA of the human genome, generated rapid advances in the application of genetics and genomics in health care, and stimulated the growth of translational genetic research (Khoury, Bowen, Clyne, et al., 2018). This genetic revolution gave rise to understanding how genetics and genomics influence health and to the development of tests and screening tools to diagnose genetic alterations and mutations. **Pharmacogenetics,** the study of the safety and efficacy of medication administration based on a person's genotype, preimplantation genetic testing, a testing procedure used to identify genetic alterations in embryos, and the use of biobanking, the storage of genetic material for research or personal use, are just a few examples of the advances in genetic and genomic technologies since the discovery of the human genome.

The anticipated rapid growth of genetics and genomics led to the creation of the Genetic Information Nondiscrimination Act (GINA), a law created to protect the privacy and confidentiality of a person's genetic information (Rothstein, 2018). The Precision Medicine Initiative is a national effort intended to advance personalized medicine through the understanding of genetic makeup, lifestyle, and the environment (National Institutes of Health [NIH], U.S. National Library of Medicine [NLM], 2019a).

Identification of genetic and genomic factors associated with disease, including gene–gene function and gene–environment interactions, contributes to the development of more effective therapies customized to that person's genetic makeup and the genomic profile of his or her disease. The term **genetics** (i.e., the study of heredity) generally applies to single genes and their impact on relatively rare single gene disorders, whereas **genomics** is the study of the interaction of all genes in the human **genome** (i.e., the total genetic complement of a person), environmental

factors, and their interactions with each other (NIH, National Human Genome Research Institute [NHGRI], 2019a). **Epigenetics** refers to changes in the expression of a given gene due to environmental exposures or personal health activity rather than the alteration of a specific gene (NIH, NLM, 2019b). Over time, epigenetic influences can cause alterations to DNA. Genetic and genomic profiles allow health care providers to prescribe individualized and effective treatment for each patient, to identify and follow individuals at high risk for disease, and to avoid adverse drug reactions (NIH, NLM, 2019a). New genomic-based strategies for disease detection, management, and treatment are being utilized, making personalized medicine a reality (Table 6-1).

TABLE 6-1 Transition from the Medical Era to the Genomic Era of Personalized Medicine

	Medical Era	Genomic Era of Personalized Medicine
Defining characteristics	• Considers single genes • Waits for disease symptoms to appear • Treats symptoms of presenting disease • Uses trial-and-error approach to treatment • Tailors medication administration according to clinical trials	• Considers interaction of genes with each other and the environment • Identifies genetic predisposition and optimizes risk reduction to prevent disease • Treats underlying genetic cause of disease • Uses personalized approach tailored to the genetic/genomic profile of the person and the disease • Adapts medication administration per clinical trials *and* personalized genetic response to medication

Chart 6-1

Essential Nursing Competencies for Genetics and Genomics

Professional Responsibilities

- Recognition of attitudes and beliefs related to genetic and genomic science
- Advocacy for genetic and genomic services
- Incorporation of genetic and genomic technologies and information into practice
- Demonstration of personalizing genetic and genomic information and services
- Providing autonomous, informed genetics- and genomics-related decision making

Professional Practice

- Integrate and apply genetic and genomic knowledge to nursing assessment.
- Identify patients who may benefit from specific genetic and genomic resources, services, or technologies.
- Facilitate referrals for genetic and genomic services.
- Provide education, care, and support related to the interpretation of genetic or genomic tests, services, interventions, or treatments.

Adapted from Consensus Panel on Genetic/Genomic Nursing Competencies (Consensus Panel). (2009). *Essentials of genetic and genomic nursing: Competencies, curricular guidelines, and outcome indicators* (2nd ed.). Silver Spring, MD: American Nurses Association.

To meet the challenges of personalized medicine, nurses must understand how genetics and genomics can influence the health of the patient and the family. Nurses must stay abreast of new genetic and genomic technologies and understand how these influence treatments that support personalized medicine. Nurses are a vital link between the patient and health care services; patients often turn to nurses first with questions about a family history of risk factors, information regarding genetics, and genetic tests and interpretations. The incorporation of genetics and genomics is relevant to all aspects of the nursing process. For instance, genetics and genomics should be included in conducting health assessments, in devising nursing diagnoses (as appropriate) in planning nursing interventions that are specific to the patient and based on the patient's diagnosis and genetic makeup, in implementing interventions that support the identification of and in response to genetic-related health

needs, and in evaluating responses to medications based on pharmacogenetics (Consensus Panel on Genetic/Genomic Nursing Competencies [Consensus Panel], 2009). This chapter offers a foundation for the clinical application of genetic and genomic principles in medical-surgical nursing; outlines the nurse's role in genetic counseling and evaluation; addresses important legal, ethical, and social issues; and provides related information and resources for nurses and patients.

Genomic Framework for Nursing Practice

Nurses' contribution to genomic focused health care offers a holistic perspective that takes into account each person's intellectual, physical, spiritual, social, cultural, biopsychological, ethical, and aesthetic experiences. Because genomics addresses all of the genes of a given person's human genome working together as a whole, genomics expands nursing's holistic view. Genetics and genomics are the basis of normal and pathophysiologic development, human health and disease, and health outcomes. Knowledge and interpretation of genetic and genomic information, gene-based testing, diagnosis, and treatment broaden the holistic view of nursing. It is a professional expectation that nurses understand genetics and genomics, and can apply this information in the clinical setting (American Nurses Association [ANA], 2017; Rogers, Lizer, Doughty, et al., 2017).

The *Essentials of Genetic and Genomic Nursing* (Consensus Panel, 2009) provides a framework for integrating genetics and genomics into nursing practice (Chart 6-1). This document includes a philosophy of care that recognizes when genetic and genomic factors play a role or could play a role in a person's health. This means assessing predictive genetic and genomic factors using family history and the results of genetic tests effectively, informing patients about genetic and genomic concepts, understanding the personal and societal impact of genetics and genomic information, and valuing the privacy and confidentiality of genetics and genomic information. There is also formal consensus regarding higher-level competencies in the application of genetics and genomics for nurses with graduate degrees. In addition, nurses need to be aware of genetic and genomic standards of practice as it relates to their specific area of clinical practice (Kerber & Ledbetter, 2017).

A person's response to genetic and genomic information, genetic testing, or genetic-related conditions may be either empowering or disabling. Genetic and genomic information may stigmatize people if it

affects how they view themselves or how others view them. Nurses help individuals and families learn how genetic traits and conditions are passed on within families as well as how genetic and environmental factors influence health and disease (Consensus Panel, 2009). Nurses facilitate communication among family members, the health care system, and community resources, and they offer valuable support to patients and families. All nurses should be able to apply genetic and genomic knowledge by (ANA, 2017):

- providing basic genetic or genomic information to a patient or family member,
- obtaining family health histories that are inclusive of genetic information for at least three generations,
- conducting physical and developmental assessments and then correlating relevant assessment findings to genetic alterations,
- formulating nursing diagnoses based on actual or potential genetic risk,
- implementing nursing care that is reflective of genetic and genomic competencies,
- facilitating genetic and genomic referrals, and
- collaborating with other health professionals.

For example, when nurses assess patients' cardiovascular risk, they can expand their assessment to include information about family history of hypertension, hypercholesterolemia, clotting disorders, or premature sudden cardiac death. Knowledge that genes are involved in the control of lipid metabolism, insulin resistance, blood pressure regulation, clotting factors, cardiac structure, and vascular lining function helps individualize care based on the patient's genetic and genomic risk profile.

Essential to a genetic and genomic framework in nursing is the awareness of one's attitudes, experience, and assumptions about genetics and genomic concepts and how these are manifested in one's own practice (Consensus Panel, 2009). To develop awareness of these attitudes, experiences, and assumptions, nurses must examine their own:

- Beliefs or values about health as well as family, religious, or cultural beliefs about the cause of illness and how one's values or biases affect understanding of genetic conditions
- Philosophical, theologic, cultural, and ethical perspectives related to health and how these perspectives influence one's use of genetic information or services
- Level of expertise about genetics and genomics

- Experiences with birth defects, chronic illnesses, and genetic conditions, along with one's view of such conditions as disabling or empowering
- Attitudes about the right to access and other rights of individuals with genetic disorders
- View and assumptions about deoxyribonucleic acid (DNA) and beliefs about the value of information about one's risk for genetic disorders
- Beliefs about reproductive options
- View of genetic testing and engineering
- Approach to patients with disability

Integrating Genetic and Genomic Knowledge

Scientific developments and advances in technology have increased our understanding of genetics, promoted prompt genetic screening and genetic testing for common and rare genetic disorders, and improved patient health outcomes (Khoury et al., 2018). Scientists are able to characterize inherited metabolic variations that interact over time and lead to common diseases such as cancer, heart disease, and dementia. The transition from genetics to genomics has increased understanding of how multiple genes act and control biologic processes. Many diseases are the result of a combination of genetic and environmental influences (Khoury, 2019).

Genes and Their Role in Human Variation

Genes are central components of human health and disease. The Human Genome Project has linked basic human genetics to human development, health, and disease (NIH, NHGRI, 2018). Knowledge that specific genes are associated with specific genetic conditions makes diagnosis possible, even in the unborn. Many common conditions have genetic causes, and many more associations between genetics, health, and disease continue to be identified.

Genes and Chromosomes

A person's unique genetic composition, called a **genotype,** is made up of approximately 25,000 genes (NIH, NLM, 2019c). A person's **phenotype** —the observable characteristics or expression of their genotype—

includes physical appearance and other biologic, physiologic, and molecular traits. Environmental influences modify every person's phenotype, even phenotypes with a major genetic component. This concept of genotype and phenotype applies to a person's total genome and the respective traits of their genetic makeup.

The concepts of genotype and phenotype also apply to specific diseases. For example, in hypercholesterolemia, the genotype refers to specific apolipoprotein genes (*LDLR, APOB, LDLRAP1,* or *PCSK9*) that involve mutations in low-density lipoprotein (LDL) receptors which control lipid metabolism (NIH, NLM, 2019d). Whereas, phenotype is characterized by early onset of cardiovascular disease, high levels of LDL, skin xanthomas, and a family history of heart disease. A person's genotype, consisting of normal functioning genes as well as some mutations, is characterized by physical and biologic traits that may predispose to disease.

Human growth and development and disease occur as a result of both genetic and environmental influences and interactions. The contribution of genetic factors may be large or small. For example, in a person with cystic fibrosis or phenylketonuria (PKU), the genetic contribution is significant. In contrast, the genetic contribution underlying a person's response to infection may be less applicable.

A single gene is conceptualized as a unit of heredity. A gene is composed of a segment of **deoxyribonucleic acid (DNA)** that contains a specific set of instructions for making the protein or proteins needed by body cells for proper functioning. Genes regulate both the types of proteins made and the rate at which proteins are produced. The structure of the DNA molecule is referred to as a double helix. The essential components of the DNA molecule are sugar–phosphate molecules and pairs of nitrogenous bases. Each nucleotide contains a sugar (deoxyribose), a phosphate group, and one of four nitrogenous bases: adenine (A), cytosine (C), guanine (G), and thymine (T). DNA is composed of two paired strands, each made up of a number of nucleotides. The strands are held together by hydrogen bonds between pairs of bases (Fig. 6-1).

Genes are arranged in a linear order within **chromosomes,** which are microscopic structures located in the cell nucleus. In humans, 46 chromosomes occur in pairs in all body cells except oocytes (eggs) and sperm, which each contains only 23 unpaired chromosomes. Twenty-two pairs of chromosomes, called *autosomes,* are the same in females and males. The 23rd pair is referred to as the sex chromosomes. A female has

two X chromosomes, whereas a male has one X chromosome and one Y chromosome. At conception, each parent normally gives one chromosome of each pair to their child. As a result, children receive half of their chromosomes from fathers and half from mothers (Fig. 6-2).

Careful examination of DNA sequences from many people shows that these sequences have multiple versions in a population. The different versions of these sequences are called *alleles*. Sequences found in many forms are said to be polymorphic, meaning that there are at least two common forms of a particular gene.

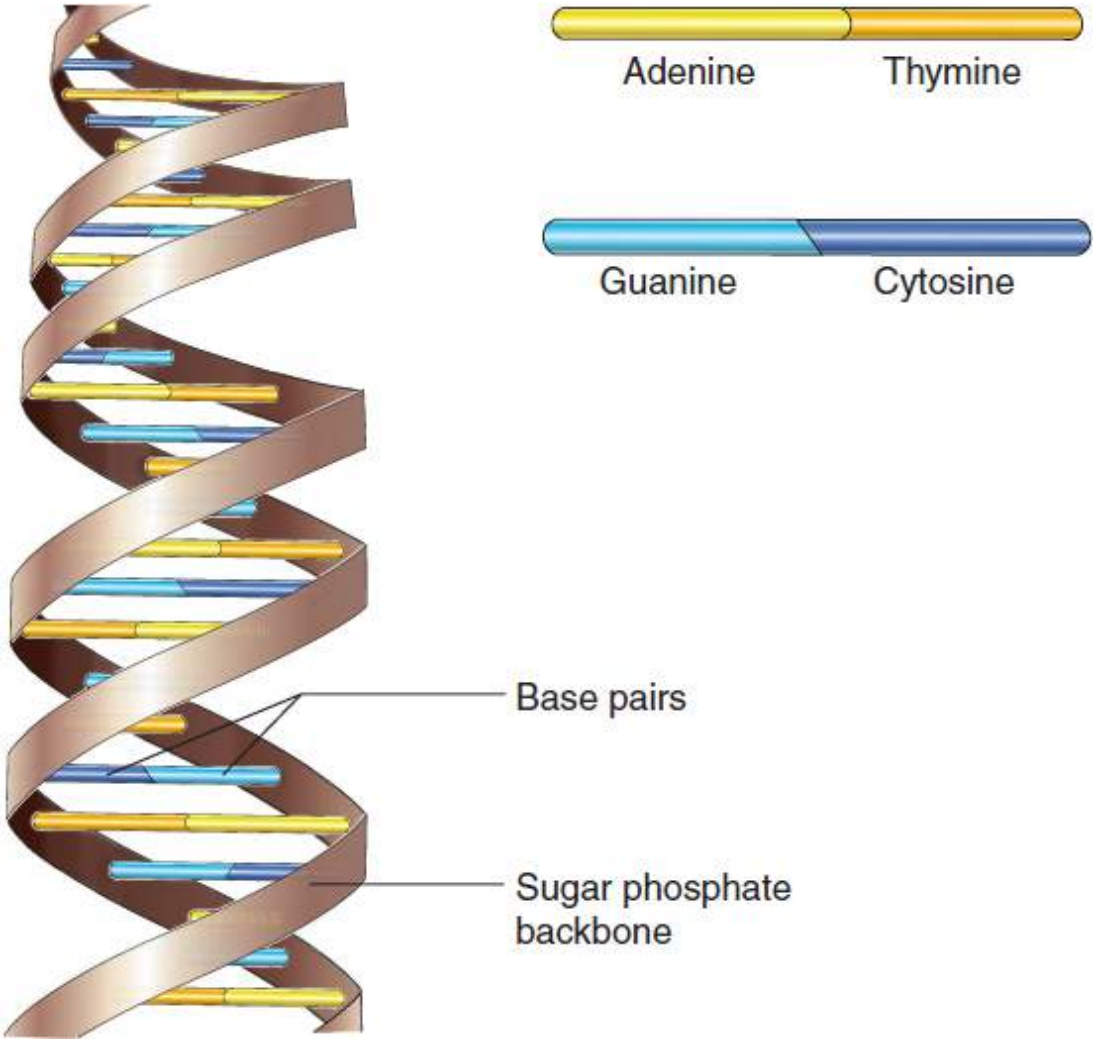

Figure 6-1 • DNA is a double helix formed by base pairs attached to a sugar-phosphate backbone. DNA carries the instructions that allow cells to make proteins. DNA is made up of four chemical bases. Redrawn from Genetics Home Reference, retrieved on 7/29/2020 at www.ghr.nlm.nih.gov/primer/basics/dna

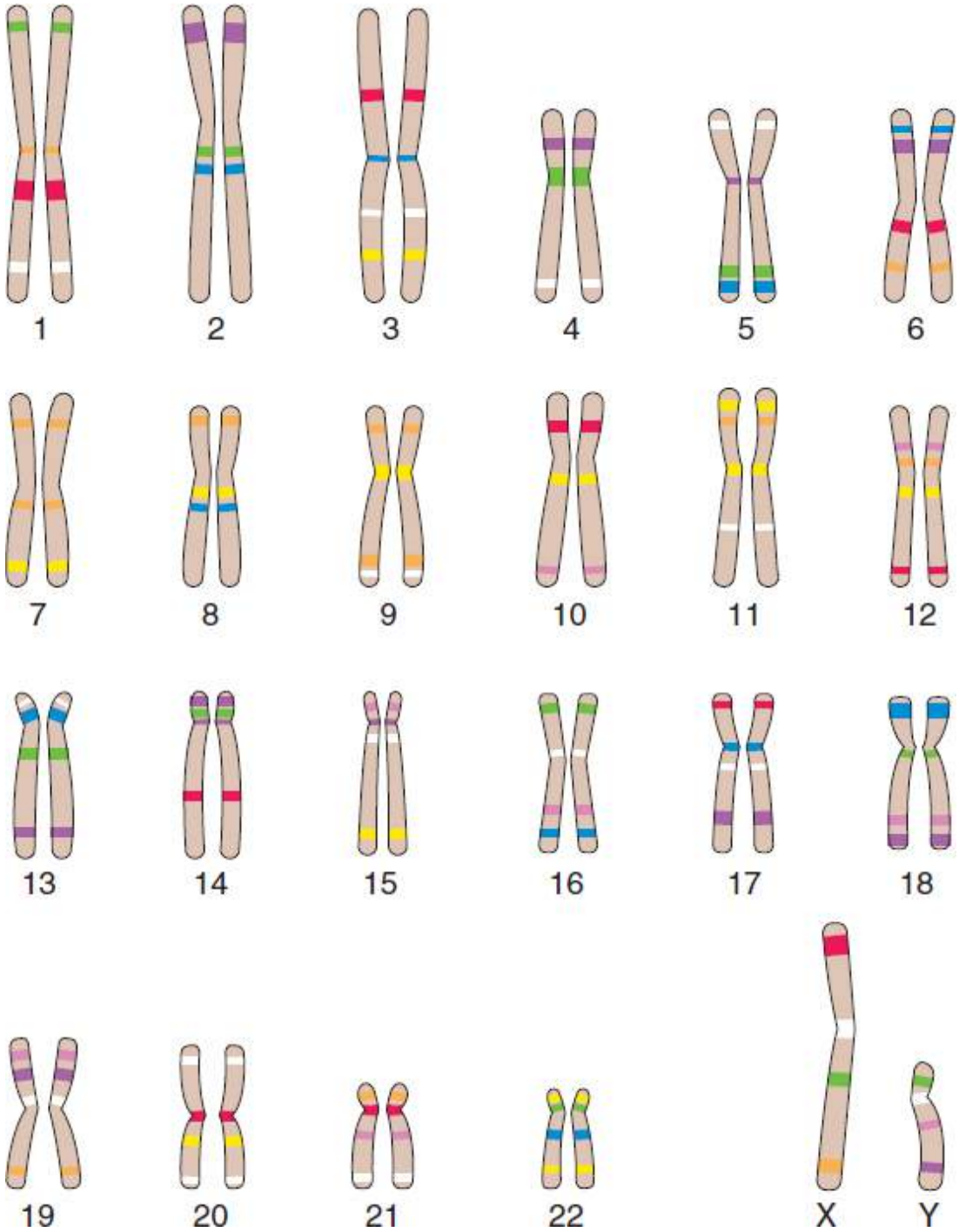

Figure 6-2 • Each human cell contains 23 pairs of chromosomes, which can be distinguished by their size and unique banding patterns. This set is from a male, because it contains a Y chromosome. Females have two X chromosomes.

Cell Division

The human body grows and develops as a result of the process of cell division. Mitosis and meiosis are two distinctly different types of cell

division.

Mitosis is involved in cell growth, differentiation, and repair. During mitosis, the chromosomes of each cell duplicate. The result is two cells, called *daughter cells,* each of which contains the same number of chromosomes as the parent cell. The daughter cells are said to be diploid because they contain 46 chromosomes in 23 pairs. Mitosis occurs in all cells of the body except oocytes and sperm.

Meiosis, in contrast, occurs only in reproductive cells and is the process by which oocytes and sperm are formed. During meiosis, a reduction in the number of chromosomes takes place, resulting in oocytes or sperm that contain half the usual number, or 23 chromosomes. Oocytes and sperm are referred to as haploid because they contain a single copy of each chromosome, compared to the usual two copies in all other body cells. During meiosis, as the paired chromosomes come together in preparation for cell division, portions cross over, and an exchange of genetic material occurs before the chromosomes separate. This event, called *recombination,* creates greater diversity in the makeup of oocytes and sperm.

During the process of meiosis, a pair of chromosomes may fail to separate completely, creating a sperm or oocyte that contains either two copies or no copy of a particular chromosome. This sporadic event, called **nondisjunction,** can lead to either a trisomy or a monosomy (Jackson, Marks, May, et al., 2018). Down syndrome is an example of trisomy, in which people have three copies of chromosome number 21. Turner syndrome is an example of monosomy, in which girls have a single X chromosome, causing them to have short stature and infertility (NIH, NLM, 2019e).

Gene Mutations

Within each cell, many intricate and complex interactions regulate and express human genes. Gene structure and function, transcription and translation, and protein synthesis are all involved. Alterations in gene structure and function and the process of protein synthesis may influence a person's health. Changes in gene structure, called **mutations,** permanently change the sequence of DNA, which in turn can alter the nature and type of proteins made (Fig. 6-3).

Some gene mutations have no significant effect on the protein product, whereas others cause partial or complete changes. How a protein is altered and its importance to body functioning determines the impact of the mutation. Gene mutations may occur in hormones, enzymes, or other

important protein products, with significant implications for health and disease. Sickle cell disease is a genetic condition caused by a small gene mutation that affects protein structure, producing hemoglobin S. A person who inherits two copies of the hemoglobin S gene mutation has sickle cell disease and experiences the symptoms of severe anemia and thrombotic organ damage resulting from hypoxia (NIH, NLM, 2019f).

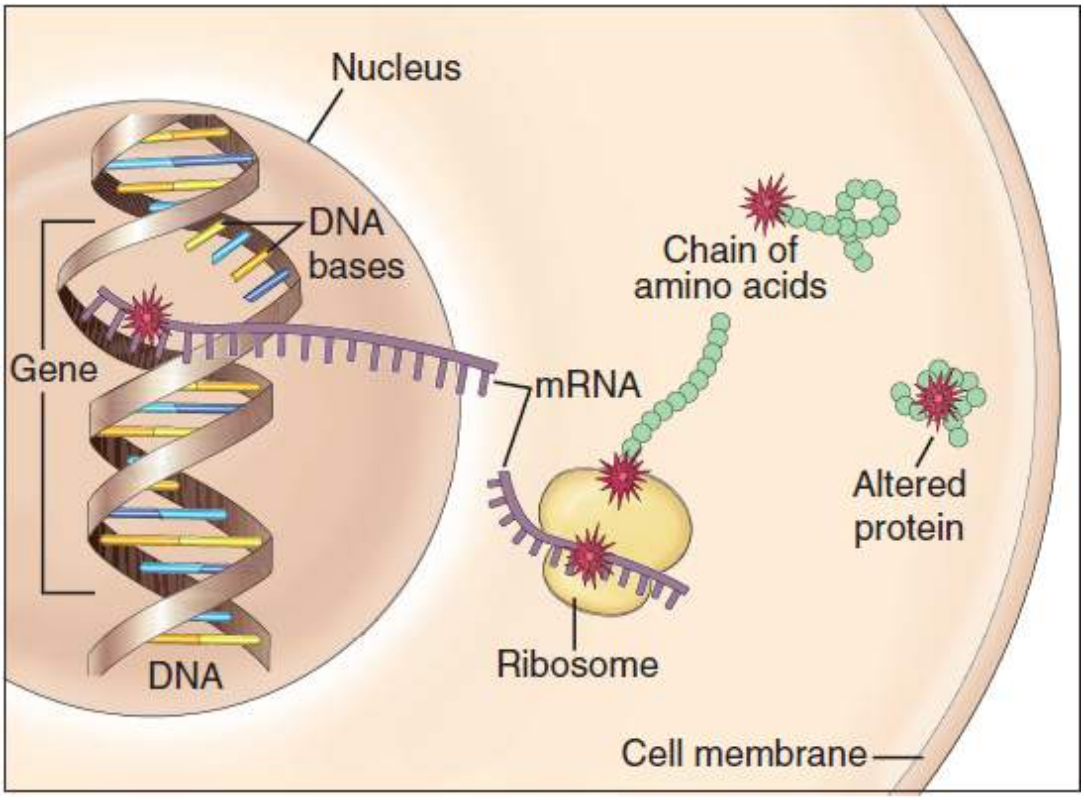

Figure 6-3 • When a gene contains a mutation, the protein encoded by that gene is likely to be abnormal. Sometimes the protein is able to function, although it does so imperfectly. In other cases, it is totally disabled. The outcome depends not only on how the mutation alters the protein's function but also on how vital that particular protein is to survival.

Other gene mutations include deletion (loss), insertion (addition), duplication (multiplication), or translocation (rearrangement) of a longer DNA segment (Jackson et al., 2018). Duchenne muscular dystrophy, myotonic dystrophy, Huntington disease, and fragile X syndrome are examples of conditions caused by gene mutations.

Gene mutations may be inherited or acquired. Inherited or germline gene mutations are present in the DNA of all body cells and are passed on in reproductive cells from parent to child. Germline or hereditary

mutations are passed on to all daughter cells when body cells replicate (Fig. 6-4). The gene that causes Huntington disease is one example of a germline mutation.

Spontaneous mutations take place in individual oocytes or sperm at the time of conception. A person who carries the new "spontaneous" mutation may pass on the mutation to his or her children. Achondroplasia, Marfan syndrome, and neurofibromatosis type 1 are examples of genetic conditions that may occur in a single family member as a result of spontaneous mutation.

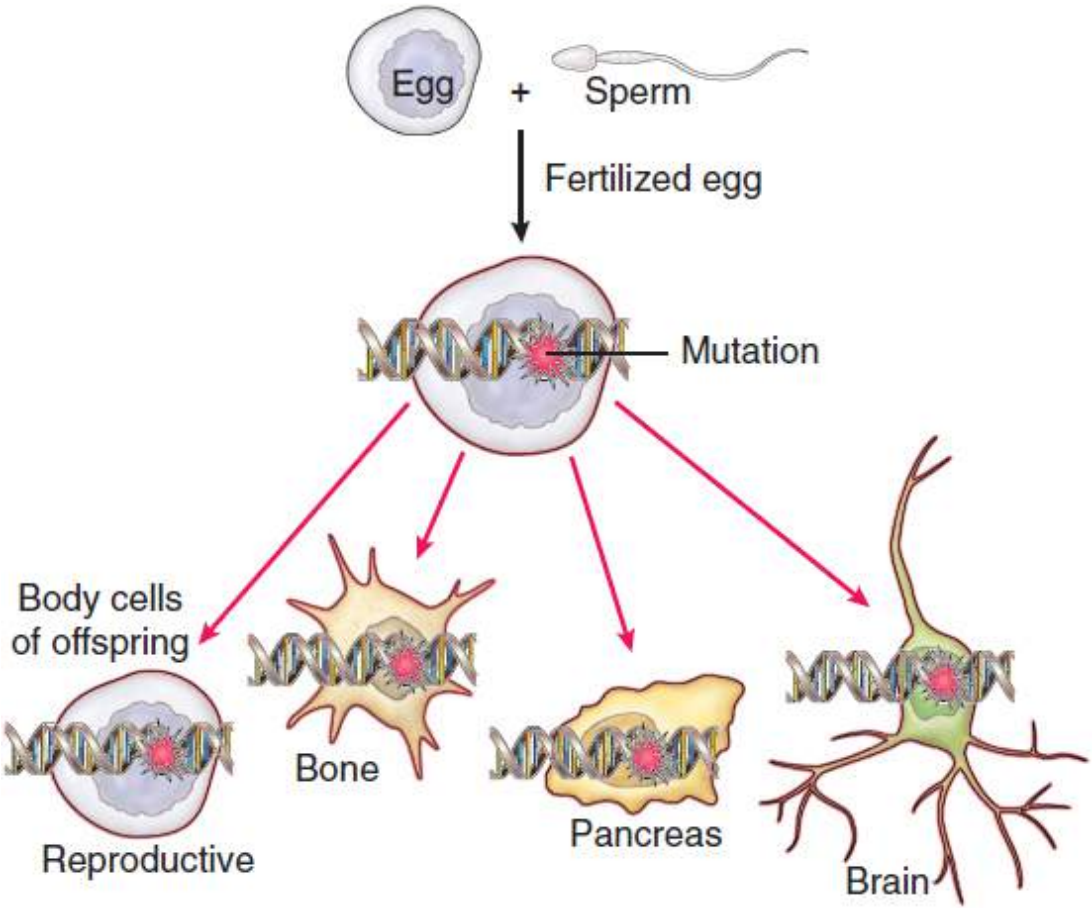

Figure 6-4 • Hereditary mutations are carried in the DNA of the reproductive cells. When reproductive cells containing mutations combine to produce offspring, the mutation is present in all of the offspring's body cells.

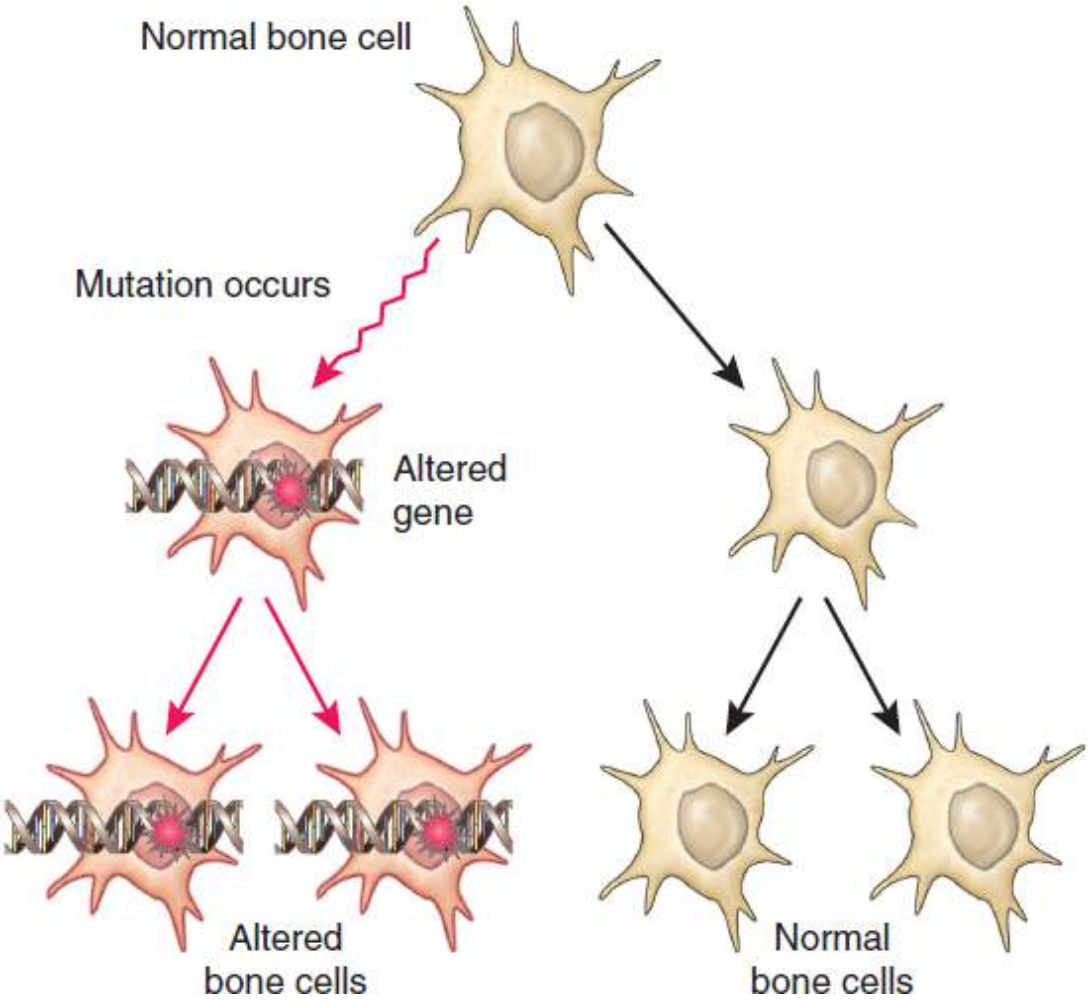

Figure 6-5 • Acquired mutations develop in DNA during a person's lifetime. If the mutation arises in a body cell, copies of the mutation will exist only in the descendants of that particular cell.

Acquired mutations take place in somatic cells and involve changes in DNA that occur after conception, during a person's lifetime. Acquired mutations develop as a result of cumulative changes in body cells other than reproductive cells (Fig. 6-5). Somatic gene mutations are passed on to the daughter cells derived from that particular cell line.

Gene mutations occur in the human body all the time. Cells have built-in mechanisms by which they can recognize mutations in DNA, and in most situations, they correct the changes before they are passed on by cell division. However, over time, body cells may lose their ability to repair damage from gene mutations, causing an accumulation of genetic changes that result in diseases such as cancer, Alzheimer's disease, and disorders associated with aging (Khoury, 2019).

Genetic Variation

Genetic variations occur among all people. Single nucleotide polymorphisms (SNPs, referred to as "snips") is the term used to identify common genetic variations that occur most frequently throughout the human genome (Jackson et al., 2018). SNPs are changes in a single nucleotide (an A, T, C, or G) of the DNA sequence. For example, a normal DNA sequence of A**A**GG could change to ATGG; in this case, there is one single nucleotide change from A to T. Most SNPs do not alter normal cell function. Some SNPs do alter gene function and may influence disease development. Knowledge about SNPs that affect biologic function will help pinpoint individuals who may be more prone to common diseases such as cancer, diabetes, and heart disease. Information on SNPs has helped to clarify why some individuals metabolize drugs differently (Centers for Disease Control and Prevention [CDC], 2018a). For example, a polymorphism or SNP can alter protein or enzyme activity of medications. If the SNP causes a variation in drug transport or drug metabolism, the drug's action, half-life, or excretion could lead to lack of drug response or drug toxicity.

Epigenetics

Epigenetics refers to generational changes within the genetic instruction (NIH, NLM, 2019b). Over time, epigenetic influences can cause cellular change throughout the lifetime of the affected person and be passed on to subsequent generations. Epigenomics, which is the study of epigenetics, is an expanding area of research that correlates epigenetics to cancer, psychiatric disorders, obesity, diabetes, and autoimmune disease (Jackson et al., 2018).

Inheritance Patterns

Nursing assessment of the patient's health includes obtaining and recording family history information in the form of a **pedigree** (i.e., a diagrammatic representation of a family history). This is a first step in establishing the pattern of inheritance. Nurses must be familiar with mendelian patterns of inheritance and pedigree construction and analysis to help identify patients and families who may benefit from further genetic counseling, testing, and treatment (Consensus Panel, 2009).

Mendelian conditions are genetic conditions that are inherited in fixed proportions among generations. They result from gene mutations that are present on one or both chromosomes of a pair. A single gene inherited

from one or both parents can cause a mendelian condition. Mendelian conditions are classified according to their pattern of inheritance: autosomal dominant, autosomal recessive, and X-linked. The terms dominant and recessive refer to the trait, genetic condition, or phenotype but not to the genes or alleles that cause the observable characteristics (Jackson et al., 2018).

Autosomal Dominant Inheritance

The term **dominant** refers to the trait of the gene that is expressed when two genes do not mirror each other on matched chromosomes. Autosomal dominant inherited conditions affect female and male family members equally and follow a vertical pattern of inheritance in families (Fig. 6-6). The presence of an autosomal dominant inherited condition only requires a genetic mutation on one of the chromosomes associated with that pair. Each of that person's offspring has a 50% chance of inheriting the gene mutation for the condition and a 50% chance of inheriting the normal version of the gene (Fig. 6-7). Offspring who do not inherit the gene mutation do not develop the condition and do not have an increased chance for having children with the same condition. Table 6-2 presents characteristics and examples of different patterns of inherited conditions.

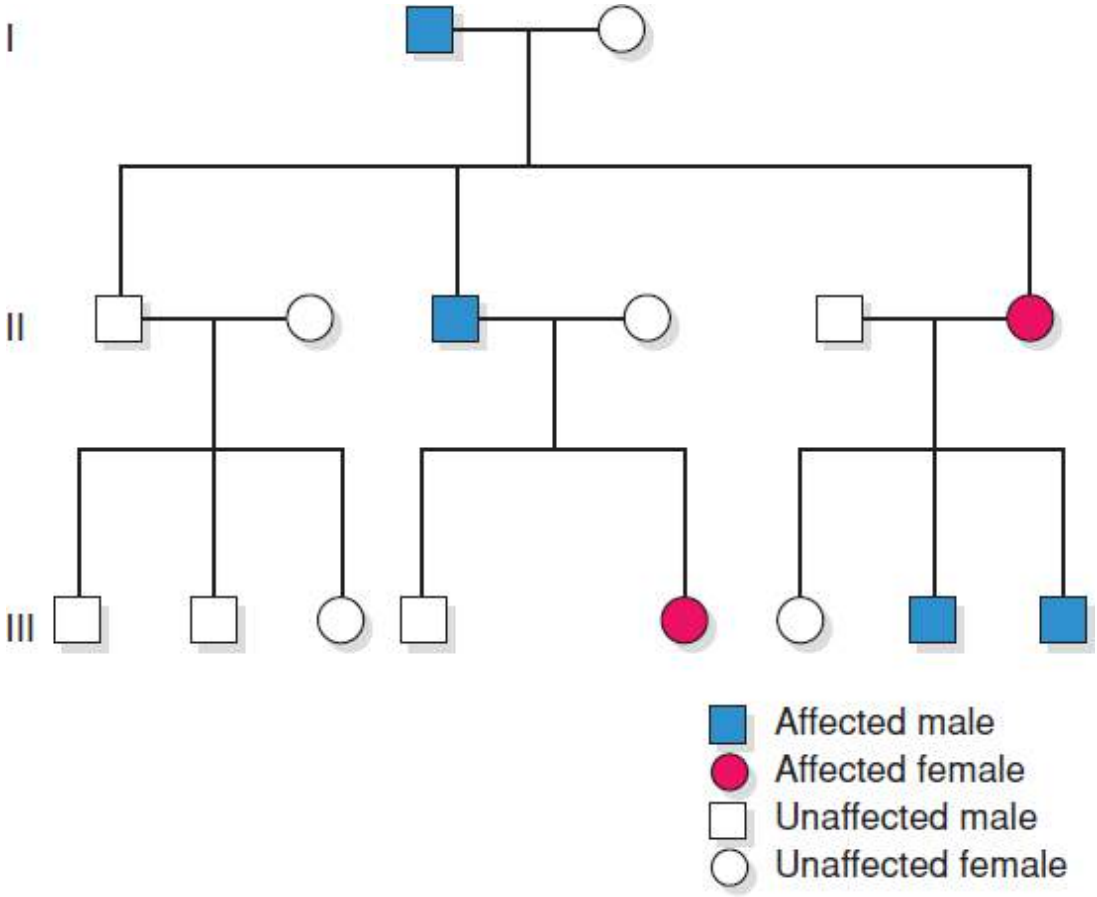

Figure 6-6 • Three-generation pedigree illustrating autosomal dominant inheritance.

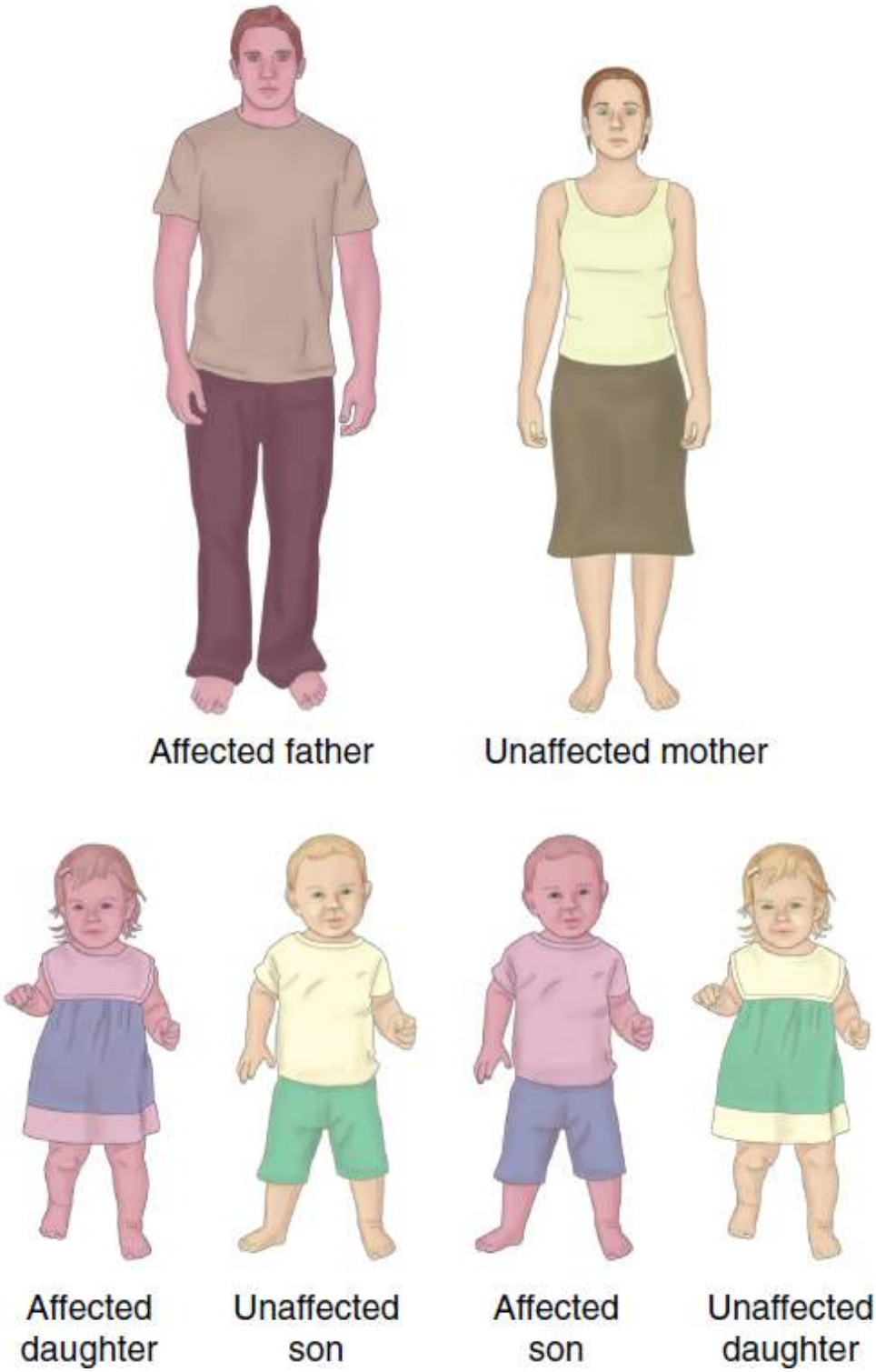

Figure 6-7 • In dominant genetic disorders, if one affected parent has a disease-causing allele that dominates its normal counterpart, each child in the family has a 50% chance of inheriting the disease allele and the disorder.

Autosomal dominant conditions often manifest with varying degrees of severity. Some affected people may have significant symptoms,

whereas others may have only mild ones. This characteristic is referred to as **variable expression;** it results from the influences of genetic and environmental factors on clinical presentation.

Another phenomenon observed in autosomal dominant inheritance is penetrance, or the percentage of people known to have a particular gene mutation who actually show the trait. Almost complete penetrance is observed in conditions such as achondroplasia, in which nearly 100% of people with the gene mutation typically display traits of the disease. However, in some conditions, the presence of a gene mutation does not invariably mean that a person has or will develop an autosomal inherited condition. For example, a woman who has the *BRCA1* hereditary breast cancer gene mutation has a lifetime risk of breast cancer that can be as high as 80%, not 100%. This quality, known as reduced or incomplete penetrance, indicates the probability that a given gene will produce disease. In other words, a person may inherit the gene mutation that causes an autosomal dominant condition but may not have any of the observable physical or developmental features of that condition. However, this person carries the gene mutation and still has a 50% chance of passing the gene for the condition to each of their children (NIH, NLM, 2019g). One of the effects of incomplete penetrance is that the gene appears to "skip" a generation, thus leading to errors in interpreting family history and in genetic counseling.

TABLE 6-2 Patterns of Inheritance

Characteristics	Examples
Autosomal Dominant Inherited Conditions	
Vertical transmission in families Males and females equally affected Variable expression among family members and others with condition Reduced penetrance (in some conditions) Advanced paternal age associated with sporadic cases	Hereditary breast/ovarian cancer syndrome Familial hypercholesterolemia Hereditary non-polyposis colorectal cancer Huntington disease Marfan syndrome Neurofibromatosis
Autosomal Recessive Inherited Conditions	
Horizontal pattern of transmission seen in families Males and females equally affected Associated with consanguinity (genetic relatedness) Associated with particular ethnic groups	Cystic fibrosis Galactosemia Phenylketonuria Sickle cell disease Tay-Sachs disease Canavan disease
X-Linked Inherited Conditions	
Vertical transmission in families Males predominantly affected	Duchenne muscular dystrophy Hemophilia A Wiskott–Aldrich syndrome Color blindness Fragile X
Mitochondrial Inherited Conditions	
Transmission occurs through the mother All children have the condition	Leber's hereditary optic neuropathy Leigh syndrome Kearns–Sayre syndrome
Multifactorial Inherited Conditions	
Occur as a result of combination of genetic and environmental factors May recur in families Inheritance pattern does not demonstrate characteristic pattern of inheritance seen with other mendelian conditions	Congenital heart defects Cleft lip and/or palate Neural tube defects (anencephaly and spina bifida) Diabetes Osteoarthritis High blood pressure Alzheimer's disease Hypothyroidism

Adapted from Learn. Genetics, Genetic Science Learning Center. (2019). Genetic disorders. Retrieved on 8/30/2019 at: www.learn.genetics.utah.edu/content/disorders; National Institutes of Health (NIH), U.S. National Library of Medicine (NLM); Genetics Home Reference. (2015). What are the different ways in which a genetic condition can be inherited? Retrieved on 8/30/2019 at: www.ghr.nlm.nih.gov/primer/inheritance/inheritancepatterns

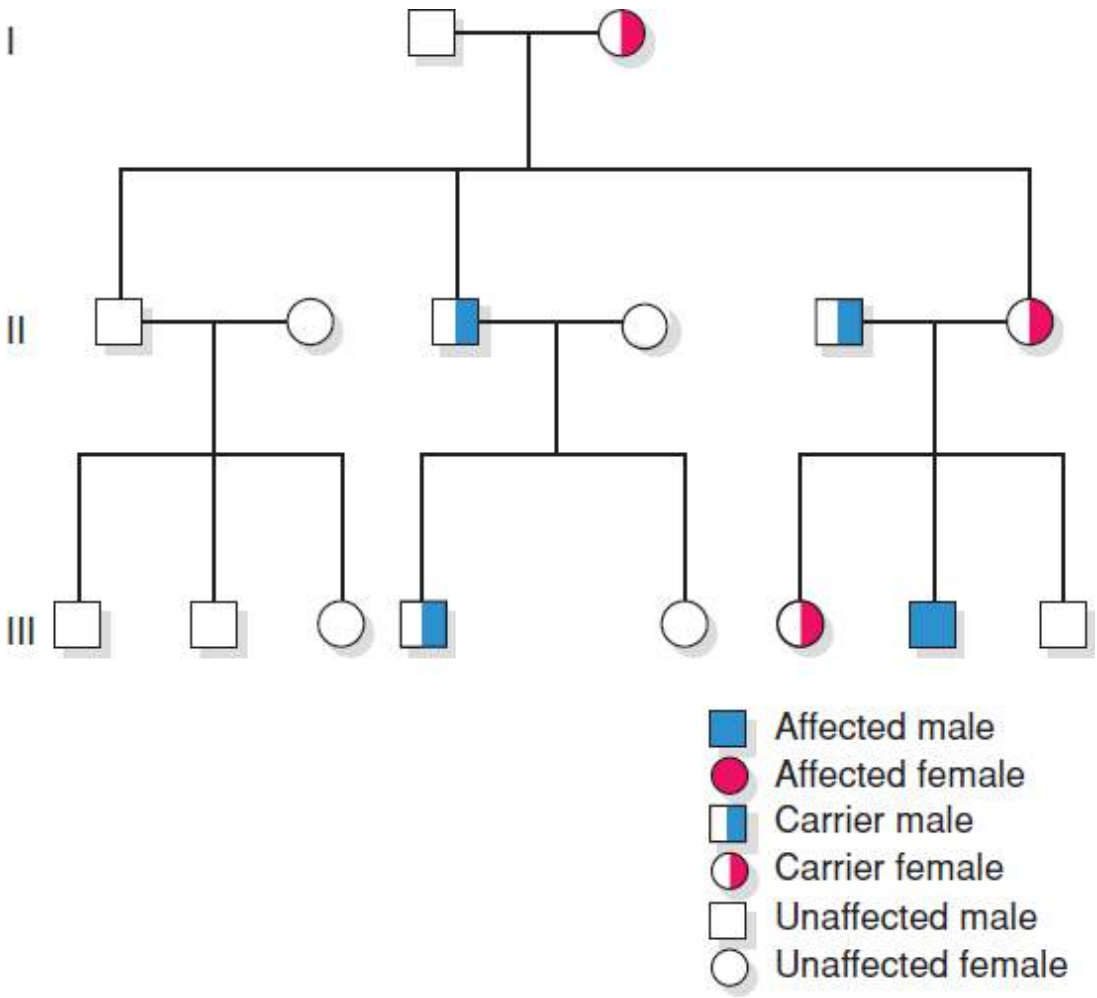

Figure 6-8 • Three-generation pedigree illustrating autosomal recessive inheritance.

Autosomal Recessive Inheritance

The term **recessive** refers to a genetic trait that is expressed only when a person has two copies of a mutant autosomal gene or a single copy of a mutant X-linked gene in the absence of another X chromosome. In contrast to autosomal dominant conditions, autosomal recessive conditions have a pattern that is more horizontal than vertical; relatives of a single generation tend to have the condition (Fig. 6-8). Autosomal recessive conditions are frequently seen among particular ethnic groups

and usually occur more often in children of parents who are related by blood, such as first cousins (see Table 6-2).

In autosomal recessive inheritance, each parent carries a gene mutation on one chromosome of the pair and a normal gene on the other chromosome. The parents are said to be **carriers** of the gene mutation. Unlike people with an autosomal dominant condition, carriers of a gene mutation for a recessive condition do not have symptoms of the genetic condition. When carriers have children together, there is a 25% chance that each child may inherit the gene mutation from both parents and have the condition (Fig. 6-9). Cystic fibrosis, sickle cell disease, and PKU are examples of autosomal recessive conditions (Jackson et al., 2018).

X-Linked Inheritance

X-linked conditions may be inherited in recessive or dominant patterns (see Table 6-2). In both, the gene mutation is located on the X chromosome. All males inherit an X chromosome from mothers and a Y chromosome from fathers for a normal sex constitution of 46, XY. Because males have only one X chromosome, they do not have a counterpart for its genes, as do females. This means that a gene mutation on the X chromosome of a male is expressed even though it is present in only one copy. Females, on the contrary, inherit one X chromosome from each parent for a normal sex constitution of 46, XX. A female may be an unaffected carrier of a gene mutation, or she may be affected if the condition results from a gene mutation causing an X-linked dominant condition. Either the X chromosome that she received from her mother or the X chromosome she received from her father may be passed on to each of her offspring, and this is a random occurrence.

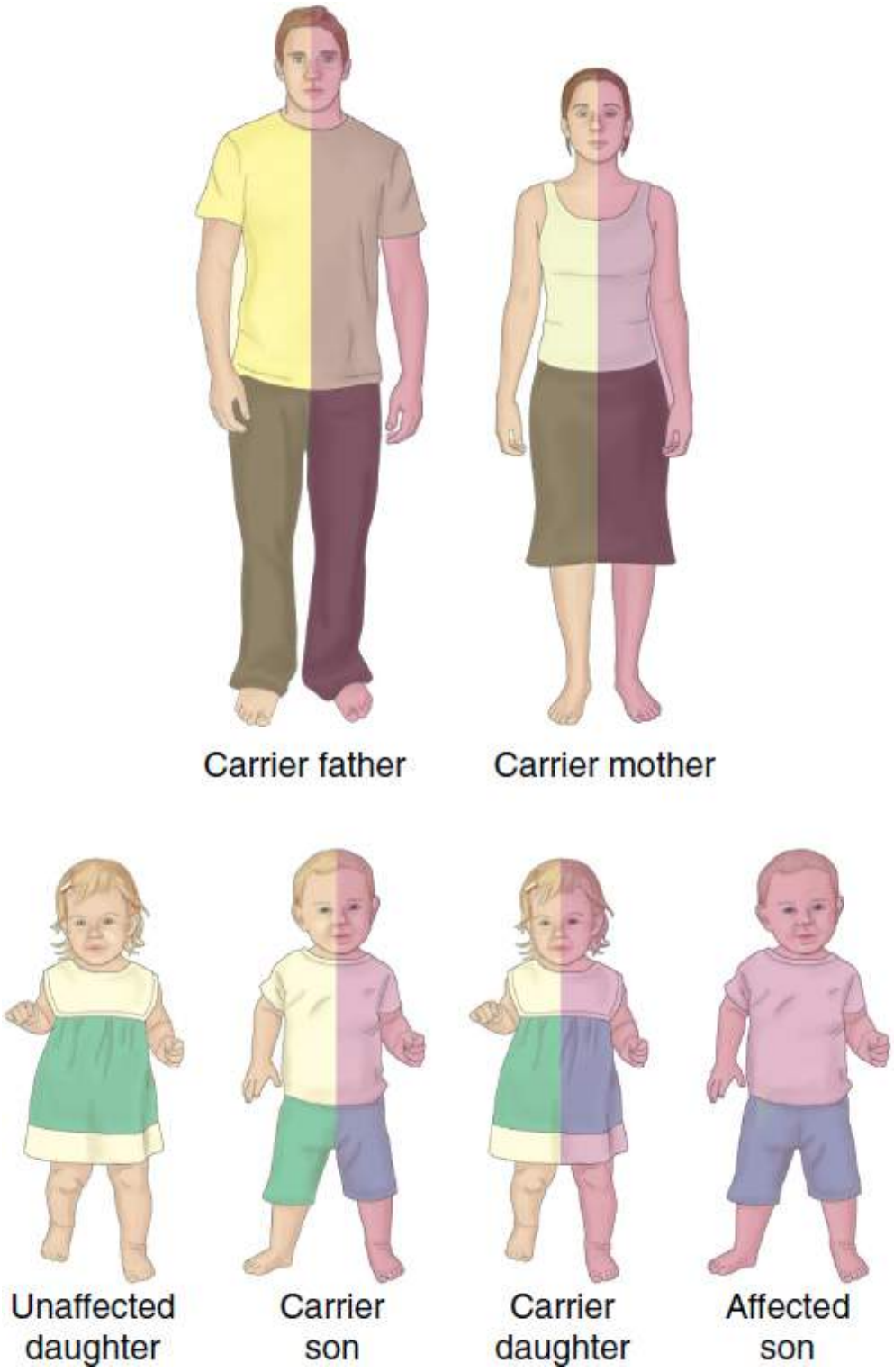

Figure 6-9 • In diseases associated with altered recessive genes, both parents—although disease free themselves—carry one normal allele and one altered allele. Each child has one chance in four of inheriting two abnormal alleles and developing the disorder; one chance in four of inheriting two normal alleles; and two chances in four of inheriting one normal

and one altered allele—therefore, being a carrier like both parents.

The most common pattern of X-linked inheritance is that in which a female is a carrier for a gene mutation on one of her X chromosomes. This is referred to as X-linked recessive inheritance, in which a female carrier has a 50% chance of passing on the gene mutation to a son, who would be affected, or to a daughter, who would be a carrier like her mother (Fig. 6-10). Examples of X-linked recessive conditions include factor VIII and factor IX hemophilia, severe combined immunodeficiency, and Duchenne muscular dystrophy (Jackson et al., 2018).

Mitochondrial Inheritance

The mitochondrium is an organelle, a cellular component associated with generating cellular energy. Although it is not a part of the nucleus, genetic alterations can occur in the mitochondria and be passed to offspring. These disorders are typically associated with muscle or nerve tissue. Unique to mitochondrial inheritance is that only the mother will pass the mitochondrial DNA to her offspring, and thus the genetic disorder to her children, and all of her children will inherit the disorder. Examples of mitochondrial inheritance include Leber's hereditary optic neuropathy, Leigh syndrome, and Kearns–Sayre syndrome (Jackson et al., 2018; see Table 6-2).

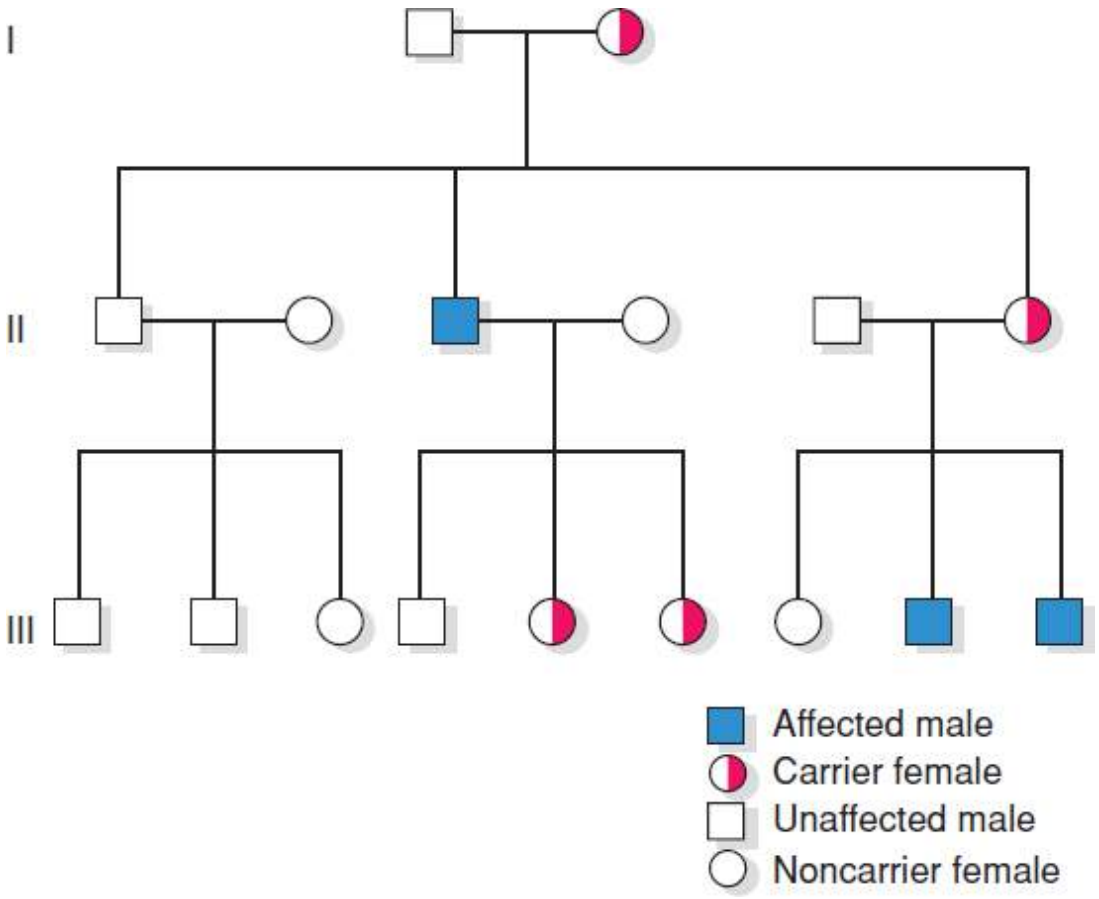

Figure 6-10 • Three-generation pedigree illustrating X-linked recessive inheritance.

Multifactorial Inheritance and Complex Genetic Conditions

Many birth defects and common health conditions such as heart disease, high blood pressure, cancer, osteoarthritis, and diabetes occur as a result of interactions of multiple gene mutations and environmental influences. Thus, they are called *multifactorial* or *complex conditions* (see Table 6-2). Other examples of multifactorial genetic conditions include neural tube defects such as spina bifida and anencephaly. Multifactorial conditions may cluster in families; however, they do not always result in the characteristic pattern of inheritance seen in families who have mendelian inherited conditions (Fig. 6-11).

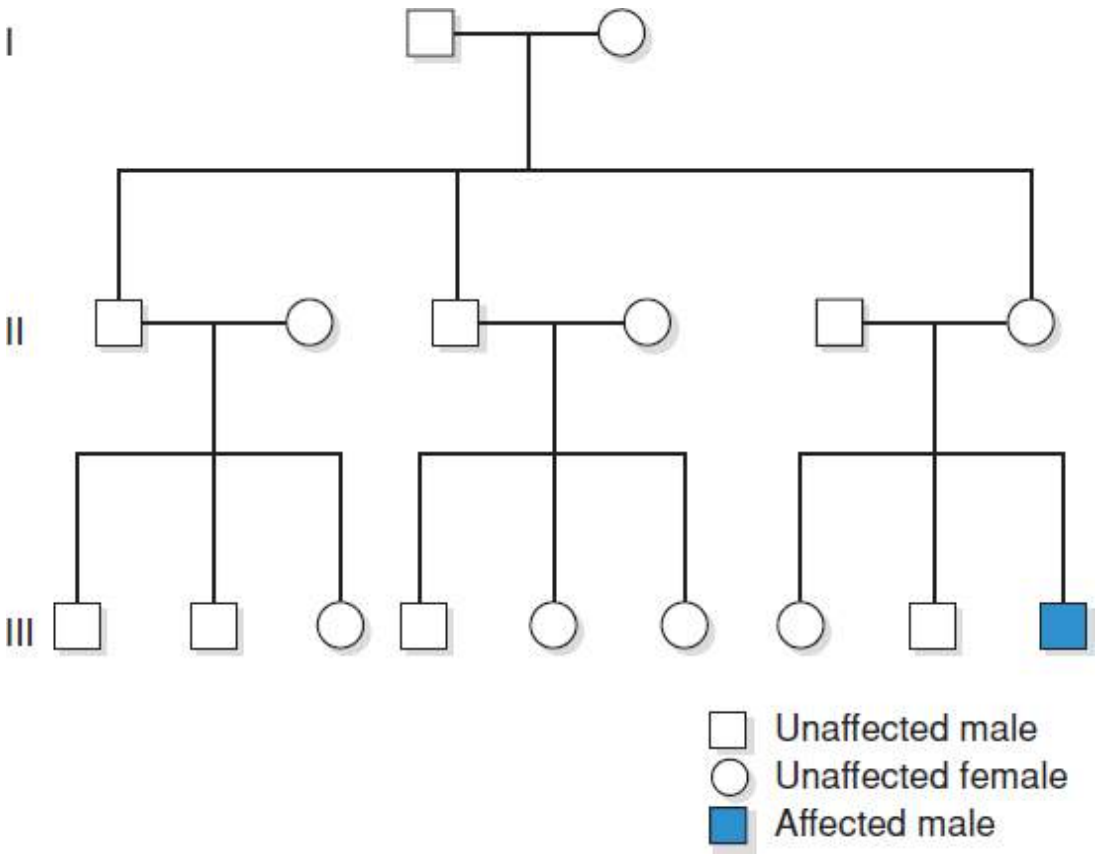

Figure 6-11 • Three-generation pedigree illustrating multifactorial conditions.

Nontraditional Inheritance

Although mendelian conditions manifest with a specific pattern of inheritance in some families, many diseases and traits do not follow these simple patterns. Various factors influence how a gene performs and is expressed. Different mutations in the same gene can produce variable symptoms in different people, as in cystic fibrosis. Different mutations in several genes can lead to identical outcomes, as in Alzheimer's disease. Some traits involve simultaneous mutation in two or more genes. A phenomenon known as genetic imprinting can determine which of a pair of genes (that of the mother or the father) is silenced or activated. This form of inheritance has been observed in Angelman syndrome, a severe form of intellectual disability and ataxia (NIH, NLM, 2019h).

Chromosomal Differences and Genetic Conditions

Differences in the number or structure of chromosomes are a major cause of birth defects, intellectual disability, and malignancies. Chromosomal differences most commonly involve an extra or missing chromosome; this

is called *aneuploidy.* These genetic alterations are neither inherited nor passed down through generations. Whenever there is an extra or missing chromosome, there is always associated intellectual or physical disability to some degree (NIH, National Center for Advancing Translational Sciences [NCATS], 2017).

Down syndrome, or trisomy 21, is a common chromosomal condition that occurs with greater frequency in pregnancies of women who are 35 years of age or older. A person with trisomy 21 has a complete extra chromosome 21, which causes a particular facial appearance and increased risk of congenital heart defects, thyroid and vision problems, and intellectual disability. Other examples of chromosomal differences include trisomy 13 and trisomy 18, both more severe than Down syndrome, and conditions involving extra or missing sex chromosomes, such as Turner syndrome (Jackson et al., 2018).

Chromosomal differences may also involve a structural rearrangement within or between chromosomes. These are less common than chromosomal conditions in which there is an extra or missing chromosome (NIH, NCATS, 2017). People who carry "balanced" chromosome rearrangements have all of their chromosomal material; however, it is rearranged. Women with a "balanced" chromosomal rearrangement have an increased risk of spontaneous pregnancy loss and of having children with an unbalanced chromosomal arrangement that may result in physical or intellectual disability. Known carriers of these chromosomal differences are offered prenatal counseling and testing.

Chromosome studies may be needed at any age, depending on the indication. Two common indications for these studies include a suspected diagnosis of Down syndrome or a history of two or more unexplained pregnancy losses. Chromosome studies are accomplished by obtaining a tissue sample (e.g., blood, skin, and amniotic fluid), preparing and staining the chromosomes, and analyzing them under a microscope. The microscopic study of chromosomes, called *cytogenetics,* is used with molecular techniques such as fluorescent in situ hybridization (FISH), which permits more detailed examination of chromosomes (Jackson et al., 2018). FISH is useful to detect small abnormalities and to characterize chromosomal rearrangements.

Genetic and Genomic Technologies in Practice

Genetic tests are used to detect a trait, to diagnose a genetic condition, or to identify people who have a genetic predisposition to a particular

disease or condition. A plethora of genetic tests are available; some may be purchased directly by the consumer. The Genetic Testing Registry recognizes genetic tests for almost 12,000 genetic conditions (National Center for Biotechnology Information [NCBI], NLM, 2019a). Advances in the application of genetic testing are noted in pharmacogenetics, preimplantation genetic diagnosis, newborn screening, direct-to-consumer testing, and prenatal screening. Forms of genetic testing or genetic screening are available across the lifespan, extending from preimplantation genetic screening during pregnancy to posthumous testing (Bilkey, Burns, Coles, et al., 2019). Future applications may include the use of gene chips to map a person's individual genome for genetic variations that may lead to disease. Nurses are involved in caring for patients who are undergoing genetic testing and gene-based treatments. Knowledge of the clinical applications of modern genetic and genomic technologies enables nurses to inform and to support patients and their family members, and to provide high-quality genetic-related health care.

Genetic Testing

Genetic testing is the primary tool used to identify individuals who are predisposed to specific genetic diseases. Genetic tests provide information leading to the diagnosis of inherited conditions or other conditions with a known genetic contribution.

Approaches to genetic testing may focus on genotype or phenotype. Genotypic methods involve analysis of the chromosomes and genes directly, using specific laboratory techniques to learn whether a genetic alteration related to a specific disease or condition is present. This testing may be DNA based, chromosomal, or biochemical. Awareness of molecular biomarkers that can enhance the sensitivity and specificity of genetic-related tests allows for early detection of genetic illness, and for researchers to understand genetic pathways that may be useful in the treatment of specific disorders (van Lanschot, Bosch, de Wit, et al., 2017). Phenotypic methods examine the familial or biologic presentation of disease and include assessment of the patient's personal or family history and medical factors influencing their disease as well as testing for gene products such as protein markers in body fluids or diseased tissues. The family history, which is considered the first genetic test, is discussed later in this chapter (see the Family History Assessment section). It is

expected that all nurses are able to create and interpret a three-generation family pedigree (Consensus Panel, 2009).

Another phenotypic approach involves searching for gene products, such as proteins and enzymes that can clinically indicate a genetic abnormality. For example, germline mutations in the repair genes *MLH1, MSH2, MSH6,* and *PMS2* are responsible for hereditary early-onset colorectal cancer or Lynch syndrome. Colorectal tumors are now tested to measure the presence or absence of these proteins using immunohistochemistry, which is a routine type of pathology test. Specific colon cancer gene mutations are used to identify other genetic forms of colon cancer which increases the likelihood of cancer in other areas of the body. These include not only Lynch syndrome, but also familial adenomatous polyposis (FAP), Peutz–Jeghers, Cowden syndrome, and juvenile polyposis syndrome (Edwards & Maradiegue, 2018).

Genetic testing can be used for various purposes in prenatal, pediatric, and adult populations. Prenatal testing is widely used for **prenatal screening** and diagnosis of conditions such as Down syndrome. **Preimplantation genetic testing,** a form of prenatal genetic testing, detects the presence of genetic abnormalities in embryos (Parikh, Athalye, Naik, et al., 2018). Carrier testing is used to determine if a person carries a recessive allele for an inherited condition (e.g., cystic fibrosis, sickle cell disease, Tay-Sachs disease) and, therefore, risks passing it on to his or her children. Genetic testing is also used widely in newborn screening. Newborn testing is performed on infants to identify conditions, such as PKU, in which interventions can be implemented to prevent severe outcomes.

Diagnostic testing is used to detect the presence or absence of a particular genetic alteration or allele to identify or confirm a diagnosis of a disease or condition (e.g., myotonic dystrophy, fragile X syndrome) (Chart 6-2). Increasingly, genetic tests are being used to predict drug response and to design specific and individualized treatment plans or personalized medicine. For example, genetic testing is used to identify specific gene variants that can predict the effectiveness of treatments of human immunodeficiency virus infection, atherothrombosis, thrombophilia, hyperlipidemia, breast cancer, pain management, hepatitis C, rheumatoid arthritis, leukemia, depression, and bipolar disorder (NCBI, NLM, 2019b). Select examples of current uses of genetic tests are shown in Table 6-3.

TABLE 6-3 Select Genetic Tests: Examples of Current Uses

Purpose of Genetic Test	Type of Genetic Test
Carrier Testing	
Cystic fibrosis	DNA analysis
Tay-Sachs disease	Hexosaminidase A activity testing and DNA analysis
Canavan disease	DNA analysis
Sickle cell disease	Hemoglobin electrophoresis
Thalassemia	Complete blood count and hemoglobin electrophoresis
Diagnosis	
Down syndrome	Chromosomal analysis
Fragile X syndrome	DNA analysis
Myotonic dystrophy	DNA analysis
Presymptomatic Testing	
Huntington disease	DNA analysis
Myotonic dystrophy	DNA analysis
Susceptibility Testing	
Hereditary breast/ovarian cancer	DNA analysis
Hereditary non-polyposis colorectal cancer	DNA analysis

DNA, deoxyribonucleic acid.

Adapted from National Institutes of Health (NIH), U.S. National Library of Medicine (NLM); Genetics Home Reference. (2019j). Help me understand genetics. Retrieved on 8/30/2019 at: www.ghr.nlm.nih.gov/primer#testing; National Institutes of Health (NIH), U.S. National Library of Medicine (NLM). (2019k). Genetic testing. *MedlinePlus*. Retrieved on 8/30/2019 at: www.medlineplus.gov/genetictsting.html

Chart 6-2 ETHICAL DILEMMA

Can Predictive Genetic Testing Threaten Patient Autonomy?

Case Scenario

M.T., a high school biology teacher, brings her 11-year-old daughter to the family practice clinic where you are employed as the nurse manager. M.T. insists that she wants her daughter to have predictive genetic testing (PGT) for familial adenomatous polyposis (FAP), an autosomal dominant disorder associated with aggressive colorectal cancer that typically evidences pathology during young adulthood. M.T. tells you that her husband's sister, who is 36 years old, was recently diagnosed with FAP and advanced colorectal cancer. She also tells you that she recently discovered that her husband's father and his father's only sibling both died of colorectal cancer before they were 50. Her husband is 34 years old; according to M.T., he has not been seen by a health care provider since he was a teenager and refuses to do so or to be tested for FAP.

Discussion

There are many legal and ethical concerns raised by health care providers regarding PGT in children. Some genetic disorders are not amenable to treatment during childhood (e.g., carrying a *BRCA* genetic mutation, which is associated with various cancers in adulthood). In these instances, it is generally advisable to forego offering PGT to a child until such time that the child reaches adulthood and is able to make the autonomous decision to either be tested or not be tested. The American College of Medical Genetics contends that ultimately, the best interest of the person tested must be the focus of PGT.

In this particular case, it is presumed that the father has not consented to be tested for the FAP genetic mutation. However, should he consent to testing and find out that he does not have the genetic mutation associated with FAP, then the daughter could not have that mutated gene, since it is conferred through autosomal dominant inheritance. By contrast, if the father does carry the gene for FAP, then the daughter would have a 50% chance of having the gene; moreover, if she has the gene, she and her parents should be advised that she should begin screening colonoscopies. Precancerous colonic polyps can be found and excised before they become malignant in children with FAP, which can be a lifesaving treatment.

Analysis

- Describe the ethical principles that are in conflict in this case (see Chapter 1, Chart 1-7). Which principle do you believe should

have preeminence in deciding whether or not parents have the right to have PGT done for a child?
- In this case, do the benefits outweigh the risks of PGT for a child? Would your viewpoint on PGT be different if the child assented to be tested? What if she tells you that she would rather not be tested and wants to follow her father's example?
- Identify the stakeholders in this case. Does the father have the right to forego being tested for the genetic mutation? What if the daughter has PGT performed despite the father's refusal to be tested, and it is found that she has the genetic mutation? In that case, the father must also have the genetic mutation. Does he have the right to be told or to not be told these results and their implications?
- Are there any professional guidelines that you can turn to for help in determining the ethical issues that revolve around PGT? If so, what are they, and how can they help?

References

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Resources

See Chapter 1, Chart 1-10 for Steps of an Ethical Analysis and Ethics Resources.

Nurses are increasingly involved in taking family histories and educating the patient about aspects of genetic testing. They contribute by ensuring informed health choices and consent, advocating for privacy and confidentiality with regard to genetic test results, assessing genetic risk, and helping patients understand the complex issues involved (Edwards & Maradiegue, 2018). The rapid uptake of direct-to-consumer genetic testing mandates that nurses educate patients about the pros and cons of the selected type of genetic testing, navigate the psychosocial needs of patients and their families, and make referrals to genetic specialists as indicated (Mahon, 2018).

Genetic Screening

Genetic screening, in contrast to genetic testing, is performed independent of having a positive family history or symptom manifestation based on a personal risk or based on the person having a risk associated with a specific population or group of people that they belong to. There are multiple forms of genetic screening which are useful at different points across the lifespan. Most commonly, genetic screening occurs in prenatal and newborn programs. For example, shortly after birth, newborns are screened for a variety of conditions, including PKU, congenital hypothyroidism, and galactosemia as a means to identify treatable genetic conditions that could prove dangerous to their health if left untreated. Prenatal genetic screening is provided as a reproductive option to people with a high probability of having children with severe, untreatable diseases and for whom genetic counseling, prenatal diagnosis, and other reproductive options could be helpful. Genetic screening of pregnant women is used to detect birth defects such as neural tube defects and Down syndrome. Cascade screening is a cost-effective strategy to identify those at risk for genetic illness based on the identification of another family member with the disorder (Silva, Jannes, Oliveira, et al., 2018). This form of genetic screening is most useful for autosomal dominant disorders such as familial hypercholesterolemia or Lynch syndrome. The results of genetic screening may also be used for public health purposes to determine the incidence and prevalence of a birth defect or to investigate the feasibility and value of new genetic testing methods. Table 6-4 gives examples of types of genetic screening.

Concept Mastery Alert

Genetic testing and *genetic screening* are terms that are often confused. Nurses need to remember that testing is individual; screening is population based.

TABLE 6-4 Applications for Genetic Screening

Timing of Screening	Purpose	Examples
Preconception/preimplantation screening	Preconception screening may be done to test for autosomal recessive inherited genetic conditions that occur with greater frequency among individuals of certain ethnic groups; furthermore, through the use of in vitro fertilization, embryos may be tested for specific genetic or chromosomal abnormalities	Cystic fibrosis—all couples, but especially northern European Caucasian and Ashkenazi Jewish Tay-Sachs disease—Ashkenazi Jewish Sickle cell disease—African American, Puerto Rican, Mediterranean, Middle Eastern Alpha-thalassemia—Southeast Asian, African American
Prenatal screening	For genetic conditions that are common and for which prenatal diagnosis is available when a pregnancy is identified at increased risk	Neural tube defects—spina bifida, anencephaly Down syndrome Other chromosomal abnormalities—trisomy 18
Newborn screening	For genetic conditions for which there is specific treatment	Phenylketonuria (PKU) Galactosemia Homocystinuria Biotinidase deficiency
Diagnostic screening	To determine whether a specific genetic mutation exists or to confirm diagnosis when phenotypic presentation exists	Hypertrophic cardiomyopathy
Carrier testing	To determine if a person carries a mutated gene; this type of testing is useful for	Cystic fibrosis—all couples, but especially

	couples to ascertain genetic risk of having a child with a genetic disorder; particularly useful with autosomal recessive disorders	northern European Caucasian and Ashkenazi Jewish Tay-Sachs disease—Ashkenazi Jewish Sickle cell disease—African American, Puerto Rican, Mediterranean, Middle Eastern
Predictive testing	For genetic conditions that appear later in life or for genetic disorders that have minimal phenotypic presentation	Colorectal cancer Huntington disease Hemochromatosis

Adapted from National Institutes of Health (NIH), U.S. National Library of Medicine (NLM); Genetics Home Reference. (2019l). What are the types of genetic tests? Retrieved on 8/30/2019 at: www.ghr.nlm.nih.gov/handbook/testing/uses

Population Screening

Population screening—the use of genetic testing for large groups or entire populations—to identify late-onset conditions is under development. For a test to be considered for population screening, there must be (1) sufficient information about gene distribution within populations, (2) accurate prediction about the development and progression of disease, and (3) appropriate medical management for asymptomatic people with a mutation. Currently, population screening is considered in some ethnic groups to identify cancer-predisposing genes. For example, individuals of Ashkenazi Jewish ancestry have a greater chance of inheriting breast and ovarian cancer than other ethnic groups (Manchanda & Gaba, 2019). The identification of one of these mutations gives patients options that may include cancer screening, chemoprevention, or prophylactic mastectomy or oophorectomy. In addition, population screening for this group could also include screening for conditions such as Tay-Sachs disease and Canavan disease. Population screening is being explored for other adult-onset conditions such as type 2 diabetes, heart disease, and hereditary hemochromatosis (i.e., iron overload disorder). In some countries, there is a push to conduct population screening as a form of precision medicine

focused on prevention (Silva et al., 2018; Turnball, Sud, & Houlston, 2019).

Testing and Screening for Adult-Onset Conditions

Adult-onset conditions with a genetic or genomic basis are manifested during adulthood and the disease is clearly observed to run in families. Some conditions typically associated with advanced age that manifest earlier in life may also have a genetic correlation and require further examination. For example, hypercholesterolemia is often considered an adult-onset disorder associated with a diet high in fat. A form of hypercholesterolemia with excessively high cholesterol levels and lack of lifestyle risk factors correlates with a genetic alteration referred to as familial hypercholesterolemia (Knowles, Rader, & Khoury, 2017). This is an autosomal dominant disorder, suggesting that there is a 50% likelihood that each child of a parent with the disorder will inherit this disorder. Cascade screening of children of parents with familial hypercholesterolemia would be indicated to identify whether or not they have the disorder so that they may be promptly identified and treated (Setia, Saxena, Sawhney, et al., 2018). Adult-onset genetic conditions can be attributed to specific genetic mutations and follow either an autosomal dominant or an autosomal recessive inheritance pattern; however, most adult-onset conditions are considered to be genomic or multifactorial—that is, they result from a combination of genes or gene–environment interactions. Examples of multifactorial conditions include heart disease, diabetes, and arthritis. Genomic or multifactorial influences involve interactions among several genes (gene–gene interactions) and between genes and the environment (gene–environment interactions), the person's lifestyle. Furthermore, some adult-onset conditions occur due to sporadic changes to a gene (Gael & Veltman, 2019).

Nursing assessment for adult-onset conditions is based on family history, personal and medical risk factors, and identification of associated diseases or clinical manifestations (the phenotype). Knowledge of adult-onset conditions and their genetic bases (i.e., mendelian vs. multifactorial conditions) influences the nursing considerations for genetic testing and health promotion. Table 6-5 describes select adult-onset conditions, their age of onset, patterns of inheritance, molecular genetics, and test availability.

Single Gene Conditions

If a single gene accounts for an adult-onset condition in a symptomatic person, testing is used to confirm a diagnosis to assist in the plan of care and management. Diagnostic testing for adult-onset conditions is most frequently used with autosomal dominant conditions, such as Huntington disease or Factor V Leiden thrombophilia, and with autosomal recessive conditions such as hemochromatosis. Other single gene conditions are associated with a confirmed genetic mutation in an affected family member or with a family history suggestive of an inherited pattern of adult-onset disease, such as a particular type of cancer. **Presymptomatic testing** provides information to people without symptoms about the presence of a genetic mutation and about the likelihood of developing the disease. Presymptomatic testing is considered for people in families with a known adult-onset condition in which either a positive or a negative test result indicates an increased or reduced risk of developing the disease, affects medical management, or allows earlier treatment of a condition.

Huntington disease has long served as the model for presymptomatic testing because the presence of the genetic mutation predicts disease onset and progression. Although preventive measures are not yet available for Huntington disease, the genetic information enables health care providers to develop a clinical, supportive, and psychological plan of care. Indeed, the presence of a single gene mutation has implications for the risk of developing many types of cancer; therefore, presymptomatic testing has become more common as a means to start early planning and implementation of select medical measures that may reduce that risk (Edwards & Maradiegue, 2018).

Genomic Conditions

The foremost factor that may influence the development and severity of disease is a person's genomic makeup. In the absence of a single disease-causing gene, it is thought that multiple genes and other environmental factors are related to the onset of most adult diseases. For some diseases, the interactions among several genes and other environmental or metabolic events affect disease onset and progression. Specific gene–gene interactions or SNPs can confer susceptibility to disease. Genomic testing helps distinguish variations within the same disease or response to treatment. For example, no single gene is associated with osteoporosis. Several polymorphisms on candidate genes related to the vitamin D receptor, estrogen and androgen receptors, and regulation of bone mineral

density (BMD) have been shown to contribute to osteoporosis and fracture risk. Moreover, diet and exercise have a strong interaction with the polymorphisms regulating BMD (Cho, Lee, & Kang, 2017).

TABLE 6-5 Select Adult-Onset Disorders

Clinical Description	Age of Onset	Genetic Inheritance	Associated Gene	Test Availability
Neurologic Conditions				
Alzheimer's Disease Progressive dementia, memory failure, personality disturbance, loss of intellectual functioning associated with cerebral cortical atrophy, beta-amyloid plaque formation, and intraneuronal neurofibrillary tangles	<60–65 y, often <55 y	A.D.	*APOE* *PSEN1* *APP* *PSEN2*	Presymptomatic and diagnostic
Parkinson's Disease Dementia and/or parkinsonism: Slowly progressive behavioral changes, language disturbances and/or extrapyramidal signs, rigidity, bradykinesia, and saccadic eye movements	40–60 y	A.D.	*MAPT* *PARK*	Diagnostic and presymptomatic
Huntington Disease Widespread degenerative brain change with progressive motor loss both voluntary disability and involuntary disability, cognitive decline, chorea (involuntary movements) at later stage, psychiatric disturbances	Mean age, 35–44 y	A.D.	*HTT*	Diagnostic and presymptomatic
Neuromuscular Disorders				
Spinocerebellar Ataxia Type 6 Progressive cerebellar ataxia, dysarthria, nystagmus, bulbar dysfunction, peripheral neuropathy, decreased deep tendon reflexes, dementia	Mean age, 30–52 y	A.D.	*CACNA1A* *ATXN*	Diagnostic and presymptomatic
Myotonic Muscular Dystrophy Type 1 Cataracts and myotonia or muscle wasting and weakness, frontal balding and electrocardiographic changes (heart block or arrhythmia), diabetes in 5% of all cases	20–70 y	A.D. with variable penetrance	*DMPK* *CNBP*	Diagnostic
Familial Amyotrophic Lateral Sclerosis Progressive loss of motor function with predominantly lower motor neuron manifestations	45–60 y	Both A.D. and A.R.	*ALS1* *ALS2* *SOD1* *SETX*	Diagnostic

Hematologic Conditions				
Hereditary Hemochromatosis High absorption of iron by gastrointestinal mucosa resulting in excessive iron storage in liver, skin, pancreas, heart, joints, and testes. Abdominal pain, weakness, lethargy, and weight loss are early symptoms. Untreated individuals can present with skin pigmentation, diabetes, hepatic fibrosis or cirrhosis, congestive heart failure, arrhythmias, or arthritis.	40–60 y in males; after menopause in females	A.R.	*HFE*	Diagnostic and presymptomatic
Factor V Leiden Thrombophilia Poor anticoagulant response to activated protein C with increased risk for venous thromboembolism and increased risk for fetal loss during pregnancy	30s; during pregnancy in females	A.D.	*F5*	Diagnostic and presymptomatic
Polycystic Kidney Disease Dominant Most common genetic disease in humans. Manifests with renal cysts, liver cysts, and occasionally intracranial/aortic aneurysm and hypertension. Loss of glomerular filtration can lead to kidney failure.	Variable onset; all carriers have detectable disease by ultrasonography at age 30 y	A.D.	*PKD1* *PKD2*	Diagnostic and presymptomatic
Cardiovascular Disease				
Familial Hypercholesterolemia Elevated low-density lipoprotein levels leading to coronary artery disease, xanthoma, and corneal arcus	40–50 y	A.D.	*LDLR* *PCSK* *APOB*	Diagnostic
Hyperlipidemia Elevated cholesterol and triglycerides associated with premature coronary disease and peripheral vascular disease	30–40 y	A.R.	*APOE* *APOA*	Clinical testing related to Alzheimer's/ research
Alpha$_1$-Antitrypsin Deficiency Small airway and alveolar wall destruction; emphysema, especially at base; chronic obstructive pulmonary disease	35-year-old smoker; 45-year-old nonsmoker	M.F. in A.R. fashion	*SERPINA-1*	Diagnostic and presymptomatic
Oncology Conditions				
Multiple Endocrine Neoplasia Familial medullary thyroid cancer: Medullary thyroid cancer, pheochromocytoma, and parathyroid abnormalities	Early adulthood 40–50 y	A.D.	*MEN1* *MEN2*	Presymptomatic
Breast Cancer *BRCA1/2* hereditary breast/ovarian cancer: Breast, ovarian, prostate, and colon (*BRCA1*); breast, ovarian, and other cancers (*BRCA2*)	30–70 y; often <50 y	A.D.	*BRCA1* *BRCA2*	Presymptomatic Presymptomatic
Lynch Syndrome Colorectal, endometrial, bladder, gastric, biliary, and renal cell cancers as well as atypical endometrial hyperplasia and uterine leiomyosarcoma	<50 y	A.D.	*MLH1* *MSH2* *MSH6* *PMS2*	Presymptomatic and diagnostic
Li–Fraumeni Syndrome Soft tissue sarcoma, breast cancer, leukemia, osteosarcoma, melanoma, and other cancers often including colon, pancreas, adrenal cortex, and brain	Often <40 y	A.D.	*TP53* *CHEK2*	Presymptomatic and diagnostic
Cowden Syndrome Breast, nonmedullary (papillary or follicular) thyroid cancer; breast fibroadenomas and noncancerous thyroid nodules or goiter; multiple buccal mucosa papillomas (cobblestone-like papules), facial trichilemmomas, gastrointestinal polyps; high-arched palate, thickened furrowed tongue, megalencephaly, and pectus excavatum	40–50 y for cancer; teens—20 y for mucocutaneous lesions	A.D.	*PTEN*	Presymptomatic and research

AD, autosomal dominant; AR, autosomal recessive; ME multifactorial.
Adapted from National Center for Biotechnology Information (NCBI), U.S. National Library of Medicine (NLM). (2019a). Genetic Testing Registry. Retrieved on 8/30/2019 at: www.ncbi.nlm.gov/gtr

Some genomic tests may predict treatment response. For example, people may present with similar clinical signs and symptoms of asthma but have different responses to corticosteroid treatment. Mutations in genes that regulate corticosteroid receptors can help classify people with asthma as sensitive or resistant to treatment with corticosteroids (NCBI, NLM, 2019b).

The Nursing Role in Testing and Screening for Adult-Onset Conditions

Nurses participate in explaining risk and genetic predisposition, supporting informed health decisions and opportunities for prevention and early intervention, clarifying legal protections and risks related to genetic testing or health concerns, and protecting patients' privacy. Nurses assess family histories, which may indicate that multiple generations (autosomal dominant inheritance) or multiple siblings (autosomal recessive inheritance) are affected with the same condition or that onset of disease is earlier than expected (e.g., multiple generations with early-onset hyperlipidemia). Possible adult-onset conditions are discussed with other members of the health care team for appropriate resources and referral. When a family history of disease is identified, a patient is made aware that this is a risk factor for disease; resources and referral are then provided. It is the patient's decision whether or not to pursue a genetic testing workup. For example, if a 45-year-old woman presents for her annual gynecology visit and reports a family history of colon cancer in multiple paternal relatives, including her father, the nurse should discuss the family history with the gynecologist. In addition, the woman should be alerted to the risk of colon cancer on the basis of the family history and given information about possible genetic testing and referral for a colonoscopy.

If the existence of a mutation for an adult-onset condition in a family is identified, at-risk family members can be referred for cascade screening for a specific genetic disorder based on genetic susceptibility or genetic predisposition. If the patient is found to carry the mutation, the nurse provides them with information and referral for risk-reduction measures and educates the person about the risk to other family members. In that discussion, the nurse assures the patient that the test results are private and confidential and will not be shared with others, including family members, without the patient's permission. If the patient is an unaffected family member, the nurse discusses inheritance and the risk of developing the disease, provides support for the decision making process, and offers referral for genetics services.

Concept Mastery Alert

Cascade screening is used for at-risk family members if the existence of a mutation for an adult-onset condition in a family is identified. Presymptomatic testing provides information to people without symptoms about the presence of a genetic mutation and about the likelihood of developing the disease.

Personalized Genomic Treatments

Information about genes and their variations helps researchers identify genetic differences that predispose certain people to more aggressive diseases and affect their responses to treatment. Genetics and genomics have revolutionized the field of oncology because genetic mutations are the basis for the development and progression of all cancers. In the medical era, individuals with cancer faced treatment based on the stage of the cancer, lymph node involvement, and spread to distant organs. Treatments of a particular type of cancer, stage for stage, were similar. Now, in the genomic era of personalized medicine, cancer is treated on the basis of genetic makeup. For example, women with early stage breast cancer (i.e., tumor diameter less than 2 cm, estrogen receptor–positive tumors, no lymph node involvement) have often received chemotherapy. In the past, deciding which of these women would benefit the most from chemotherapy was unclear. Currently, a gene tumor profile of these women's tumors can be used to predict which women are more likely to have an aggressive cancer. Genetic testing helps clinicians to provide personalized care and the most effective treatment based on the genetic signature of the tumor treatment, called *targeted therapy,* which tries to match the treatment to the specific malfunctioning genes expressed in the tumor, or to selectively inhibit genetic factors that promote cancer growth (Dodson, 2017; National Cancer Institute, 2019). Progressive personalized genomic treatment has expanded into genome editing, known as CRISPR (clustered regularly interspaced short palindromic repeats), which shows promise for single gene disorders and cancer by repairing, replacing, or deleting genes that are altered or damaged (Foss, Hochstrasser, & Wilson, 2019).

Pharmacogenomics

The difference between genetics and genomics, described earlier in this chapter, corresponds to the terms *pharmacogenetics* and

pharmacogenomics, which combine pharmacology and genetics or genomics. Pharmacogenetics refers to the study of the effect of variations in a single gene on drug response and toxicity. The field of pharmacogenetics has evolved so that it has become a broader genomic-based approach that recognizes the interaction of multiple genes and the environment on drug response. Pharmacogenomics refers to the study of the combined effect of variations in many genes on drug response and toxicity and involves methods that rapidly identify which genetic variations influence a drug's effect. The aim of pharmacogenomics is to deliver safe, effective medication and dosages that are specifically tailored to a person's genetic makeup (Dodson, 2017). The clinical application of pharmacogenetics has provided a better understanding of drug pathways, leading to the development of new drugs that do not have toxic side effects and that have the potential to change current standards of treatment (Conyers, Devaraja, & Elliott, 2018; Mannino, Andreozzi, & Sesti, 2019; Pickard, 2017). Drug pathways target specific gene biomarkers to elicit a specific and therapeutic response (U.S. Food and Drug Administration [FDA], 2019).

It has long been known that patients differ in their response to medications. The genetic and genomic variations in drug metabolism account largely for the differences in drug response and drug-related toxicities. Drug metabolism involves genetically controlled protein/enzyme activity for absorption, distribution, drug–cell interaction, inactivation, and excretion—metabolic processes that are known as pharmacokinetics. The cytochrome P450 (CYP) genes play a key role in the pharmacokinetic process of drug metabolism (Clinical Pharmacogenetics Implementation Consortium [CPIC], 2019). Once a drug reaches its target cell, other genes such as those regulating cell receptors and cell signaling control the drug's effect. This process is known as pharmacodynamics. Single genes may affect drug response. More commonly, drug response involves the interaction of multiple genes, the host, and the effects of other drugs. Figure 6-12 is a schematic display of the genetic and genomic influences on drug metabolism and treatment effect.

SNPs, described earlier, are common genetic variations that occur most frequently throughout the human genome and often contribute to variations in enzymatic activity that affect drug metabolism. The CYPs, a family of enzymes, play a key role in the pharmacokinetic process of drug metabolism. Numerous variations (SNPs) of genes that control CYP activation and deactivation have been identified. Researchers have created

a catalog of CYP variations because of their role in drug metabolism (CPIC, 2019).

Four classes of CYP metabolic activity levels have been identified based on a person's CYP genotype and the corresponding drug response: (1) poor metabolizers, (2) intermediate metabolizers, (3) extensive metabolizers, and (4) ultrarapid metabolizers. Poor metabolizers have a specific SNP variation in a CYP gene that causes little or no function, resulting in very little or no drug metabolism and higher blood levels of active drug because the drug cannot be absorbed or excreted. Conversely, ultrarapid metabolizers have SNP variations that cause increased enzyme activity, resulting in rapid absorption, distribution, and excretion of a drug. Ultrarapid metabolizers have lower drug blood levels, usually with inadequate therapeutic response or longer treatment time to achieve therapeutic results. Both poor metabolizers and ultrarapid metabolizers are predisposed to adverse drug reactions. Poor metabolizers may have adverse effects or toxicities from high blood levels of drugs and need a lower dose, whereas ultrarapid metabolizers have inadequate treatment response because of lower drug blood levels and may need a higher dose or more frequent dosing. Intermediate metabolizers have reduced enzyme activity levels and metabolize drugs at a slower than normal rate. Because intermediate metabolizers have some enzyme activity, they may have differences in treatment response. Extensive metabolizers have normal enzyme activity levels and normal drug metabolism. Differences in metabolism of other medications occur with other genetic variations.

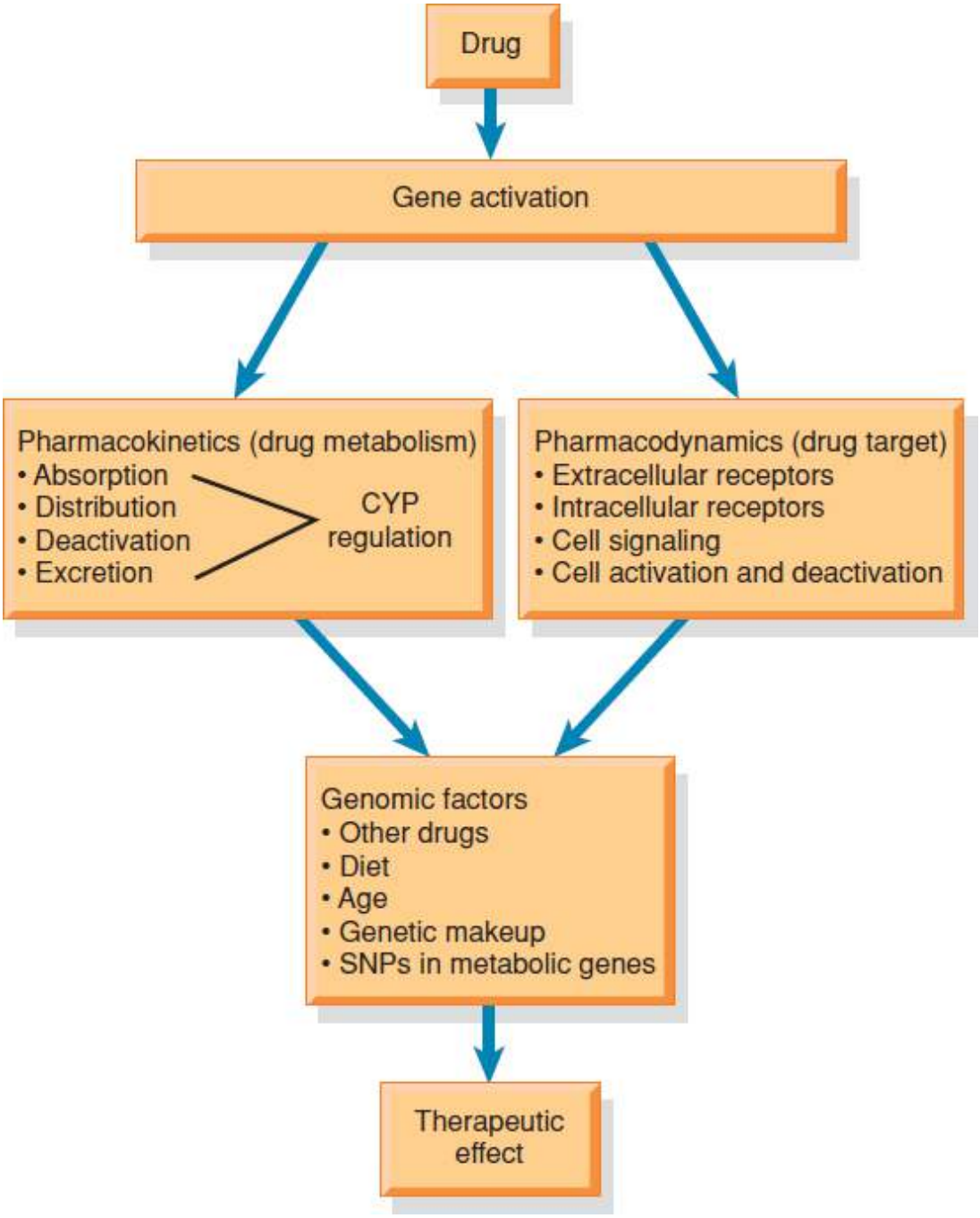

Figure 6-12 • Simplified schematic representation of the multiple, complex, genetic-regulated mechanisms involved in pharmacokinetics (cytochrome [CYP] dependent) and pharmacodynamics, along with other genomic and environmental factors affecting drug metabolism and treatment effect. SNPs, single nucleotide polymorphisms.

Nurses have traditionally monitored and reported drug response and drug adverse effects. Pharmacogenomic (drug–gene) testing is currently available for more than 16 drugs (Mayo Clinic, 2019). This type of testing

offers patients and health care providers more information about a specific drug and whether the medication is the best option for the patient based on genetic interactions that may influence the absorption, metabolism, or excretion of the drug, and the likelihood of an adverse effect from the medication. Nurses are in a position not only to provide education about a particular patient's genomic profile for drug metabolism, but also to explain the rationale for the recommended dosage and discuss associated symptoms related to potential adverse effects. Nurses will continue to incorporate information about gender differences, food interactions, and drug adherence into patient education (Consensus Panel, 2009).

Ethical, Legal, and Social Issues Surrounding Genetics

The rapid application of genetics and genomics across all sectors of health care has had implications for gathering, recording, and sharing personal health information. An ethical foundation provides nurses with a holistic framework for handling these issues with integrity and provides a basis for communicating genetic and genomic information to a patient, a family, other care providers, community agencies and organizations, and for society. Nurses must consider their responsibilities in handling genetic and genomic information and strive to ensure that informed decision making occurs, that patient and family health information is kept private and confidential, and that access to and justice in health care is available to everyone (ANA, 2017).

Ethical Concerns

Ethical principles of beneficence (i.e., to do good) and nonmaleficence (i.e., to do no harm), as well as autonomy, justice, fidelity, and veracity, are used to resolve ethical dilemmas that may arise in clinical care. Respect for persons is the ethical principle underlying all nursing care. Using these principles and the values of caring, nurses can promote thoughtful discussions that are useful when patients and families are facing genetics- and genomics-related health and reproductive decisions and consequences (ANA, 2017; Consensus Panel, 2009). The ethical principles of autonomy, fidelity, and veracity are also important (ANA, 2015). (Further information about ethics is included in Chapter 1.)

Ethical questions relating to genetics and genomics occur in all settings and at all levels of nursing practice. At the level of direct patient care, nurses participate in providing genetic information, testing, and gene-based therapeutics. They offer patient care based on the values of self-determination and personal autonomy. To be as fully informed as possible, patients need appropriate, accurate, and complete information given at a level and in a form so that they and their families can make well-informed personal, medical, and reproductive health decisions. Nurses can help patients clarify values and goals, assess understanding of information, protect their rights, and support their decisions. Nurses can advocate for patient autonomy in health decisions. Several resources and position statements have been developed to guide genetic-related nursing practice (International Society of Nurses in Genetics [ISONG], 2019).

Respecting the patient's right to self-determination—that is, supporting decisions that reflect the patient's personal beliefs, values, and interests—is a central principle in directing how nurses provide genetic and genomic information and counseling. Nurses and others participating in genetic counseling make every attempt to respect the patient's ability to make autonomous decisions. Recognizing one's own attitudes and beliefs and how communication of genetic and genomic information may be influenced by those attitudes and beliefs is a first step toward assuring patients' autonomous decision making.

Confidentiality of genetic and genomic information and respect for privacy are other essential principles underlying genetic counseling. Patients have the right to not have test results divulged to anyone, including insurers, primary providers, employers, or family members. Some patients pay for testing themselves so that insurers will not learn of the test, and others use a different name for testing to protect their privacy.

Ethical challenges may occur for family members and health care providers when the findings of one person's test may inadvertently disclose another family member's risk or carrier status. A nurse may want to disclose genetic information to family members who could experience significant harm if they do not know such information. However, the patient may have other views and may wish to keep this information from the family, resulting in an ethical dilemma for both patient and nurse. The nurse must honor the patient's wishes, while explaining to the patient the potential benefit this information may have for other family members (ANA, 2017; ISONG, 2019).

Ethical considerations must be reviewed as part of genetic and genomic research. For example, before a person participates in genetic and genomic clinical research, the research team must discuss how incidental findings will be addressed. Incidental findings are genetic-related illnesses which are found secondary to the intended goals of the research project or purpose of the test (Boardman & Hale, 2018). The American College of Medical Genetics and Genomics (American College of Medical Genetics and Genomics Policy Statement [ACMG], 2017) issued a policy statement that lists conditions known to be treatable and should be reported to the patient if found incidentally during clinical research.

Legal Aspects of Personalized Health Care

The Genetic Information Nondiscrimination Act (GINA), a law passed in 2008, protects individuals from genetic discrimination (Rothstein, 2018). Its purpose is to protect Americans against improper use of genetic and genomic information in insurance and employment decisions. GINA is particularly helpful for people who carry a gene mutation but are asymptomatic for the illness. The act prohibits health insurers from denying coverage to a healthy person or charging higher insurance rates based on a person's genetic predisposition to a disease. GINA offers legal protection with regard to health insurance and employment; however, gaps in protection exist with regard to disability, life, and long-term care insurance. The act also prevents employers from using a person's genetic and genomic information to make decisions about hiring, job placement, promotion, or firing. Protection provided by GINA does not apply to employers with less than 15 employees, to people in the military, Veterans Health Administration, Indian Health Services, and Federal Employees Health Benefits Programs (Rothstein, 2018). As a result of GINA, most Americans are free to use genetic and genomic information in health care without the fear of misuse; however, public awareness of this law is limited (Cragun, Weidner, Kechik, et al., 2019).

While not specifically intended for genetic health-related concerns, other health care laws offer some additional protection to individuals with regard to genetics. For example, the Affordable Care Act, enacted in 2010, offers some protection for a person with a genetic illness by prohibiting health insurers from discrimination based on a preexisting condition (Rich, 2018). The Americans With Disabilities Act offers legal protection related to employment concerns and physical or intellectual

impairment as a result of a genetic disorder. Finally, the Health Insurance Portability and Accountability Act (HIPAA), enacted in 1996, places restrictions on sharing identifiable health information and places stringent requirements on maintaining the privacy of health-related content and prohibits the use of genetic information to establish insurance eligibility (U.S. Department of Health and Human Services [HHS], 2017). However, HIPAA does not prohibit group plans from increasing premiums, excluding coverage for a specific condition, or imposing a lifetime cap on benefits.

The National Human Genome Research Institute, Policy and Program Analysis branch, has a summary of each state's legislation related to genomic statutes and bills (NIH, NHGRI, 2019b). See also the Resources section at the end of this chapter.

Ancestry, Cultural, Social, and Spiritual Concerns Related to Genetic and Genomic Practice

Genetic assessment addresses the ancestry of patients and families, as well as their ethnicity. This information helps identify individual patients and groups who could benefit from genetic testing for carrier identification, prenatal diagnosis, and susceptibility testing. For example, carrier testing for sickle cell disease is routinely offered to people of African American descent, and carrier testing for Tay-Sachs disease and Canavan disease is offered to people of Ashkenazi Jewish descent. The American College of Obstetricians and Gynecologists ([ACOG], 2019) recognizes the benefit of a thorough family history in correlation with the identification of personalized risks and the option of genetic testing prior to conception. Health care providers must be aware of at-risk status based on racial and ethnic population. Ideally, carrier testing is offered before conception to allow people who are carriers to make decisions about reproduction. Prenatal diagnosis is offered and discussed when both partners of a couple are found to be carriers.

It is important to inquire about the patient's ethnic backgrounds when assessing for susceptibilities to adult-onset conditions such as hereditary breast or ovarian cancer. For example, a *BRCA1* cancer–predisposing gene mutation seems to occur more frequently in women of Ashkenazi Jewish descent. Therefore, asking about ethnicity can help identify people with an increased risk of cancer gene mutations.

Nurses should consider patients' views about the significance of a genetic condition and its effect on self-concept, as well as patients'

perception of the role of genetics in health and illness, reproduction, and disability. For instance, among women without a history of breast cancer but with a strong family history of breast cancer, negative results for the *BRCA1* and *BRCA2* genetic mutations may not be a relief, since those women's risks for having breast cancer is estimated to be four times as high as women who do not have a family history. Among these women, negative findings for known genetic mutations may simply seem uninformative and cause frustration (Schroeder, Duggleby, & Cameron, 2017; see Chart 6-3: Nursing Research Profile: Living with Breast Cancer Risk). Patients' social and cultural backgrounds determine their interpretations and values about information obtained from genetic testing and evaluation and thus influence their perceptions of health, illness, and risk. Family structure, decision making, and educational background contribute in the same way (Consensus Panel, 2009).

Assessment of the patients' beliefs, values, and expectations regarding genetic testing and genetic and genomic information helps nurses provide appropriate information about the specific genetics or genomics topic. For example, in some cultures, people believe that health means the absence of symptoms and that the cause of illness is supernatural. Patients with these beliefs may initially reject suggestions for presymptomatic or carrier testing. However, by including resources such as family and cultural and religious community leaders when providing genetics- or genomics-related health care, nurses can help ensure that patients receive information in a way that transcends social, cultural, and economic barriers (Tluczek, Twal, Beamer, et al., 2019).

Chart 6-3 **NURSING RESEARCH PROFILE**

Living with Breast Cancer Risk

Schroeder, D., Duggleby, W., & Cameron, B. L. (2017). Moving in and out of the what-ifs: The experiences of unaffected women living in families where a breast cancer 1 or 2 genetic mutation was not found. *Cancer Nursing, 40*(5), 386–393.

Purpose

The genetic mutations of *BRCA1* and *BRCA2* account for approximately 15% of cases of familial breast cancer in women. For women without these mutations and without breast cancer but with a strong family history, the risk of eventually having breast cancer remains high. These risks may be related to another currently unidentified *BRCA* mutation or to a mutation in another gene not yet identified. Little is known about the effects that living with a high breast cancer risk has on these women. Therefore, the aims of this study were to discover the day-to-day lived experience of having breast cancer risk on women with a strong family history of breast cancer but who are *BRCA1* and *BRCA2* negative, and to elucidate how they cope with the knowledge of their breast cancer risk.

Design

This was a hermeneutic phenomenologic study that used van Manen's methods to explore the lived experiences among *BRCA1* and *BRCA2* negative women without breast cancer but with a strong family history of breast cancer and to uncover the meanings this knowledge had on their everyday lives. Purposive sampling was used to recruit participants eligible to be included in the study. The researchers hoped to recruit between five and eight participants. Ten patients who received care in a hereditary breast and ovarian cancer clinic (HBOC) in Western Canada consented to participate in this study, although one dropped out prior to data collection, resulting in a total of nine participants.

Findings

Participants (N = 9) engaged in a total of 20 interviews with the researchers. Each participant engaged in at least two conversations. After each session, participants were given copies of the summaries of the conversations and proposed emerging themes that researchers posited for corroboration, in order to ensure trustworthiness of findings. Researchers identified one main overarching theme of *Moving In and Out of the What-Ifs,* which identified the tensions between "normal" living, as expressed in the subtheme *Just Moving Along: Living a Normal Life,* that was juxtaposed with the "what-ifs" subthemes, which included *Moving Into Those Dark Spaces, Is There Something Wrong*

with Me? and *Markings in Time.* For instance, all participants identified that most of the time they had an awareness of their familial breast cancer risk, but kept it in the background, expressing the need to "live a normal life." The "dark spaces" were described as triggers that provoked anxiety about their risks, such as anticipating an appointment at the HBOC, or hearing news of a close relative newly diagnosed with cancer. Although all participants identified themselves as "healthy," they found that many times, others who knew of their risks tended to label them as not healthy, causing conflict within them "Is there something wrong with me?" Lastly, there were key milestones in participants' lives that caused tension, or "time marks," such as approaching or surpassing an age when a family member was diagnosed with cancer, or when a family member died of cancer. Coping through the "dark spaces" the "wrongness" and the "marks in time" was facilitated through the methods employed in the subthemes *Living in the Moment,* or slowing down to enjoy the "here and now"; *Being Cared For,* or feeling cared for by significant others as well as the staff at the HBOC; and, *Keeping Me Grounded,* expressed by having family and significant others find ways to keep them out of the "dark spaces," supporting their view of themselves as healthy, and celebrating significant "time marks" with them.

Nursing Implications

Findings from this study suggest that being *BRCA1* and *BRCA2* negative can be seen as both a blessing and a curse for women who are nonetheless at risk for familial breast cancer. These women must deal with conflicting emotions and anxieties that surround the uncertainty of living with this risk. Nurses who care for women at risk for familial breast cancer who are *BRCA1* and *BRCA2* negative should aim to foster their coping mechanisms by encouraging them to focus on the positives in the "here and now" of their lives, by keeping them grounded, and by demonstrating a caring relationship with them.

Applications of Genetics and Genomics in Nursing Practice

Nurses who provide genetics- and genomics-related health care blend the principles of human genetics with nursing care in collaboration with other professionals, including genetic specialists, to foster improvement, maintenance, and restoration of patients' health (Tluczek et al., 2019). Genetic-related nursing practice involves the care of people who have

genetic conditions, those who may be predisposed to develop or pass on genetic conditions, and those who are seeking genetic information and referral for additional genetics services. The application of genomic information has been integrated into clinical practice areas of preconception, preimplantation, and prenatal testing, newborn screening, disease susceptibility, screening and diagnosis, prognosis and therapeutic decisions, and in monitoring disease recurrence (see Table 6-4). In the near future, nurses will need to engage in public health efforts to improve genetic literacy within the public domain so that patients can make informed genetic-genomic related decisions (Boerwinkel, Yarden, & Waarlo, 2017).

Nurses are positioned to support patients and families with genetics- and genomics-related health concerns by ensuring not only that their health choices are informed ones but by also advocating for the privacy and confidentiality of genetic and genomic information and for equal access to genetic testing and treatments. Nurses are expected to attend to the genetic and genomic health care needs of the patient (ANA, 2017).

Genetics and Genomics in Health Assessment

Assessment of a person's genetic and genomic health status is an ongoing process. Nurses collect information that can help identify individuals and families who have actual or potential genetics- or genomics-related health concerns or who may benefit from further genetic information, counseling, testing, and treatment. This process can begin before conception and continue throughout the lifespan. Nurses evaluate family and past medical histories, including prenatal history, childhood illnesses, developmental history, adult-onset conditions, past surgeries, treatments, and medications; this information may relate to the genetic or genomic condition at hand or to a condition being considered (see Chapter 4 for more information on assessing past medical history). Nurses also identify the patient's ethnic background and conduct a physical assessment to gather pertinent genetic information. The assessment also includes information about culture, spiritual beliefs, and ancestry. Health assessment includes determining a patient's or family's understanding of actual or potential genetics- or genomics-related health concerns and awareness of how these issues are communicated within a family (ANA, 2017).

Family History Assessment

Nurses in any practice setting can assess families' genetics histories to identify a genetic trait, inherited condition, or predisposition. Obtaining a thorough family health history is the first, most important tool when determining the potential risk for a genetic illness. Targeted questions are used to identify genetic and genomic conditions for which further information, education, testing, or treatment can be offered (Chart 6-4). A three-generation family history should be collected that includes ages of each family member, medical illnesses, age and cause of death, history of miscarriages or stillbirths, and ethnicity (ACOG, 2018). After consultation and collaboration with other health care providers and specialists, further genetic testing and evaluation is offered for the trait or condition in question. A genetic family history is used to make a diagnosis, identify testing strategies, and establish a pattern of inheritance. Nurses can also inquire about medical conditions that are known to have a heritable component and for which genetic testing may be available. Information is obtained about the presence of birth defects, intellectual disability, familial traits, or similarly affected family members (Consensus Panel, 2009).

Nurses need to consider the closeness of the relationship (genetic relatedness or consanguinity) among family members when assessing the risk of genetic conditions in couples or families. For example, when obtaining a preconception or prenatal family history, it is important for the nurse to ask if the prospective parents have common ancestors (i.e., are they cousins?). This is key because, as noted previously, people who are related have more genes in common than those who are unrelated, thus increasing their chance of having children with an autosomal recessive inherited condition such as cystic fibrosis. Ascertaining genetic relatedness provides direction for genetic counseling and evaluation. It may also serve as an explanation for parents who have a child with a rare autosomal recessive inherited condition or for an adult who is similarly affected.

When the assessment of family history reveals that a patient has been adopted, genetic- and genomic-based health assessment becomes more challenging. Every effort is made to help the patient obtain as much information as possible about their biologic parents, including their ethnic backgrounds.

Questions about previous miscarriage or stillbirth are included in genetics health assessments to identify possible chromosomal conditions. Nurses can also inquire about any history of family members with inherited conditions or birth defects; maternal health conditions such as

type 1 diabetes, seizure disorders, or PKU, which may increase the risk for birth defects in children; and about exposure to alcohol or other drugs during pregnancy. Maternal age is also noted; women who are 35 years of age or older who are considering pregnancy and childbearing or who are already pregnant should be offered prenatal diagnosis (e.g., testing through amniocentesis) because of the association between advanced maternal age and chromosomal abnormalities such as Down syndrome. Advanced paternal age, which includes men over 40 years of age, is associated with a slightly higher risk for a child to have autism, schizophrenia, or leukemia (Mayo Clinic, 2018).

Chart 6-4 GENETICS FAMILY HISTORY

An Essential Tool for All Nurses

A Well-Documented Family History Can Be Used to:

- Assess risk of certain diseases
- Decide on testing strategies, such as what genetic and other diagnostic tests to order
- Establish a pattern of inheritance
- Identify other family members who are at increased risk
- Identify shared environmental risk factors
- Calculate risks
- Assess risk of passing on conditions to children
- Determine and recommend treatments that modify disease risk
- Make decisions about management or surveillance
- Develop patient rapport
- Educate patients

Key Questions to Ask About Each Family Member Include:

- What is the current age, or what was the age at death?
- What is the ethnic background (some genetic conditions are more common in certain ethnic groups)?
- Is there a history of:
  - Multiple pregnancy losses/stillbirths?
  - Unexplained infertility?
  - Birth defects?
  - Intellectual disability or developmental delay?
  - Learning disability?
  - Medical problems in children whose parents are closely related (second cousins or closer)?
  - Congenital or juvenile blindness, cataracts, hearing loss, or deafness?
  - Very short or very tall stature?
  - Several close relatives with the same or related conditions (e.g., breast or colon cancer, diabetes, heart disease, asthma, stroke, high blood pressure, kidney disease)?
  - Occurrence of a common condition with earlier age of onset than is usual (e.g., breast or colon cancer, hearing loss, dementia, heart disease)?

Adapted from Ginsburg, G. S., Wu, R. R., & Orlando, L. A. (2019). Family health history: Underused for actionable risk assessment. *Lancet, 394*(10198), 596–603.

Physical Assessment

Physical assessment may provide clues that a particular genetic or genomic condition is present in a person and family. Family history assessment may serve as a guide to focus the physical assessment. For example, a history of familial hypercholesterolemia would alert the nurse to assess for symptoms of hyperlipidemias (xanthomas, corneal arcus, and abdominal pain of unexplained origin). A family history of neurofibromatosis type 1, an inherited condition involving tumors of the central nervous system, would prompt the nurse to carry out a detailed assessment of closely related family members. Skin findings such as *café-au-lait* spots, axillary freckling, or tumors of the skin (neurofibromas) would warrant referral for further evaluation, including genetic evaluation and counseling (NIH, NLM, 2019i).

If a genetic or genomic condition is suspected as a result of a family history or physical assessment, the nurse, as a part of their role, and in collaboration with the health care team, may initiate further discussion of genetics and genomic information, offering and discussing genetic tests, and suggesting a referral for further genetic evaluation (Chart 6-5).

Chart 6-5

Indications for Making a Genetics Referral

Prepregnancy and Prenatal

- Maternal age of 35 y or older at expected time of delivery
- Previous child with a chromosome problem
- Positive alpha-fetoprotein profile screening test
- Previous child with a birth defect or family history of birth defects
- Pregnancy history of two or more unexplained miscarriages
- Maternal conditions such as diabetes, epilepsy, or alcoholism
- Exposures to certain medications or drugs during pregnancy
- Family history of intellectual disability
- Either member of the couple has a birth defect such as cleft lip or palate, spina bifida, or congenital heart defect
- Either member of the couple has a chromosome abnormality

Pediatric

- Positive newborn screening test
- One or more major birth defects
- Unusual (dysmorphic) facial features
- Developmental delay/intellectual disability
- Suspicion of a metabolic disorder
- Unusually tall or short stature, or growth delays
- Known chromosomal abnormality

Adult

- Intellectual disability without a known cause
- Unexplained infertility or multiple pregnancy losses
- A personal or family history of thrombotic events
- Adult-onset conditions such as hemochromatosis, hearing loss, and visual impairment
- Family history of an adult-onset neurodegenerative disorder (e.g., Huntington disease)
- Features of a genetic condition such as neurofibromatosis (*café-au-lait* spots, neurofibromas on the skin), Marfan syndrome (unusually tall stature, dilation of the aortic root), others
- Personal or family history of cardiovascular disorders known to be associated with genetic factors such as cardiomyopathy or long QT syndrome
- Family history of cancers known to be associated with specific genes such as hereditary breast/ovarian cancer or Lynch syndrome

- Family history of early-onset cancers and familial clustering of related tumors

Adapted from Centers for Disease Control and Prevention (CDC). (2017). Family health history. Retrieved on 8/30/2019 at: www.cdc.gov/genomics/famhistory; McClatchey, T., Lay, E., Strassberg, M., et al. (2018). Missed opportunities: Unidentified genetic risk factors in prenatal care. *Prenatal Care, 38*, 75–79.

Chart 6-6 ASSESSMENT

Assessing Psychosocial Genetic Health

The nurse's assessment of psychosocial factors impacting a patient's genetic health is based on the nurse's professional responsibility to "demonstrate in practice the importance of tailoring genetic and genomic information and services to patients based on their culture, religion, knowledge level, literacy and preferred language." (Consensus Panel, 2009; p. 11).

The nurse assesses:

- Educational level and understanding of the genetic condition or concern in the family.
- Desired goals and health outcomes in relation to the genetic condition or concern.
- Family rules regarding disclosure of medical information (e.g., some families may not reveal a history of a disease such as cancer or mental illness during the family history assessment).
- Family rules, boundaries, and cultural practices as well as personal preference about knowing genetic information.
- Past coping mechanisms and social support.
- Ability to make an informed decision (e.g., is the patient under stress from family situations, acute or chronic illness, or medications that may impair the patient's ability to make an informed decision?).

Adapted from Consensus Panel on Genetic/Genomic Nursing Competencies (Consensus Panel). (2009). *Essentials of genetic and genomic nursing: Competencies, curricular guidelines, and outcome indicators* (2nd ed.). Silver Spring, MD: Author.

Psychosocial Assessment

Psychosocial assessment is an essential nursing component of the genetics health assessment. The assessment findings can help identify the potential impact of new genetic and genomic information on the patient and the family and how they may cope with this information (Chart 6-6).

Genetic Counseling and Evaluation Services

People seek genetic counseling for various reasons and at different stages of life. Some are seeking preconception or prenatal information, others are referred after the birth of a child with a birth defect or suspected genetic condition, and still others are seeking information for themselves or their families because of the presence of, or a family history of, a genetic condition. Regardless of the timing or setting, genetic counseling is offered to all people who have questions about genetics or genomics and their health.

As the contribution of genetics and genomics to the health–illness continuum is recognized, genetic counseling will become a responsibility of all health care professionals in clinical practice. Nurses are in an ideal position to assess the patient's health and genetics family history and to make referrals for specialized diagnosis and treatment. They offer anticipatory guidance by explaining the purpose and goals of a referral. They collaborate with other health care providers in giving support and follow-up counseling; additionally, they coordinate follow-up and case management.

Genetic Services

Genetic services provide genetic information, education, and support to patients and families. Medical geneticists, genetic counselors, and advanced practice nurses in genetics provide specific genetics services to patients and families who are referred by their primary or specialty health care providers. A team approach is often used to obtain and interpret complex family history information, evaluate and diagnose genetic conditions, interpret and discuss complicated genetic test results, support patients throughout the evaluation process, and offer professional and family support. Patients participate as team members and decision makers throughout the process. Genetics services enable patients and their families to learn and understand relevant aspects of genetics and genomics, to make informed health decisions, and to receive support as they integrate personal and family genetic and genomic information into daily living.

Genetic counseling may take place over an extended period and may entail more than one counseling session, which may include other family members. The components of genetic counseling are outlined in Chart 6-7. Although genetic counseling may be offered at any point during the lifespan, counseling issues are often relevant to the life stage in which counseling is sought (CDC, 2018b). Examples are presented in Chart 6-8.

Providing Precounseling Information

All genetic specialists, including nurses who participate in the genetic counseling process and those with access to a person's genetic information, must honor a patient's desire for confidentiality. Genetic information should not be revealed to family members, insurance companies, employers, and schools if the patient so desires, even if keeping the information confidential is difficult.

Preparing the patient and the family, promoting informed decision making, and obtaining informed consent are essential in genetic counseling. Nurses assess the patient's capacity and ability to give voluntary consent. This includes assessment of factors that may interfere with informed consent, such as hearing loss, language differences, cognitive impairment, and the effects of medication. Nurses make sure that a person's decision to undergo testing is not affected by coercion, persuasion, or manipulation. Because information may need to be repeated over time, nurses offer follow-up discussion as needed (ANA 2017; Consensus Panel, 2009).

The genetic service to which a patient or a family is referred for genetic counseling will ask the nurse for background information for evaluation. Genetic specialists need to know the reason for referral, the patient's or family's reason for seeking genetic counseling, and potential genetic-related health concerns. For example, a nurse may refer a family with a new diagnosis of hereditary breast or ovarian cancer for counseling or to discuss the likelihood of developing the disease and the implications for other family members. The family may have concerns about confidentiality and privacy. The nurse and the genetic specialist tailor the genetic counseling to respond to these concerns.

With the patient's permission, genetic specialists will request the relevant test results and medical evaluations. Nurses obtain permission from the patient and, if applicable, from other family members to provide medical records that document the genetic condition of concern. In some situations, evaluation of more than one family member may be necessary to establish a diagnosis of a genetic disorder. Nurses explain that the

medical information is needed to ensure that appropriate information and counseling (including risk interpretation) are provided.

Chart 6-7

Components of Genetic Counseling

Information and Assessment Sources

- Reason for referral
- Family history
- Medical history/records
- Relevant test results and other medical evaluations
- Social and emotional concerns
- Relevant cultural, educational, and financial factors

Analysis of Data

- Family history
- Physical examination as needed
- Additional laboratory testing and procedures (e.g., echocardiogram, ophthalmology, or neurologic examination)

Communication of Genetic Finding

- Natural history of disorder
- Pattern of inheritance
- Reproductive and family health issues and options
- Testing options
- Management and treatment issues

Counseling and Support

- Identify individual and family questions and concerns
- Identify existing support systems
- Provide emotional and social support
- Refer for additional support and counseling as indicated

Follow-Up

- Written summary to referring primary providers and family
- Coordination of care with primary providers and specialists
- Additional discussions of test results or diagnosis

Genetics Resources

Genetic and Rare Diseases Information Center: provides links with experienced information specialists who can answer questions in English and Spanish to patients, families, and health care providers regarding specific genetic diseases, rarediseases.info.nih.gov

Genetics Home Reference: provides a layman's online encyclopedic guide to understanding genetic conditions, ghr.nlm.nih.gov

National Human Genome Research Institute, Genome Statute and Legislative Database: summarizes each state's legislation on employment and insurance discrimination, www.genome.gov/about-genomics/policy-issues/Genome-Statute-Legislation-Database

National Organization for Rare Disorders (NORD): a directory of support groups and information for patients and families with rare genetic disorders, rarediseases.org

Online Mendelian Inheritance in Man (OMIM): a complete listing of inherited genetic conditions, omim.org

The genetic service asks nurses about the emotional and social status of the patient and the family. Genetic specialists want to know the coping skills of patients and families who have recently learned of the diagnosis of a genetic disorder as well as what type of genetic information is being sought. Nurses help identify cultural and other issues that may influence how information is provided and by whom. For example, for patients with hearing loss, a sign interpreter's services may have to be arranged. For those with vision loss, alternative forms of communication may be necessary. Genetics professionals prepare for the genetic counseling and evaluation with these relevant issues in mind (CDC, 2018b).

Chart 6-8

Genetic Counseling across the Lifespan

Prenatal Issues

- Understanding prenatal screening and diagnosis testing
- Implications of reproductive choices
- Potential for anxiety and emotional distress
- Effects on partnership, family, and parental–fetal bonding

Newborn Issues

- Understanding newborn screening results
- Potential for disrupted parent–newborn relationship on diagnosis of a genetic condition
- Parental guilt
- Implications for siblings and other family members
- Coordination and continuity of care

Pediatric Issues

- Caring for children with complex medical needs
- Coordination of care
- Potential for impaired parent–child relationship
- Potential for social stigmatization

Adolescent Issues

- Potential for impaired self-image and decreased self-esteem
- Potential for altered perception of family
- Implications for lifestyle and family planning

Adult Issues

- Potential for ambiguous test results
- Identification of a genetic susceptibility or diagnosis without an existing cure
- Effect on marriage, reproduction, parenting, and lifestyle
- Potential impact on insurability and employability

Adapted from Dwyer, T. M., Glaser, R. L., & Mason, T. M. (2016). Inheritance patterns in human phenotypes and types of genetic disorders. In C. E. Kasper, T. A. Schneidereith, & F. R. Lashley. (Eds.). (2015). *Lashley's essentials of clinical genetics in nursing practice* (pp. 65–114). New York: Springer Publishing Company.

Preparing Patients for Genetics Evaluation

Before a genetic counseling appointment, the nurse discusses with the patient and the family the type of family history information that will be collected during the consultation. Family history collection and analysis are comprehensive and focus on information that may be relevant to the genetics- or genomics-related concern in question. The genetic analysis always includes assessment for any other potentially inherited conditions for which testing, prevention, and treatment may be possible.

A physical examination may be performed by the medical geneticist to identify specific clinical features commonly associated with a genetic condition. The examination also helps determine if further testing is needed to diagnose a genetic disorder. This examination generally involves assessment of all body systems, with a focus on specific physical characteristics. Nurses describe the diagnostic evaluations that are part of a genetics consultation and explain their purposes.

Communicating Genetic and Genomic Information to Patients

After the family history and the physical examination are completed, the genetics team reviews the information gathered before beginning genetic counseling with the patient and the family. The genetic specialists meet with the patient and the family to discuss their findings. If information gathered confirms a genetic condition in a family, genetic specialists discuss with the patient the natural history of the condition, the pattern of inheritance, and the implications of the condition for reproductive and general health. When appropriate, specialists also discuss relevant testing and management options.

Providing Support

The genetics team provides support throughout the counseling session and identifies personal and family concerns. Genetic specialists use active listening to interpret patient concerns and emotions, seek and provide feedback, and demonstrate understanding of those concerns. They suggest referral for additional social and emotional support. In addition, genetic specialists discuss pertinent patient and family concerns and needs with nurses and primary health care teams so that they can provide additional support and guidance (CDC, 2018b). Nurses assess the patient's understanding of the information given during the counseling session, clarify information, answer questions, assess patient reactions, and identify support systems.

Follow-Up After Genetic Evaluation

As a follow-up to genetic evaluation and counseling, genetic specialists prepare a written summary of the evaluation and counseling session for the patient and, with the patient's consent, send this summary to the primary provider as well as other providers identified by the patient as participants in care. The consultation summary outlines the results of the family history and physical and laboratory assessments, provides a discussion of any specific diagnosis made, reviews the inheritance and associated risk of recurrence for the patient and the family, presents reproductive and general health options, and makes recommendations for further testing and management. The nurse reviews the summary with the patient and identifies information, education, and counseling for which follow-up genetic counseling may be useful (ANA, 2017).

Follow-up genetic counseling is always offered because some patients and families need more time to understand and discuss the specifics of a genetic test or diagnosis, or they may wish to review reproductive options again later, when pregnancy is being considered. Follow-up counseling is also offered to patients when further evaluation and counseling of extended family members is recommended (ANA, 2017).

During follow-up sessions, nurses can educate patients about sources of information related to genetic and genomic issues. Some resources that provide the most up-to-date and reliable genetic and genomic information are available on the Internet (see the Resources section at the end of this chapter).

Genetics and Genomics Tomorrow

The pace of genetic and genomic research is transforming our understanding of the role of genetics and genomics in health and disease. In addition, it is increasing clinical opportunities for presymptomatic prediction of illness based on a patient's genetic makeup. Genetic research is now focused on identifying the genetic and environmental causes of common diseases such as diabetes, heart disease, and asthma. The studies are opening the doors for many advances in the prevention and treatment of both rare and common diseases (NIH, NHGRI, 2019c). Genetic testing as a part of palliative care is being discussed as having the potential to inform future generations of genetic health risk (Morrow, Jacobs, Best, et al., 2018). For example, a person dying of a rare cancer may biobank a DNA sample that could be helpful to future generations as research and technology advances to treat that specific illness. Additionally, advances are ongoing in the microbiome, the genetic

structure of the gut, which is now known to play a key role in many absorption and malabsorption disorders (Greathouse, Faucher, & Hastings-Tolsma, 2017; Sun, 2018). In addition, alterations to the telomere, the end unit or cap on each chromosome, referred to as telomeropathies, is providing insight to understanding the molecular mechanism of rare genetic disorders (Armando, Gomez, Maggio, et al., 2019).

As applications of genetics and genomics to health and disease develop, genetic testing may be used to scan all of a patient's genetic material so that disease risk variants can be identified and early interventions and treatments can be determined. It is estimated that the cost of testing a patient's entire genome is less than $1000. Personalized medicine will continue to expand, and many treatments and interventions for medical conditions will be chosen on the basis of what genetic testing indicates about a patient's genetic makeup. Nurses will be on the front line in communicating genetic and genomic information to patients, families, and communities. Patients, families, and communities will also expect that health care providers, including nurses, will use new genetic and genomic information and technologies in the provision of care. It is, therefore, imperative that all nurses become fluent in the language of genetics and genomics so that they can provide effective nursing care (ANA 2017; Consensus Panel, 2009).

CRITICAL THINKING EXERCISES

1 ipc A 34-year-old male reports urinary difficulty. Following a medical examination and subsequent laboratory work, he is diagnosed with early stages of kidney failure. After a further, more extensive workup, he is diagnosed with polycystic kidney disease, an autosomal dominant disorder. You work as a nurse in the nephrology clinic where he is now being treated. How should this inheritance pattern be explained to the patient? Utilizing knowledge of the inheritance pattern, whom should you include as part of the family assessment of this patient as it relates to this genetic condition? What comorbidities should you be alert to and include in future assessments? Understanding the progressive nature of this illness, what additional members of the health care team should be included in the care of this patient?

2 pq You work as a nurse in a family practice office setting. Linda, the mother of three children, tells you during a well-child physical that her 2-year-old son tends to have bleeding gums. She relates this to aggressive brushing because he is still learning how to brush his teeth. Through further questioning, you begin to suspect that the child may have hemophilia A, an X-linked recessive disorder. Based on the inheritance pattern of X-linked recessive disorders, what would be critical to know in this family history? Linda states that she has a brother who has two daughters, ages 9 and 12, and she has a sister with an infant son. Her father died when she was young and sadly, she doesn't recall much about his family history. Her mother is 77 years of age and has rheumatoid arthritis. How could you use knowledge of the inheritance pattern to guide the care of Linda and her family? Create a three-generation pedigree to determine if anyone else in the family should be screened for hemophilia.

3 ebp A 50-year-old female is being screened in the neurology clinic where you work for progressive neurologic impairment and physical decline. Through DNA analysis and chromosomal testing, a diagnosis of Huntington chorea is made. This illness has an autosomal dominant inheritance pattern. What is the best evidence you find to guide the care of this patient and her family? What ethical concerns must be taken into consideration when caring for a patient with this genetic disorder? This patient has two daughters who are 17 and 20 years of age. Should the age of her daughters have an impact as to whether or not they should have genetic testing?

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

Association of Women's Health, Obstetric and Neonatal Nurses (AWHONN), awhonn.org

Centers for Disease Control and Prevention, Public Health Genomics, www.cdc.gov/genomics
Genetic and Rare Diseases Information Center, www.rarediseases.info.nih.gov
International Society of Nurses in Genetics (ISONG), www.isong.org
Learn.Genetics, Genetic Learning Science Center, learn.genetics.utah.edu
National Cancer Institute (NCI), www.cancer.gov
National Center for Biotechnology Information, www.ncbi.nlm.nih.gov
National Human Genome Research Institute, Genome Statute and Legislative Database, www.genome.gov/about-genomics/policy-issues/Genome-Statute-Legislation-Database
National Organization for Rare Disorders (NORD), www.rarediseases.org
Oncology Nursing Society (ONS), www.ons.org
Online Mendelian Inheritance in Man, www.omim.org
The Human Genome Project, www.genome.gov/human-genome-project

7 Disability and Chronic Illness

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Compare and contrast the concepts of disability, chronic illness, and chronic disease.
2. Differentiate between models of disability.
3. Critically analyze the influence of disability on nursing care decisions and actions for patients.
4. Identify factors related to the increasing incidence of chronic conditions.
5. Describe characteristics of chronic conditions and nursing implications for people with chronic conditions and for their families.

NURSING CONCEPTS

Development
Diversity
Health Promotion and Legal Issues
Health, Wellness, and Illness

GLOSSARY

chronic disease: medical or health problem with associated symptoms or disabilities that require long-term management; also referred to as noncommunicable disease, chronic condition, or chronic disorder

chronic illness: the experience of living with a chronic disease or condition; the person's perception of the experience and the person's and others' responses to the chronic disease or condition

cognitive disability: limitations in mental functioning and difficulties with communication, self-care, and social skills

developmental disability: a set of heterogeneous disorders characterized by difficulties in one or more domains; can include cognitive, physical, or both cognitive and physical impairments with an onset before 22 years of age

disability: restriction or lack of ability to perform an activity in a normal manner; the consequences of impairment in terms of a person's functional performance and activity—disability represents impairment at the level of the person (e.g., bathing, dressing, communication, walking, grooming)

intellectual disability: a disability that occurs before 18 years of age characterized by significant limitations in both intellectual functioning and in adaptive behavior, which includes many everyday social and practical skills

multiple chronic conditions (MCC): presence of more than one chronic disease or condition

noncommunicable diseases: a group of conditions that are not caused by an acute infection

secondary health conditions or disorders: any physical, mental, or social disorders resulting directly or indirectly from an initial disabling condition

sensory disability: a disorder characterized by impairment of the sense of sight, hearing, smell, touch, or taste (e.g., hearing loss, deafness, vision loss, blindness)

Disability and chronic illness affect people of all ages—the very young, the middle aged, older adults, and the very old. Disability and chronic illness are found in all ethnic, cultural, racial, and socioeconomic groups, although some disorders occur more frequently in some groups than in others. Nurses in all settings will encounter patients with disability and chronic illness. This chapter presents concepts about disability and chronic illness and ways that nurses can address the health issues of these patients and their families.

Disability

Definitions of Disability

A person is considered to have a **disability** (limitation in performance or function in everyday activities) if they have difficulty talking, hearing, seeing, walking, climbing stairs, lifting or carrying objects, performing activities of daily living (ADLs), such as feeding oneself, bathing, dressing, grooming, toileting, doing school work, or working at a job. A severe disability is present if a person is unable to perform one or more activities, uses an assistive device for mobility, or needs help from another person to accomplish basic activities. People are also considered severely disabled if they receive federal benefits because of an inability to work.

According to the World Health Organization (WHO, 2018a), *disability* is the interaction between individuals with a health condition (e.g., cerebral palsy, spinal cord injury, Down syndrome) personal and environmental factors (e.g., negative attitudes on the part of society, inaccessible transportation and public buildings, and limited social supports). In 2001, WHO developed the International Classification of Functioning, Disability and Health (ICF), which defined disability as an umbrella term for impairments, activity limitations, participation restrictions, and environmental factors.

The term *impairment* describes a loss or abnormality in body structure or physiologic function, including mental function. The term *societal participation* is used in the WHO classification system in place of *handicap* to acknowledge the fact that the environment is always interacting with people to either assist or hinder participation in life activities. The environment may have a greater impact on a person's ability to participate in life activities than do physical, mental, or emotional factors or conditions (WHO, 2018a).

In the United States, federal legislation uses multiple definitions of disability, which makes common understanding of disability difficult. The Americans With Disabilities Act of 1990 (ADA; discussed later in this chapter) defines a person with a disability as one who (1) has a physical or mental impairment that substantially limits one or more major life activities, (2) has a record of such an impairment, or (3) is regarded as having such an impairment. Other phrases used to describe people with disabilities that are not universally accepted, understood or recommended are "people who are physically challenged" and "people with special needs."

Prevalence of Disability

According to the WHO (2018a), over one billion people, or about 15% of the global population, have some type of disability. Between 110 and 190 million adults worldwide have significant difficulties in function due to disability. The number of people with disabilities is increasing and is expected to continue to climb as people with early-onset disability, chronic disorders, and severe

trauma survive. People with disability comprise the world's largest minority (United Nations, n.d.).

The Centers for Disease Control and Prevention (CDC, 2017) reported that in 2016, one in four noninstitutionalized adults, or 61 million adults in the United States, had a disability that negatively affected major life activities. This reflects an increase from 2013 in which one in five noninstitutionalized adults in the United States had a disability (Okoro, Hollis, Cyrus, et al., 2018). The estimate is likely low as these figures do not include people who are living in institutions or are active duty military personnel.

The last U.S. Census indicated that more than 46% of people with one disability have other disabilities. Although the prevalence of disability is higher in men than in women for people younger than 65 years, the prevalence is higher in women than in men for people older than 65 years (U.S. Census Bureau, 2018a). In the United States, the prevalence of disability is higher among American Indians as well as Alaska Natives, adults with incomes below the federal poverty level, and people living in the southwestern U.S. census region (Okoro et al., 2018). In addition, the prevalence of disability in the United States is higher for African Americans and Whites than for Hispanics and Asians (U.S. Department of Labor, Bureau of Labor Statistics, 2019). Globally, more than 80% of the one billion people worldwide with disability live in low- and middle-income countries, in which all people have limited access to basic health care and social services. However, limited access to basic health care and support services has a more profound effect on those with disability.

The proportion of individuals with disability employed in 2018 was 19.1%. In contrast, 65.9% of those without disability were employed. About 8 in 10 people with a disability were not in the labor force in 2018, compared to about 3 in 10 of those with no disability. Individuals with disability are more likely to be employed part time than those with no disability. These discrepancies exist across all educational attainment groups (U.S. Department of Labor, Bureau of Labor Statistics, 2019). A consequence of lack of employment or only part-time employment is that those with a disability earn less money than people without disabilities. Low income along with limited access to basic health care and support services has a profound effect on those with disability. In 2017, the poverty rate of those individuals of working age, generally considered 18 to 64 years, with disability was 29.6%. In contrast, the poverty rate in 2017 of those without disability was 13.2% (Houtenville & Boege, 2019). See Chart 7-1 for a summary of additional facts about people with disabilities.

Characteristics of Disability

The characteristics of disability include an understanding of the categories, types, and models of disability. Additional characteristics include understanding the broad concept of disability.

Categories and Types of Disability

There are many categories and types of disabilities that include cognitive, developmental, intellectual, sensory, acquired, psychiatric, and physical. A **cognitive disability** is defined as limitations in mental functioning and difficulties with communication, self-care, and difficulty with social skills.

Developmental disabilities are those that occur any time from birth to 22 years of age and result in impairment of physical or mental health, cognition, speech, language, or self-care. This is an umbrella term that includes intellectual disabilities but can be a physical disability only. Examples of developmental disabilities include spina bifida, cerebral palsy, Down syndrome, muscular dystrophy, dwarfism, and osteogenesis imperfecta. Some developmental disabilities occur as a result of birth trauma or severe illness or injury at a very young age, whereas many developmental disabilities are genetic in origin (see Chapter 6). Some developmental disabilities overlap with cognitive and/or intellectual disabilities that affect intellectual functioning and adaptive behavior. An **intellectual disability** occurs before 18 years of age and is characterized by significant limitations in both intellectual functioning as well as in adaptive behavior, including many everyday social and practical skills. Because individuals with developmental and intellectual disabilities are living well into adulthood and aging with a disability, all nurses and other health care providers will encounter them in practice and must be knowledgeable and prepared to provide high quality health care.

Chart 7-1

Summary of Facts About People with Disability

- Approximately 61 million people in the United States have a disability, or one in every four people.
- The prevalence of disabilities in adults is approximately 10% of people 18–64 years of age and 38% of adults 65 years of age and older.
- The prevalence of disabilities varies by state and by gender, with higher prevalence in the South and among females.
- More than 11 million people with disabilities require personal assistance with everyday activities (e.g., getting around inside the home, bathing or showering, preparing meals, and performing light housework).
- Approximately 3.3 million people use a wheelchair; another 10 million use a walking aid such as cane, crutches, or walker.
- More than 1.8 million people report being unable to see printed words because of vision impairment, 1 million are unable to hear conversations because of hearing impairment, and 2.5 million have difficulty with their speech being understood.
- More than 16 million people have limitations in cognitive function or have a mental or emotional illness that interferes with daily activities, including those with Alzheimer's disease and intellectual disabilities.
- Self-reported health status among adults with disabilities differs from that of people without disabilities, with fewer people with disabilities describing their health as excellent or good.
- The percentage of people with disabilities who are employed ranges from 17.8% to 23.4%; of those without disabilities, the percent ranges from 63.5% to 66.2%.
- Among all age groups, people with a disability are much less likely to be employed than those without a disability. People with a disability who work are more likely than those without disability to work part time. People with a disability who were not in the labor force (neither employed nor unemployed) are about 8 in 10, compared with about 3 in 10 of those without a disability.
- Many people with disabilities would like to work but are hampered in doing so by limited access, lack of accommodations in the workplace, lack of transportation, and reluctance of employers to hire them.
- The percentage of people with disabilities below the poverty level is more than twice that of people without disabilities.

Adapted from Centers for Disease Control and Prevention (CDC), National Center for Health Statistics. (2017). Disability and functioning (noninstitutionalized adults aged 18 and over). Retrieved on 7/15/2019 at: www.cdc.gov/nchs/fastats/disability.htm; Centers for Disease Control and Prevention (CDC). (2018). Disability and health. Common barriers to participation experienced by people with disabilities. Retrieved on 7/16/2019 at: www.cdc.gov/ncbddd/disabilityandhealth/disability-barriers.html; Lauer, E. A., & Houtenville, A. J. (2018). Estimates of

prevalence, demographic characteristics and social factors among people with disabilities in the USA: A cross-survey comparison. *BMJ Open, 8*, e017828; Na, L., Hennessy, S., Boner, H. R., et al. (2017). Disability stage and receipt of recommended care among elderly Medicare beneficiaries. *Disability & Health Journal, 10*(1), 48–57; U.S. Department of Labor, Bureau of Labor Statistics. (2019). Persons with a disability: Labor force characteristics—2018. Retrieved on 7/5/2019 at: www.bls.gov/news.release/pdf/disabl.pdf; United Nations. (n.d.). Factsheet on persons with disabilities. Retrieved on 7/20/2019 at: www.un.org/development/desa/disabilities/resources/factsheet-on-persons-with-disabilities.html

A sensory disability is characterized by impairment of the sense of sight, hearing, smell, touch, and/or taste. Sensory disabilities most commonly affect hearing or vision; however, they also include learning disabilities that affect the ability to learn, remember, or concentrate; disabilities that affect the ability to speak or communicate; and disabilities that affect the ability to work, shop, and care for oneself, or access health care. Risks associated with sensory disabilities include isolation, reduced cognitive function, poor physical and psychological health, and increased risk of falls and hospitalization (McKee, 2019).

Psychiatric disability is defined as a mental illness or impairment that substantially limits one's ability to complete major life activities, such as learning, working, and communicating (WHO, 2018b). Although psychiatric disability and mental health disorders are not the focus of this chapter, it is important to note that a person may have more than one type of disability at the same time, requiring health care providers to be prepared to care for patients with several types of disabilities.

Whether a disability is cognitive, developmental, intellectual, physical, or sensory it may also be characterized as acquired. Acquired disabilities may occur as a result of an acute and sudden injury (e.g., traumatic brain injury [TBI]; spinal cord injury; and traumatic amputation due to traffic crashes, falls, burns, or acts of violence such as intimate partner violence and war and military conflicts), acute nontraumatic disorders (e.g., stroke, myocardial infarction), or progression of a chronic disorder (e.g., arthritis, multiple sclerosis, Parkinson's disease, chronic obstructive pulmonary disease, heart disease, blindness due to diabetic retinopathy).

Many disabilities are visible; however, invisible disabilities are often as disabling as those that can be seen. Some disabilities affect only instrumental activities of living (IADLs), such as shopping for food, doing laundry, housekeeping, and handling financial matters. Other disabilities affect ADLs only. People can be temporarily disabled because of an injury or acute exacerbation of a chronic disorder but later return to full functioning.

A common challenge for people with disability is the need to hire and oversee caregivers who come into their homes to assist with ADLs and IADLs. For many, it is difficult to be in a position of hiring, supervising, and sometimes firing people who may provide them with intimate physical care. The need to balance the roles of receiving care and overseeing the person providing that care may lead to blurring of role boundaries.

Many people with disabilities are at risk for **secondary health conditions** (e.g., pressure injuries, urinary tract infections, low bone density, depression) because of a narrow margin of health. Many of these conditions are predictable and with treatment are preventable with appropriate assessment for risk, prevention and treatment strategies (WHO, 2018a). Some conditions can be both primary and secondary conditions depending on circumstances. For example, a mobility disability could lead to social isolation and absence of participation in activities. This in turn could lead to depression as a secondary condition (Krahn, 2019). Comorbidities (e.g., cardiac disease, cancer, hearing loss) are not due to disability and thus can occur in those with or without disability.

Although different impairments may result from different types of disabilities, there are some similarities across disabilities. People with disabilities are often considered by society to be dependent and needing to be cared for by others; however, many people with disabilities are highly functioning, independent, productive people who are capable of caring for themselves and others, having children and raising families, holding full-time jobs, and making significant and major contributions to society. Like other people, most individuals with disabilities prefer to live in their own homes with family members. Most of them are able to live at home independently. Some individuals with disabilities live alone in their own homes and use home care services. However, alternative living arrangements may be necessary; these include assisted living facilities, long-term care facilities, and group homes.

Chart 7-2

Models of Disability

Medical Model

The Medical Model equates people who are disabled with their disabilities and views disability as a problem of the person, directly caused by disease, trauma, or other health condition, that requires medical care provided in the form of individual treatment by professionals. Health care providers, rather than people with disabilities, are viewed as the experts or authorities. Management of the disability is aimed at cure or the person's adjustment and behavior change. The model is viewed as promoting passivity and dependency. People with disabilities are viewed as tragic.

Rehabilitation Model

The Rehabilitation Model emerged from the medical model. It regards disability as a deficiency that requires a rehabilitation specialist or other helping professional to fix the problem. People with disabilities are often perceived as having failed if they do not overcome the disability.

Social Model

The Social Model, which is also referred to as the barriers or disability model, views disability as socially constructed and as a political issue that is a result of social and physical barriers in the environment. Its perspective is that disability can be overcome by removal of these barriers.

Biopsychosocial Model

The Biopsychosocial Model integrates the medical and social models to address perspectives of health from a biologic, individual, and social perspective. Critiques of this model have suggested that the disabling condition, rather than the person and the experience of the person with a disability, remains the defining construct of the Biopsychosocial Model.

Functional Model

The Functional Model is driven by the World Health Organization's *International Classification of Functioning, Disability and Health* (*ICF*). Disability is considered an umbrella term for impairments, activity limitations, participation restrictions, and their interaction with environmental factors. The ICF addresses components of health rather than consequence of disease.

Interface Model

The Interface Model is based on the life experience of the person with a disability and views disability at the intersection (i.e., interface) of the medical diagnosis of a disability and environmental barriers. It considers rather than ignores the diagnosis. The person with a disability, rather than others, defines the problems and seeks or directs solutions.

Other Models of Disability

Other models include the Identity Model (views disability as a positive rather than negative identity), the Human Rights Model (emphasizes the human dignity of individuals with disability and policy change), the Cultural Model (focuses on different views of disability within the context of a specific culture), the Charity Model (encourages humane treatment of people with disabilities, but views people with disabilities as victims of their impairment), and the Economic Model (approaches disability from the perspective of the ability of people with disabilities to work and contribute to society). Each of these models introduces elements that affect how individuals with disability are perceived and, as a result, how they are treated. Therefore, the underlying views and implications suggested by each model need to be examined and critiqued. Importantly, an analysis of these models helps promote introspection and discussion of the concept of disability.

Adapted from Drum, C. F. (2014). The dynamics of disability and chronic conditions. *Disability and Health Journal, 7*(1), 2–5; Goodall, C. J. (1995). Is disability any business of nurse education? *Nurse Education Today, 15*(5), 323–327; Retief, M., & Letšosa, R. (2018). Models of disability: A brief overview. *HTS Teologiese Studies/Theological Studies, 74*(1), a4738; Smeltzer, S. C. (2007). Improving the health and wellness of persons with disabilities: A call to action too important for nursing to ignore. *Nursing Outlook, 55*(4), 189–193; Smeltzer, S. C. (2021). *Delivering quality healthcare for people with disability*. Indianapolis, IN: Sigma Theta Tau International. World Health Organization. (2001). *International Classification of Functioning, Disability and Health—ICF*. Geneva, Switzerland: Author.

Models of Disability

Several models of disability have been used to address or explain the issues encountered by people with disabilities. Chart 7-2 describes several models of disability. The Interface Model (Goodall, 1995), developed by a nurse, promotes care designed to be empowering rather than care that promotes dependency. It takes into account the disabling condition and its disabling effects. Furthermore, it promotes the view that people with disabilities are capable, responsible people who are able to function effectively despite having a disability. The Interface Model can serve as a basis for the role of nurses as advocates for the removal of barriers to health care and for the examination of how society and health care professionals contribute to discrimination by viewing disability as an abnormal state. Several other models of disability exist and serve as a guide for reflection on what disability means as well as its antecedents and outcomes (Retief & Letšosa, 2018).

Disability versus Disabling Disorders

Regardless of which definition or model of disability is adopted, it is important to realize that one can understand xthe pathophysiology and physical changes related to a disabling condition or injury without understanding the concept of disability. The nurse caring for patients with preexisting disabilities or new disabilities must recognize the impact of a disability on patients' well-being and their current and future health, their ability to participate in self-care or self-management, and their ability to obtain required health care and recommended health screening. Nursing management—from assessment through evaluation of the effectiveness of nursing interventions—must be monitored frequently to ensure that appropriate modifications have been made so that people with disabilities can receive health care equal to that of people without disabilities. Furthermore, nurses as well as other health care providers need to examine their facilities and procedures to ensure that the needs of people with various disabilities can be adequately addressed. Although the health care needs of people with disabilities generally do not differ from those of the general population, some disabilities create special needs and necessitate the use of special accommodations. Chart 7-3 reviews questions to ask to ensure quality health care for people with disabilities.

Chart 7-3

Questions to Ask to Ensure Quality Health Care for People with Disability

Communication Strategies

- Does the patient with a disability require or prefer accommodations (e.g., a sign language interpreter) to ensure full participation in conversations about their health care?
- Are appropriate accommodations made to communicate with the patient?
- Are efforts made to direct all conversations to the patient rather than to others who have accompanied the patient to the health care facility?
- Is appropriate language (people-first language) used in referring to the patient?

Accessibility of the Health Care Facility

- Are clinics, hospital rooms, offices, restrooms, laboratories, and imaging facilities accessible to people with disabilities, as legally required by the Americans With Disabilities Act and Rehabilitation Act?
- Has accessibility been verified by a person with a disability?
- Is a sign language interpreter other than a family member available to assist in obtaining a patient's health history and in conducting a physical assessment?
- Does the facility include appropriate equipment to permit people with disabilities to obtain health care (including mammography, gynecologic examination and care, dental care) in a dignified and safe manner?

Assessment

Usual Health Considerations

- Does the health history address the same issues that would be included when obtaining a history from a person without disabilities, including recent preventive health screening, sexuality, sexual function, and reproductive health issues?

Disability-Related Considerations

- Does the health history address the patient's specific disability and the effect of disability on the patient's ability to obtain health care, manage self-care activities, and obtain preventive health screening and follow-up care?
- What physical modifications and positioning are needed to ensure a thorough physical examination, including pelvic or testicular and rectal examination?

Abuse

- Is the increased risk for abuse (physical, emotional, financial, and sexual) by various people (family, paid care providers, strangers) addressed in the assessment?

- If abuse is detected, are men and women with disability who are survivors of abuse directed to appropriate resources, including accessible shelters and hotlines?

Depression

- Is the patient experiencing depression? If so, is treatment offered just as it would be to a patient without a disability, without assuming that depression is normal and a result of having a disability?

Aging

- What concerns does the patient have about aging with a preexisting disability?
- What effect has aging had on the patient's disability, and what effect has the disability had on the patient's aging?

Secondary Health Conditions

- Does the patient have secondary health conditions related to their disability or its treatment?
- Is the patient at risk for secondary health conditions because of environmental barriers or lack of access to health care or health promotion activities?
- Are strategies in place to reduce the risk for secondary health conditions or to treat existing secondary health conditions?

Accommodations in the Home

- What accommodations does the patient have at home to encourage or permit self-care?
- What additional accommodations does the patient need at home to encourage or permit self-care?

Cognitive Status

- Is it assumed that the patient is able to participate in discussion and conversation rather than assuming that they are unable to do so because of a disability?
- Are appropriate modifications made in written and verbal communication strategies?

Modifications in Nursing Care

- Are modifications made during hospital stays, acute illness or injury, and other health care encounters to enable a patient with disability to be as independent as they prefer?
- Is "people-first language" used in referring to a patient with disability, and do nurses and other staff talk directly to the patient rather than to those who accompanied the patient?
- Are all staff informed about the activities of daily living for which the patient will require assistance?

- Are accommodations made to enable the patient to use his or her assistive devices (hearing/visual aids, prostheses, limb support devices, ventilators, service animals)?
- If a patient with disability is immobilized because of surgery, illness, injury, or treatments, are risks of immobility addressed and strategies implemented to minimize those risks?
- Is the patient with a disability assessed for other illnesses and health issues (e.g., other acute or chronic illness, depression, psychiatric-mental health, cognitive disorders) not related to the primary disability?

Patient Education

- Are accommodations and alternative formats of instructional materials (large print, Braille, visual materials, audiotapes) provided for patients with disabilities?
- Does patient instruction address the modifications (e.g., use of assistive devices) needed by patients with disabilities to enable them to adhere to recommendations?
- Are modifications made in educational strategies to address learning needs, cognitive changes, and communication impairment?

Health Promotion and Disease Prevention

- Are health promotion strategies discussed with people with disabilities along with their potential benefits: improving quality of life and preventing secondary health conditions (health problems that result because of preexisting disability)?
- Are patients aware of accessible community-based facilities (e.g., health care facilities, imaging centers, public exercise settings, transportation) to enable them to participate in health promotion?

Independence versus Dependence

- Is independence, rather than dependence, of the patient with a disability the focus of nursing care and interaction?
- Are care and interaction with the patient focused on empowerment rather than promoting dependence of the patient?
- Is the patient aware of available resources and supports and do they know how to access them?

Insurance Coverage

- Does the patient have access to the health insurance coverage and other services for which they qualify?
- Is the patient aware of various insurance and other available programs?
- Would the patient benefit from talking to a social worker about eligibility for Medicaid, Medicare, disability insurance, and other services?

Federal Legislation

Because of widespread discrimination against people with disabilities, the U.S. Congress has enacted legislation to address health care disparities in this population. This legislation includes the Rehabilitation Act of 1973 and the ADA. The Rehabilitation Act of 1973 protects people from discrimination based on their disability. This act applies to employers and organizations that receive financial assistance from any federal department or agency, including many hospitals, long-term care facilities, mental health centers, and human service programs. It forbids organizations from excluding or denying people with disabilities equal access to program benefits and services. It also prohibits discrimination related to availability, accessibility, and delivery of services, including health care services.

The ADA, implemented in 1990, mandates that people with disabilities have access to job opportunities and to the community without discrimination based on having a disability. The ADA also requires that "reasonable accommodations" be provided for transportation and to facilitate employment of a person with a disability. Examples of reasonable accommodations in health care settings include accessible facilities and equipment (e.g., accessible restrooms, adjustable examination tables, access ramps, grab bars, elevated toilet seats) and alternative communication methods (e.g., telecommunication devices and sign language interpreters for use by people who are deaf). Failure to make reasonable accommodations can result in poor care for patients with disabilities. For example, lack of accommodation for people who have hearing loss or are deaf can lead to failed communication and inadequate sharing of important information between them and their health care providers (McKee, 2019).

Although the ADA took effect in 1992, compliance has been slow, and some facilities continue to be inaccessible although all new construction and modifications of public facilities must address access for people with disabilities. Because some courts previously interpreted the definition of disability in the ADA so narrowly that few people could meet it, the ADA Amendments Act was signed into law in 2008 and enacted in January 2009 (U.S. Department of Justice, 2009). The act broadly defines *disability* to encompass impairments that substantially limit a major life activity. This wording states that effective use of assistive devices, auxiliary aids, accommodations, medical therapies, and supplies (other than eyeglasses and contact lenses) does not alter the determination of whether a disability qualifies under the law. The purpose of these amendments was to cover more people and to shift the attention from focusing on who has a disability to making accommodations and avoiding discrimination.

Right of Access to Health Care

People with disabilities have the right of access to health care that is equal in quality to that of other people. The United Nations Convention on the Rights of Persons with Disabilities (CRPD, 2006) identifies the rights of people with disabilities to receive the highest standard of health care, without discrimination. More than 30 years after the passage of the ADA, the United States has not ratified the CRPD. Despite the rights identified by the CRPD and the ADA in the United States, people with disabilities continue to experience health disparities (Kaye, 2019; McClintock, Kurichi, Barg, et al., 2018).

For years, people with disabilities around the world have been discriminated against in employment, public accommodations, and public and private services, including health care (WHO, 2018a). Unmet needs of people with disabilities include but are not limited to medical, dental, and prescription medication needs. The needs of people with disabilities in health care settings present challenges to health care providers: how to communicate effectively if there are communication deficits, how to address the additional physical requirements for mobility, and how to ensure sufficient time to provide assistance with self-care routines during hospitalization. Nurses and other clinicians need to be aware of the specific needs of people with disabilities and to provide appropriate care and services for them. People with disabilities have a legally mandated right to accessible health care facilities for all medical care and screening procedures. Furthermore, they have the right to health care provided by knowledgeable clinicians who are sensitive to the effects of disability on access to health care, including care that addresses their reproductive issues and sexuality. As multiple recent studies have demonstrated, however, improvements are needed to provide women with disabilities with quality care targeting their sexuality and reproductive health care needs (Hayward, Chen, Forbes, et al., 2017; LaPierre, Zimmerman, & Hall, 2017; Mitra, Smith, Smeltzer, et al., 2017; Morris, Maragh-Bass, Griffin, et al., 2017; Tarasoff, 2017).

Figure 7-1 • Examples of inappropriate communication by nurse with young woman with a disability in a wheelchair. The nurse stands instead of sitting at the patient's eye level (**A**) and talks to the patient's mother rather than directly to the patient (**B**).

Reasonable accommodations are mandated by law and are the financial responsibility of the health care provider or facility. People with disabilities should not be expected to provide their own accommodations (e.g., sign language interpreters, assistants). Family members should not be expected to serve as interpreters because of concern for the patient's privacy and confidentiality and the risk of errors in interpreting information by either the patient or the health care provider. Chart 7-4 identifies strategies to communicate effectively with people with disabilities. Figures 7-1A,B and 7-2A,B illustrate inappropriate and appropriate communication, respectively, with a person with a disability who uses a wheelchair or is seated.

Figure 7-2 • Examples of appropriate communication by nurse with young woman with a disability in a wheelchair. **A.** The nurse is sitting at patient's eye level and talks directly to the patient after asking her mother to step out of the room during the history. **B.** The nurse explains to the patient how the examination table moves up and down, which allows the patient to be as independent as possible in moving the table.

In response to continued accessibility issues, the U.S. Surgeon General issued *Call to Action to Improve the Health and Wellness of Persons with Disabilities* (Smeltzer, 2007; U.S. Department of Health and Human Services [HHS], 2005). This report recognized that all people with disabilities need to have access to comprehensive health care so that they are able to have full, engaged, and productive lives in their own communities. Among strategies to accomplish this, the call to action stipulated that health care professionals need to become knowledgeable about disability. It further recommended that schools educating health care professionals educate about disability and address the need for increased availability of methods to screen, diagnose, and treat the whole person with a disability with dignity.

Chart 7-4

Interacting and Communicating with People Who Have Disabilities

Patients will feel most comfortable receiving health care if you consider the following suggestions.

General Considerations

- Do not be afraid to make a mistake when interacting and communicating with someone with a disability or chronic medical condition. Keep in mind that a person with a disability is a person first and is entitled to the dignity, consideration, respect, and rights you expect for yourself.
- Treat adults as adults. Address people with disabilities by their first names only if extending the same familiarity to all others present. Never patronize people by patting them on the head or the shoulder.
- Relax. If you do not know what to do, allow the person who has a disability to identify how you may be of assistance and to put you at ease.
- If you offer assistance and the person declines, do not insist. If your offer is accepted, ask how you can best help, and follow directions. Do not take over.
- If someone with a disability is accompanied by another person, address the person with a disability directly rather than speaking through the accompanying companion.
- Be considerate of the extra time it might take for a person with a disability to get things done or said. Let the person set the pace.
- Do not be embarrassed to use common expressions, such as “See you later” or “Got to be running,” that seem to relate to the person’s disability.
- Use people-first language: Refer to “a person with a disability” rather than “a disabled person” and avoid referring to people by the disability or disorder they have (e.g., “the diabetic”).

Mobility Limitations

- Do not make assumptions about what a person can and cannot do.
- Do not push a person’s wheelchair or grab the arm of someone walking with difficulty without first asking whether you can be of assistance and how you can assist. Personal space includes a person’s wheelchair, scooter, crutches, walker, cane, or other mobility aid.
- Never move someone’s wheelchair, scooter, crutches, walker, cane, or other mobility aid without permission.
- When speaking for more than a few minutes to a person who is seated in a wheelchair, try to find a seat for yourself so that the two of you are at eye level (see Fig. 7-2A,B).

- When giving directions to people with mobility limitations, consider distance, weather conditions, and physical obstacles such as stairs, curbs, and steep hills.
- Shake hands when introduced to a person with a disability. People who have limited hand use or who wear an artificial limb do shake hands.

Vision Loss (Low Vision and Blindness)

- Identify yourself when you approach a person who has low vision or blindness. If a new person approaches, introduce them.
- Touch the person's arm lightly when you speak so that they know to whom you are speaking before you begin.
- Face the person and speak directly to them. Use a normal tone of voice.
- Do not leave without saying that you are leaving.
- If you are offering directions, be as specific as possible and point out obstacles in the path of travel. Use specifics such as "Left about 20 feet" or "Right 2 yards." Use clock cues, such as "The door is at 10 o'clock."
- When you offer to assist someone with vision loss, allow the person to take your arm. This will help you guide rather than propel or lead the person. When offering seating, place the person's hand on the back or the arm of the seat.
- Alert people with low vision or blindness to posted information.
- Never pet or otherwise distract a canine companion or service animal unless the owner has given you permission.

Hearing Loss (Hard of Hearing, Deaf, Deaf–Blind)

- Ask the person how they prefer to communicate.
- If you are speaking through a sign language interpreter, remember that the interpreter may lag a few words behind—especially if there are names or technical terms to be finger spelled—so pause occasionally to allow the interpreter time to translate completely and accurately.
- Talk directly to the person who has hearing loss, not to the interpreter. However, although it may seem awkward to you, the person who has hearing loss will look at the interpreter and may not make eye contact with you during the conversation.
- Before you start to speak, make sure that you have the attention of the person you are addressing. A wave, a light touch on the arm or the shoulder, or other visual or tactile signals are appropriate ways of getting the person's attention.
- Speak in a clear, expressive manner. Do not over enunciate or exaggerate words. Unless you are specifically requested to do so, do not raise your voice. Speak in a normal tone; do not shout.
- To facilitate lip reading, face the person and keep your hands and other objects away from your mouth. Maintain eye contact. Do not turn

your back or walk around while talking. If you look away, the person might assume that the conversation is over.

- Avoid talking while you are writing a message for someone with hearing loss, because the person cannot read your note and your lips at the same time.
- Try to eliminate background noise.
- Encourage feedback to assess clear understanding.
- If you do not understand something that is said, ask the person to repeat it or to write it down. The goal is communication; do not pretend to understand if you do not.
- If you know any sign language, try using it. It may help you communicate, and it will at least demonstrate your interest in communicating and your willingness to try.

Speech Disabilities or Speech Difficulties

- Talk to people with speech disabilities as you would talk to anyone else.
- Be friendly; start up a conversation.
- Be patient; it may take the person a while to answer. Allow extra time for communication. Do not speak for the person.
- Give the person your undivided attention.
- Ask the person for help in communicating with them. If the person uses a communication device such as a manual or electronic communication board, ask the person the best way to use it.
- Speak in your regular tone of voice.
- Tell the person if you do not understand what they are trying to say. Ask the person to repeat the message, spell it, tell you in a different way, or write it down. Use hand gestures and notes.
- Repeat what you understand. The person's reactions will clue you in and guide you to understanding.
- To obtain information quickly, ask short questions that require brief answers or a head nod. Avoid insulting the person's intelligence with oversimplification.
- Keep your manner encouraging rather than correcting.

Intellectual/Cognitive Disabilities

- Treat adults with intellectual/cognitive disabilities as adults.
- Be alert to the person's responses so that you can adjust your method of communication as necessary. For example, some people may benefit from simple, direct sentences or from supplementary visual forms of communication, such as gestures, diagrams, or demonstrations.
- Use concrete rather than abstract language. Be specific, without being too simplistic. When possible, use words that relate to things you both can see. Avoid using directional terms such as right, left, east, or west.

- Be prepared to give the person the same information more than once in different ways.
- When asking questions, phrase them to elicit accurate information. People with intellectual/cognitive disabilities may be eager to please and may tell you what they think you want to hear. Verify responses by repeating the question in a different way.
- Give exact instructions. For example, “Be back for lab work at 4:30,” not “Be back in 15 min.”
- Avoid giving too many directions at one time, which may be confusing.
- Keep in mind that the person may prefer information provided in written or verbal form. Ask the person how you can best relay the information.
- Using humor is fine, but do not interpret a lack of response as rudeness. Some people may not grasp subtleties of language.
- Know that people with brain injuries may have short-term memory deficits and may repeat themselves or require information to be repeated.
- Recognize that people with auditory perceptual problems may need to have directions repeated and may take notes to help them remember directions or the sequence of tasks. They may benefit from watching a task demonstrated.
- Understand that people with perceptual or “sensory overload” problems may become disoriented or confused if there is too much to absorb at once. Provide information gradually and clearly. Reduce background noise if possible.
- Repeat information using different wording or a different communication approach if necessary. Allow time for the information to be fully understood.
- Do not pretend to understand if you do not. Ask the person to repeat what was said. Be patient, flexible, and supportive.
- Be aware that some people who have an intellectual disability are easily distracted. Try not to interpret distraction as rudeness.
- Do not expect all people to be able to read well. Some people may not read at all.

Psychiatric-Mental Health Disabilities

- Speak directly to the person. Use clear, simple communication.
- Offer to shake hands when introduced. Use the same good manners in interacting with a person who has a psychiatric-mental health disability that you would with anyone else.
- Make eye contact and be aware of your own body language. Like others, people with psychiatric-mental health disabilities will sense your discomfort.
- Listen attentively, and wait for the person to finish speaking. If needed, clarify what the person has said. Never pretend to understand.

- Treat adults as adults. Do not patronize, condescend, or threaten. Do not make decisions for the person or assume that you know the person's preferences.
- Do not give unsolicited advice or assistance. Do not panic or summon an ambulance or the police if a person appears to be experiencing a mental health crisis. Calmly ask the person how you can help.
- Do not blame the person. A person with a psychiatric disability has a complex, biomedical condition that is sometimes difficult to control. The person cannot just "shape up." It is rude, insensitive, and ineffective to tell or expect a person to do so.
- Question the accuracy of media stereotypes of psychiatric-mental health disabilities: Movies and media often sensationalize psychiatric-mental health disabilities. Most people never experience symptoms that include violent behavior.
- Relax. Be yourself. Do not be embarrassed if you happen to use common expressions that seem to relate to a psychiatric-mental health disability.
- Recognize that beneath the symptoms and behaviors of psychiatric disabilities is a person who has many of the same wants, needs, dreams, and desires as anyone else. If you are afraid, learn more about psychiatric-mental health disabilities.

This material is adapted and based in part on U.S. Department of Labor, Office of Disability Employment Policy. *Effective Interaction: Communicating With and About People with Disabilities in the Workplace*. Retrieved on 11/26/20 at: www.dol.gov/general/aboutdol/majorlaws

Health care in people with disabilities received further national attention through specific national objectives in *Healthy People 2020* (HHS, 2010). The midcourse review of those objectives indicated some improvement in health and health-related outcomes for people with disabilities (Sinclair, Fox, Jonas, et al., 2018). For example, the midcourse review revealed that national goals for health were improved or exceeded for 44.6% of objectives for people without disabilities compared to only 30.6% for people with disabilities (National Center for Health Statistics, 2016). These results indicate that work toward achieving equity in health care for individuals with disability is still needed.

Thirty years after the passage of the ADA in 1990, significant health status and health care disparities persist for people with disabilities. Furthermore, progress has been slow in ensuring that health care professionals receive adequate education about providing quality health care to them.

Barriers to Health Care

People with disabilities often encounter barriers in their daily lives and in their efforts to obtain health care, health promotion, and preventive health screening. For example, structural barriers such as stairs, lack of ramps, and narrow doorways may prevent people who are wheelchair users from entering facilities. Other structural barriers include restroom facilities that lack grab bars or sufficiently large restroom stalls, elevated toilet seats, and accessible sinks (CDC, 2018; WHO, 2018a).

Structural barriers to accessibility are most easily identified and eliminated. Other less visible barriers include negative and stereotypic attitudes (e.g., believing that all people with disabilities have a poor quality of life and are dependent and nonproductive) on the part of the public. Health care providers with similar negative attitudes make it difficult for people with disabilities to obtain health care equal in quality to that of people without disabilities. The Rehabilitation Act and the ADA were passed more than 46 and 30 years ago, respectively, to ensure equal access to people with disabilities; however, people with disabilities continue to encounter and report multiple barriers to health care facilities and providers. This legislation, the U.S. Surgeon General's call to action (HHS, 2005) and the ADA Amendments Act of 2008 are examples of efforts to eliminate barriers encountered by people with disabilities.

People with disabilities have also reported lack of access to information, transportation difficulties, inability to pay because of limited income, difficulty finding a health care provider knowledgeable about their particular disability, previous negative health care encounters, reliance on caregivers, and the demands of coping with the disability itself (HHS, 2005). These issues affect both men and women with severe disabilities; however, women are at higher risk for receiving a lower level of health care than men. Women with disabilities are significantly less likely to receive pelvic examinations than women without disabilities; the more severe the disability, the less frequent the examination. In particular, minority women and older women with disabilities are less likely to have regular pelvic examinations and Papanicolaou (Pap) tests. Reasons given by women for not having regular pelvic examinations are difficulty transferring on to the examination table, belief that they do not need pelvic examinations because of their disability, difficulty in accessing the office or the clinic, and difficulty finding transportation (HHS, 2005). Health care providers often underestimate the effect of disabilities on women's ability to access health care, including health screening and health promotion, and they focus on women's disabilities while ignoring women's general health issues and concerns. Furthermore, women with disabilities have reported lack of knowledge about disability and insensitivity on the part of health care providers.

Individuals with disabilities living in rural settings also face barriers associated with having fewer resources and less access to care than those

living in larger communities or urban settings. Therefore, establishing and maintaining involvement in their community can help ensure that they remain active and connected to others living around them, as described by Thurman, Harrison, and Walker (2019) (see the Nursing Research Profile in Chart 7-5). Additionally, those living in rural areas are less likely to have many types of recommended screenings (Goyat, Vyas, & Sambamoorthi, 2016; Magaña, Parish, Morales, et al., 2016; WHO, 2018a, 2018b).

Costs of care continue to be a factor in delaying or forgoing health care despite changes brought about by legislation, including the ADA and the Patient Protection and Affordable Care Act (ACA) (see later discussion in this chapter). Working individuals with disability are two to four times more likely to delay necessary health care than those without disabilities. Lack of transportation and being refused care are also associated with failure to obtain needed health care among those with disabilities. Further, individuals with multiple limitations and more severe disabilities are less likely to obtain or receive health care than those without disabilities and those without multiple limitations or less severe disability (Na, Hennessy, Boner, et al., 2017; Reichard, Stransky, Phillips, et al., 2017).

Race, gender, and type of disability also affect prevalence, health status and receipt of health care and screening. For example, African American women with intellectual disabilities are less likely to receive mammography than Caucasian women with intellectual disabilities.

Because of the persistence of these and other barriers, it is essential that nurses and other health care providers take steps to ensure that clinics, offices, hospitals, and other health care facilities are accessible to people with disabilities. This includes removal of structural barriers by the addition of ramps, designation of accessible parking spaces, and modification of restrooms to make them usable by people with disabilities. Alternative communication methods (e.g., sign language interpreters, teletypewriter devices, assistive listening devices) and types of patient education (e.g., audiotapes, large print, Braille) are essential to provision of appropriate health-related information to people with disabilities. Such accommodations are mandated by the ADA, which requires their provision without cost to the patient.

People with intellectual and developmental disabilities often need assistance in obtaining health care, including preventive health screening. They often lack knowledge about cancer screening, including breast cancer screening. Educational materials and interventions modified to accommodate patients with intellectual and developmental disabilities are needed to enable them to make informed decisions about screening. Major barriers to breast cancer screening by this population of women include fear, anxiety, and embarrassment, primarily due to lack of understanding about cancer and the importance of its early detection.

Federal Assistance Programs

Lack of financial resources, including health insurance, is an important barrier to health care for people with chronic illness and disabilities. However, several federal assistance programs provide financial assistance for health-related expenses for people with some chronic illnesses, acquired disabling acute and chronic diseases, and childhood disabilities.

Medicare is a federal health insurance program that is available to most people 65 years of age and older, people with permanent kidney injury, and qualified people with disabilities. Title II of the Social Security Disability Insurance program pays benefits to those people who meet medical criteria for disability, who have worked long enough (40 quarters of covered employment) to qualify, and who have paid Social Security taxes. Title II also provides benefits to people disabled since childhood (younger than 22 years), who are dependents of a deceased insured parent or a parent entitled to disability or retirement benefits, and disabled widows or widowers, 50 to 60 years of age, if their deceased spouse was insured under Social Security. Title XVI of the Social Security Disability Insurance program provides supplemental security income payments to people who are disabled and have limited income and resources.

Chart 7-5 **NURSING RESEARCH PROFILE**

Well-Being among Adults with Disabilities in Rural Settings

Thurman, W. A., Harrison, T. C., Walker, V. G., et al. (2019). Pursuing well-being among rural-dwelling adults with disabilities. *Qualitative Health Research, 29*(12), 1699–1710.

Purpose

The rate of disabilities is higher in rural areas globally than in more urban settings across gender, race, and type of disability or impairment. Individuals with disability who reside in rural communities are at a greater disadvantage for receiving services than those who live in urban settings. Although sociocultural and environmental factors affect the well-being of individuals with disabilities, little is known about the experience of adults with disabilities who live in rural areas. This qualitative study was conducted to explore the experience of living with a disability in rural America with the goal of greater understanding of how disability affects social roles, adaptation to impairments, and use of resources to improve well-being in individuals. The researchers' goal was to examine how working-age adults (35–70 years of age) with mobility and sensory disabilities living in rural areas of the United States define and pursue well-being.

Design

The researchers used a constructivist grounded theory approach with constant comparison analysis to study the well-being of community-residing adults with disabilities living in rural settings, defined as communities with fewer than 10,000 residents. The study participants were recruited through community organizations, newspaper announcements, word of mouth, and professional networks of the researchers. Twelve individuals who met inclusion criteria, including the ability to understand spoken or written English, participated in up to three one-to-one interviews. The interview questions addressed participants' perceptions of how their disability affected their lives over time, activities they enjoyed, qualities of their rural communities, and people who interacted with them regularly. Demographic data (e.g., age, race/ethnicity, length of time they lived in their rural setting, level of education, income, housing, employment status, occupation, age at onset of their disability, and the structure of their family) were collected to describe the sample. The study participants had a variety of mobility and sensory impairments, including osteoarthritis, paraplegia, multiple sclerosis, hearing loss, diabetes, and heart disease. Ten of the participants used some type of assistive device.

Findings

Six concepts related to well-being were identified: values, rural attitude, demands, set expectations, strategic participation, and membership. Membership in the rural community, identified as the core category, refers to a feeling of belonging and being part of something greater than one's self.

This was sustained by ongoing contributions to the rural community. Establishing and maintaining membership in the community described participants' sense of belonging to a group, and they felt that they were regarded as contributing participants in their communities. Membership also provided access to support from other community members when needed. These findings support previous research on rural settings indicating the importance of a sense of belonging to well-being. In the rural setting, social processes are used to mobilize resources needed to overcome functional limitations secondary to disability to establish group membership and create a sense of well-being. Meaningful social relationships contributed to participants' well-being, self-confidence, and self-valuing.

Nursing Implications

The findings indicate the importance of having social support, being a member of a group, and belonging to a network in which there is a reciprocal exchange of support and services for individuals with disabilities from rural communities. Thus, nurses and other health professionals working in rural settings could encourage individuals with disabilities to maintain social relationships, memberships, and participation in meaningful activities. Such participation could promote confidence and a sense of well-being and facilitate access to material and psychological support.

Medicaid provides home and community-based services to people with disabilities and long-term illnesses to enable them to lead meaningful lives in their families and communities (Krahn, Walker, & Correa-De-Araujo, 2015). The ACA has expanded insurance options for people with disabilities and made these options more affordable. Furthermore, although the ACA stipulates that people with preexisting chronic conditions and disabilities can no longer be dropped by insurance companies and no longer have a lifetime cap on benefits, comparison of pre-ACA and post-ACA access to health care indicates that health disparities based on disability status persist (Kaye, 2019). Because of differences in states' implementation of the ACA, differences in access to health care among people with disability also differ (Lindner, Rowland, Spurlock, et al., 2018). See later discussion of the ACA in this chapter, and the Resources section at the end of this chapter.

Despite the availability of these federal programs, people with disabilities often have health-related costs and other expenses related to disability that result in low-income status. Furthermore, people must undergo a disability determination process to establish eligibility for benefits, and the process can be prolonged and cumbersome for those who may need assistance in establishing their eligibility.

Nursing Care of Patients with Disability

As active members of society, people with disabilities are no longer an invisible minority. An increased awareness of their needs will bring about changes to improve access and accommodations. Modification of the physical environment permits access to public and private facilities and services, including health care, and nurses can serve as advocates for people with disabilities to eliminate discriminatory practices.

Nursing Considerations during Hospitalization

During hospitalization, as well as during periods of acute illness or injury or while recovering from surgery, patients with preexisting disabilities may require assistance with carrying out ADLs that they could otherwise manage at home independently and easily. Patients should be asked preferences about approaches to carrying out their ADLs, and assistive devices they require should be readily available. Careful planning with patients to ensure that the hospital room is arranged with their input enables them to manage as independently as possible. For example, patients who have paraplegia may be able to transfer independently from bed to their wheelchair; however, if the bed is left in an elevated position, they may be unable to do so. If patients usually use service animals to assist them with ADLs, it is necessary to make arrangements for the accommodation of these animals.

If patients with hearing loss or vision impairment are hospitalized, it is essential to establish effective communication strategies. Alternative methods for these patients to communicate with the health care team must be put in place and used, and all staff members must be aware that some patients are not able to respond to the intercom or telephone. If patients have vision impairment, it is necessary to orient them to the environment and talk to them in a normal tone of voice. When a patient has a disability that affects speech, referral with a speech-language therapist or communication specialist may assist in identifying alternative communication methods (use of sounds, gestures, eye movements) between the nurse and the patient. When a person with intellectual, cognitive, or psychiatric-mental health disability is hospitalized, the health care team must determine what strategies are effective in ensuring that the patient understands what is happening and can communicate his or her needs, promoting a safe and nonstressful environment, adhering as closely as possible to the patient's daily patterns, and consulting with the patient's family caregiver.

Health Promotion and Prevention

Health care providers often neglect health promotion concerns of people with disabilities, who may be unaware of these concerns. For example, people who have had hearing loss since childhood may lack exposure to information about

new immunizations through television and podcasts. People with lifelong disabilities may not have received information about general health issues as children, and people with new onset as well as lifelong disabilities may not receive encouragement to participate in health promotion activities. Because individuals with disabilities, including those with intellectual and developmental disabilities, are living longer and aging with their disability, the need for health promotion takes on increasing importance. Therefore, nurses should take every opportunity to emphasize the importance of participation in health promotion activities (e.g., healthy diet, exercise, social interactions) and preventive health screening.

The management of some disabilities increases the risk of illness, and in some people, health screening (e.g., bone density testing, gynecologic examinations, mammography) may be required earlier in life or more frequently (HHS, 2005). Referrals by nurses to accessible sites for screening may be needed, because many imaging centers are inaccessible or staff are unprepared to make modifications for women who need assistance for screening (McClintock et al., 2018). In addition, nursing consultation with physical therapists may be needed to identify creative ways of enabling people with disabilities to exercise safely, because exercise facilities are also often inaccessible for people with disabilities.

General health promotion strategies and health-screening recommendations for all men and women also apply to those with disabilities. Although physical limitations, cognitive impairments, and structural and attitudinal barriers existing in clinical facilities may make it difficult for some men and women to obtain health care and preventive health screening, the presence of a disability should not be used as a reason or excuse to defer recommended screening. Rather, the presence of a disability may *increase* the risk of secondary health conditions or disorders that require screening and follow-up. Just as people without disabilities should have regular screening tests, such as mammography or testicular and prostate examinations, so should people with disabilities. Nurses are often in a position to influence decisions about how equipment and procedures can be adapted to meet the special needs of their patients, whether these needs are cognitive, motor, or communicative.

The effect of the disabling condition on health risks should be considered. For example, the risk of osteoporosis may be increased in women and men whose disabilities limit their ability to participate in weight-bearing exercise or who use medications that contribute to bone loss (Smeltzer & Qi, 2014). Individuals with intellectual disabilities have several additional risk factors, such as taking medications to treat seizures that contribute to bone loss. Although people with certain disabilities have an increased risk of osteoporosis at a younger age than people without disabilities, little attention is given to prevention, detection, and treatment of osteoporosis, despite the increased risk for falls associated with many disabling disorders.

Nurses can provide expert health promotion education classes that are targeted to people with disabilities and refer them to accessible online resources. Classes on nutrition and weight management are extremely important to people who are wheelchair users and need assistance with transfers. Safer sex classes are needed by adolescents and young adults who have spinal cord injury, TBI, or developmental disabilities, because the threats of sexually transmitted infections and unplanned pregnancy exist for these populations just as they do for the population in general.

The need for health promotion in the areas of establishing relationships, sex, pregnancy, and childbearing is as great in people with disabilities, including those with intellectual and cognitive disabilities, as in people without disabilities. However, societal attitudes and biases against sexual relationships and childbearing in people with disabilities often result in health care providers either excluding such individuals from discussions about these issues, or failing to take their interest and questions seriously. Approaching these topics at the point of interest and knowledge level of a patient with a disability is important for sexual health. Furthermore, addressing sexual issues is important to prepare people with disabilities, who are at risk for sexual and other forms of abuse, to distinguish between healthy and abusive or exploitative sexual interactions and relationships. The increased risk for abuse and violence affects both men and women with disabilities; such abuse and violence has potential physical and psychological consequences that must be assessed and addressed (Dembo, Mitra, & McKee, 2018).

Other healthy behaviors about which people with neurologic disabilities need education include avoiding alcohol and nonprescription medications while taking antispasmodic and anticonvulsant medications, which are commonly prescribed for those with disabilities.

Veterans Considerations

Growing attention has addressed health issues of veterans, those individuals who have served in the military, including service-connected disability and chronic illness. There are currently 18.5 million U.S. veterans. Over 41% of those who served in the military after September 11, 2001 (“911”) in Afghanistan, Iraq, and other war zones have disabilities, which is significantly higher than the rate of 25% of veterans from earlier eras (U.S. Census Bureau, 2018b). Many have more severe disabilities than previous veterans, because of survival of those who previously would have died from their injuries. In addition, the increased use of explosive devices in warfare has increased the number of veterans with limb loss and TBI. The impact of disability on the lives of veterans and their families is considerable and multifaceted and must be considered when providing care to them. Asking patients, “Have you ever served in the military?” is the first step to identifying health-related issues that

veterans face when seeking health care; asking this question also acknowledges the importance of military service to veterans.

Significance of "People-First" Language

It is important to all people, both those with and those without disabilities, that they not be equated with their illness or physical condition. Therefore, nurses should refer to all people using "people-first" language. That means referring to the person first: "the patient with diabetes" rather than "the diabetic" or "the diabetic patient," "the person with a disability" rather than the "disabled person," "women with disabilities" rather than "disabled women," and "people who are wheelchair users" rather than "the wheelchair bound." This simple use of language conveys the message that the person, rather than the illness or disability, is of greater importance to the nurse.

Gerontologic Considerations

The demographic profile in the United States reflects an increased number of older adults with disabilities, with two thirds of Americans 85 years of age and older experiencing functional limitations. Age-related disabilities are those that occur in the older adult population and are thought to be attributable to the aging process. Examples of age-related disabilities include osteoarthritis, osteoporosis, and hearing loss.

Although disability is often perceived as being associated with old age, it occurs across the lifespan; in fact, the majority of people with disabilities are younger than 65 years, with one third between 44 and 65 years of age (Krahn et al., 2015). While many people with intellectual and developmental disabilities (cerebral palsy, Down syndrome, autism spectrum disorder) have a slightly shorter lifespan than other people from their age cohort, others live well into adulthood and old age. The number of adults with intellectual and developmental disabilities aged 60 years and older is expected to nearly double from 850,600 in 2010 to 1.4 million by 2030 (Heller, 2017).

Aging is an important issue that affects people with preexisting disabilities, as they often develop changes associated with aging at a younger age than do those without disabilities. Therefore, people with preexisting disability should be evaluated for early onset of changes related to aging. The nurse must also consider the effects of aging on a preexisting disability and in turn the effects of disability on aging. The following are examples of changes that occur with aging in people with preexisting disabilities:

- People who use crutches for ambulation because of spina bifida, polio, and lower extremity amputation may experience muscle or joint problems as they age because of long-time overuse of the upper

extremities; symptoms may not occur for many years but may cause discomfort and interfere with the person's ability to perform ADLs.

- People who experienced respiratory compromise with the onset of polio decades earlier may experience increasing respiratory symptoms with aging (National Institute of Neurological Disorders and Stroke, 2019). Others experience increased muscle weakness and fatigue, making it necessary to begin to use more extensive assistive devices for mobility (Duncan & Batliwalla, 2018).
- Women with long-standing mobility limitations, lack of weight-bearing exercise, and issues associated with intellectual disabilities may experience bone loss and osteoporosis prior to menopause, yet their rate of screening is low (Dreyfus, Lauer, & Wilkinson, 2014; Heller, 2017; Smeltzer & Qi, 2014).

Concern about what the future holds is common in people aging with preexisting disabilities, who may have questions about what physical, financial, and emotional supports they will have as they age (Nosek, 2000). For example, if their disability becomes more severe, they may be concerned about entering an assisted living or a long-term care facility. The nurse should recognize the concerns of people with disabilities about their future and encourage them to make suitable plans, which may relieve some of their fears about what will happen to them as they age.

Aging parents of adult children with intellectual or developmental disabilities often fear what will happen when they are no longer available and able to care for their children. Limited long-term care resources, increased life expectancy for people with developmental disabilities, changing family patterns, and competition with the older adult population for similar resources increase the fears of these parents. Thus, nurses must identify needed community resources and services. Identifying these issues and concerns and assessing arrangements made by aging parents of adult children with disabilities can help reduce some of parents' fears about their children's futures.

Disability in Medical-Surgical Nursing Practice

Disability is often considered an issue that is specific or confined to rehabilitation, pediatrics, or gerontologic nursing. However, as noted previously, disability can occur across the lifespan and is encountered in all settings. Patients with preexisting disabilities due to conditions that have been present from birth or to illnesses or injuries experienced as an adolescent or young adult or during middle age often require health care and nursing care in medical-surgical settings. It is important to note that even if a disability has been present for patients' entire lives and they have adapted to it, the disability

may still have implications for nursing care and needs to be considered in planning and providing care.

Although in the past many people with lifelong disabilities or adult onset of severe disabilities may have had shortened lifespans, today most can expect to have normal or near-normal lifespans and to live productive and meaningful lives. They are also at risk for the same acute illnesses that can affect all people and are at increased risk for aging-related chronic diseases due to smoking, obesity, and lack of physical activity. In addition, they are at increased risk for unintentional injuries, with fall-related injuries the most common type of injury.

Because of unfavorable interactions with health care providers, including negative attitudes, insensitivity, and lack of knowledge, people with disabilities may avoid seeking medical intervention or health care services. For this reason, and because the number of people with disabilities is increasing, nurses must acquire knowledge and skills and be available to assist them in maintaining a high level of wellness. Nurses are in key positions to influence the architectural design of health care settings and the selection of equipment that promotes ease of access and health. Padded examination tables that can be raised or lowered make transfers easier for people with disabilities. Birthing chairs benefit women with disability during yearly pelvic examinations and Pap smears and during urologic evaluations. Ramps, grab bars, and raised and padded toilet seats benefit many people who have neurologic or musculoskeletal disabilities and need routine physical examination and monitoring. When a patient with a disability is admitted to the hospital for any reason, the patient's needs for these modifications should be assessed and addressed.

Men and women with disabilities may be encountered in hospitals, clinics, offices, and nursing centers when they seek health care to address a problem related to their disability. However, they may also be encountered in these settings when they seek care for a health problem that is not related in any way to their disability. For example, a woman with spina bifida, spinal cord injury, or post-polio syndrome might seek health care related to a gynecologic issue, such as vaginal bleeding. Although her disability should be considered in the course of assessment and delivery of health and nursing care, it should not be the exclusive focus of the assessment or care that she receives. Furthermore, neither a severe physical disability that affects a woman's ability to transfer to an examination table for a gynecologic examination nor a cognitive disability should be a reason to defer a complete health assessment and physical examination, including a pelvic examination. Reproductive care for women with disabilities is notoriously lacking due to absence of appropriate accessible equipment and facilities, health care providers' unfamiliarity with health issues of women with disabilities, and negative attitudes toward women with disabilities who are sexually active or who are pregnant or considering

pregnancy (Hasson-Ohayon, Hason-Shaked, Silberg, et al., 2018; Hayward et al., 2017; LaPierre et al., 2017; Mitra et al., 2017; Nosek, 2000; Tarasoff, 2017). Nurses who are knowledgeable about these issues and other barriers can make a significant impact on the quality of health care these women receive.

Health care, including preventive health screening and health promotion, is essential to enable people with disabilities to live the highest quality of life within the limitations imposed by their disabling conditions. Men and women with disabilities have the same needs and same rights for health care and preventive health screening as others, although in some cases, the consequences of their disability increase rather than decrease their need for health screening and participation in health-promoting activities. Therefore, it is essential that medical-surgical nurses be knowledgeable about disability and how it affects people across the lifespan as well as how to provide sensitive and quality nursing care for patients with preexisting and new-onset disability. In an effort to address these issues, specific information on health care of people with disabilities has been included throughout this book.

Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

Chart 7-6 contains points the nurse should consider when educating patients about managing disability at home. A major and often overlooked issue in educating patients about a health problem, a treatment regimen, or health promotion strategies is the need for alternative formats to accommodate people with various disabilities. Patients with disabilities are in need of the same information as other patients; however, they often require large print, Braille, audiotapes, or the assistance of a sign language interpreter. Materials may be obtained from a variety of sources for patients who need these educational strategies and for patients with cognitive impairments attributable to developmental disabilities or newly acquired disabilities.

Nurses should ensure that all people—whether or not they have disabilities—recognize the warning signs and symptoms of stroke, heart attack, and cancer, as well as how to access help. In addition, nurses should educate all patients who are stroke survivors and those with diabetes how to monitor their own blood pressure or glucose levels.

Continuing and Transitional Care

When caring for patients with disabilities and helping them plan for discharge and continuing care in the home, it is important to consider how a particular disability affects a patient's ability to adhere to recommended treatment regimens and keep follow-up appointments. Furthermore, it is important to

consider how the health issue or treatment regimen affects the disability. Although many people with disabilities are independent and able to make decisions, arrangements for transportation, and appointments to accessible facilities, others may have difficulty doing so, particularly if they are experiencing a health problem. The nurse should recognize the effect that the disability has on the patient's ability to follow-up. The nurse should ask the patient whether they anticipate having any difficulties arranging for follow-up care. It is important for the nurse to assist the patient with disabilities to identify unmet needs and to find and use resources (community and social resources, and transportation services) that enable the patient to obtain needed services while remaining in his or her home, if preferred. The nurse should have a list of accessible sites and services available and share those resources with the patient and the family. In collaboration with other health care providers (occupational and physical therapists, speech therapists), the nurse can identify needed home modifications, including those that are simple and inexpensive, that will enable the patient to participate in self-care at home.

Chart 7-6 **HOME CARE CHECKLIST**

Managing Disability and Chronic Illness at Home

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of disability or chronic illness on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- State changes in lifestyle (e.g., diet, activity) necessary to maintain health.
- State the name, dose, side effects, frequency, and schedule for all medications.
- State how to carry out prescribed regimens (e.g., skin care, bladder/bowel care, daily weights).
- State how to obtain medical supplies after discharge.
- Identify durable medical equipment needs, proper usage, and maintenance necessary for safe utilization.
- Demonstrate safe usage of adaptive equipment for ADLs.
- Identify community resources for peer and caregiver/family support:
  - Identify sources of support (e.g., friends, relatives, faith community)
  - Identify phone numbers of support groups for people with chronic illness/disabilities and their caregivers/families
  - State meeting locations and times
- Demonstrate safe mobility skills and/or how to access transportation.
- Identify community resources for recreation:
  - State local recreation centers that offer programs for people with disabilities
  - Identify leisure activities that can be pursued in the community
- State how to reach health care provider with questions or complications.
- State time and date of follow-up appointments.
- Identify the need for health promotion, disease prevention, and preventive screening activities.

Transitional care, if available, is ideal for patients with severe disabilities being discharged home. Patients hospitalized for an acute or secondary health condition may be more vulnerable to deterioration in health status or developing other health conditions because of their narrow margin of health or deconditioning that occurs with hospitalization. Important roles of the transitional care nurse are to ensure that required services are available in the home at the time of the patient's discharge, to assess and monitor the patient through home visits, and to provide support and assistance to the patient and

the family in the aftermath of hospitalization and discharge (Naylor, Shaid, Carpenter, et al., 2017).

Chronic Disease and Chronic Illness

Chronic disease refers to **noncommunicable diseases** (conditions not caused by an acute infection or injury), chronic conditions, or chronic disorders. In contrast, **chronic illness** refers to the human experience of living with a chronic disease or condition. Chronic illness includes the person's perception of the experience of having a chronic disease or condition and the person's and others' responses to it, including health care professionals (Larsen, 2019). Persons' and their families' values and previous experiences determine their perceptions and beliefs about the condition, which in turn affect their illness and wellness behaviors. Their values are influenced by a number of demographic, socioeconomic, technologic, cultural, and environmental variables. Only the person and the family really know what it is like to live with chronic illness (Larsen, 2019).

The following section of this chapter discusses chronic illness and its implications for nursing practice. Because some degree of disability is often present in severe or advanced chronic illness, the previous discussion about disability is relevant to chronic disease as well.

Chronic diseases are long-term health conditions that affect one's well-being and function in an episodic, continuous, or progressive way over many years of life. Although each chronic disease or condition has its own specific physiologic characteristics, many chronic conditions share common features. For example, common symptoms typically include pain, fatigue, sleep disturbances, and difficulty adjusting to the onset and uncertainty of a chronic condition (Larsen, 2019). Many people with chronic health conditions and disability function independently with little or no inconvenience to their everyday lives; others, however, require frequent and close monitoring or placement in long-term care facilities. Certain conditions require advanced technology for survival, as in the late stages of chronic obstructive lung disease or end-stage renal disease, or intensive care or mechanical ventilation for periods of weeks, months, or years. People with disorders such as these have been described as being chronically critically ill, although there is no consensus on a definition of chronic critical illness. An overview of chronic disease in the United States is presented in Chart 7-7.

Multiple Chronic Conditions

Having **multiple chronic conditions (MCC)** increases the complexity of care and often necessitates care by multiple health care specialists, a variety of

treatment regimens, and prescription medications that may not interact. Thus, patients with MCC are at risk for conflicting medical advice, adverse effects of medications, unnecessary and duplicative tests, and preventable hospitalizations, all of which can negatively affect their health (CDC, 2019b). Patients with MCC and their families may have to keep track of different medications with different schedules and multiple appointments with various health care professionals. Costs of health care increase with the number of chronic conditions a person has; those with five or more chronic conditions account for 41% of total health expenditures in the United States (Buttorff, Ruder, & Bauman, 2017). Approximately 80% of health care costs in the United States are associated with having MCC. Approximately 93% of the total health care expenditures for those who are covered by Medicare are associated with MCC. In addition, out-of-pocket health-related expenses increase with the number of MCC. Facts about MCC are summarized in Chart 7-8.

Chart 7-7

Overview of Chronic Illness in the United States

- Chronic diseases are the leading causes of death and disability in the United States.
- Chronic disease and conditions (e.g., heart disease, stroke, cancer, diabetes, obesity, arthritis) are among the most common, costly, and preventable of all health problems.
- Heart disease, cancer, stroke, chronic lower respiratory diseases, Alzheimer's disease, and diabetes pose greater risks as people age.
- Chronic disease, specifically diabetes, is the leading cause of kidney failure, amputation of lower extremities, and new causes of blindness among adults.
- Obesity is a serious health concern with one third of adults and one of five youths having obesity.
- Lack of exercise or physical activity, poor nutrition, use of tobacco, and excessive alcohol use contribute to the growing prevalence of chronic diseases and resulting disability. Tobacco remains the leading cause of six million preventable deaths per year globally. Although cigarette smoking among U.S. youths has declined steadily over the past two decades, the recent introduction of electronic nicotine delivery systems (ENDS) has resulted in increased exposure of youth to nicotine, considered an epidemic by the U.S. Surgeon General's office.
- Americans living in rural communities are more likely to have chronic disease, such as high blood pressure, heart disease, and diabetes, than those living in nonrural areas.
- Eighty-six percent of all health care spending is related in general to chronic disease.
- People with chronic disease may have other health problems that may or may not be related to the primary chronic disease; these include alcohol abuse and substance use or addiction disorders, mental illness, dementia or other cognitive impairments, and developmental disabilities.

Adapted from AARP. (2017). Chronic conditions among older adults. Retrieved on 11/25/20 at: www.assets.aarp.org/rgcenter/health/beyond_50_hcr_conditions.pdf; Agency for Healthcare Research and Quality. (2018). *2017 National healthcare quality and disparities report*. Rockville, MD: Agency for Healthcare Research and Quality; American Heart Association. (2019). Cardiovascular diseases affect nearly half of American adults, statistics show. Retrieved on 7/19/2019 at: www.heart.org/en/news/2019/01/31/cardiovascular-diseases-affect-nearly-half-of-american-adults-statistics-show; Buttorff, C., Ruder, T., Bauman, M. (2017). Multiple chronic conditions in the United States. Retrieved on 01/01/2018 at: www.rand.org/pubs/tools/TL221.html; Centers for Disease Control and Prevention (CDC), National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP). (2019a). At a glance.

Prevalence of chronic illnesses. Retrieved on 7/19/2019 at: www.cdc.gov/chronicdisease/resources/infographic/chronic-diseases.htm; Centers for Disease Control and Prevention (CDC), National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP). (2019b). Multiple chronic conditions. Retrieved on 7/19/2019 at: www.cdc.gov/chronicdisease/about/multiple-chronic.htm; Raghupathi, W., & Raghupathi, V. (2018). An empirical study of chronic diseases in the United States: A visual analytics approach to public health. *International Journal of Environmental Research and Public Health, 15*(3), 431–455.

Chart 7-8

Facts About Multiple Chronic Conditions (MCC)

- About half of all adults—117 million people—have one or more chronic health conditions. One of every four adults has two or more chronic health conditions.
- The occurrence of MCC increases with age. Three in every four Americans 65 years of age and older have MCC.
- The number of people with MCC is predicted to increase substantially over the next decade, adding to the pressures on the health care system to deliver high quality of care, at optimal cost, while improving the health of this complex population.
- Women are more likely than men to have MCC.
- Non-Hispanic White adults, non-Hispanic Black adults, and non-Hispanic adults of other races have a high prevalence of MCC.
- As the number of chronic conditions a person has increases, the greater the risk of dying prematurely, being hospitalized, and having poor day-to-day functioning.
- Many patients with MCC have mobility limitations and require assistance with dressing, bathing, or preparing meals.
- People with MCC account for the majority of health care visits, prescriptions, home health visits, and hospital stays in the United States.

Adapted from Buttorff, C., Ruder, T., & Bauman, M. (2017). Multiple chronic conditions in the United States. Retrieved on 11/25/20 at: www.rand.org/pubs/tools/TL221.html; Centers for Disease Control and Prevention (CDC), National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP). (2019b). Multiple chronic conditions. Retrieved on 11/25/20 at: www.cdc.gov/chronicdisease/about/multiple-chronic.htm

Health Disparities and Chronic Disease

Although chronic disease occurs in all socioeconomic groups, people from low-income and disadvantaged backgrounds are more likely to report poor health. Factors such as poverty and inadequate health insurance decrease the likelihood that people with chronic illness or disability receive health care and preventive health-screening measures such as mammography, cholesterol testing, and routine checkups (National Academies of Sciences, Engineering, and Medicine [NASEM], 2017; Raghupathi & Raghupathi, 2018). In addition, chronic conditions can lead to poverty for the patient and the family. There also are implications for society or the nation as a whole, because chronic conditions or subsequent premature deaths occur most commonly during the most productive years for people with chronic conditions.

Disparities in health and health outcomes are associated with social, economic, and environmental disadvantages. Although the gap between health outcomes in African Americans and Caucasians has decreased in some areas, in others (e.g., mortality due to breast cancer) the gaps have increased. Disparities in health and health outcomes are associated with higher incidence and prevalence, earlier onset, faster progression, and poorer outcomes of disease and conditions (NASEM, 2017; Raghupathi & Raghupathi, 2018).

Some chronic conditions have little effect on quality of life, whereas others have a major effect because they result in disability. However, not all disabilities are a result of chronic illness, and not all chronic illnesses cause disability. Unlike the term *acute,* which implies a curable and relatively short disease course, the term *chronic* describes a long disease course that may be incurable. This often makes managing chronic conditions difficult for those who live with them. Yet nurses can and do make a difference in the experience of chronic illness by providing quality nursing care in the absence of a cure (Larsen, 2019).

Psychological and emotional reactions of patients to acute and chronic conditions and changes in their health status are described in Chapter 5. People who develop chronic conditions or disabilities may react with shock, disbelief, anger, resentment, or other emotions. How people react to and cope with chronic illness is usually similar to how they react to other events in their lives, depending, in part, on their understanding of the condition and their perceptions of its potential impact on their own and their family's lives. Adjustment to chronic illness (and disability) is affected by various factors:

- Suddenness, extent, and duration of lifestyle changes necessitated by the illness
- Uncertainty related to the course and outcome of chronic illnesses
- Family and individual resources for dealing with stress
- Availability of support from family, friends, and the community
- Stages of individual/family life cycle
- Previous experience with illness and crises

- Underlying personality characteristics
- Unresolved anger or grief from the past

Psychological, emotional, and cognitive reactions to chronic conditions are likely to occur at their onset and to recur if symptoms worsen or return after a period of remission. Symptoms associated with chronic health conditions are often unpredictable and may be perceived as crisis events by patients and their families, who must contend with both the uncertainty of chronic illness and the changes it brings to their lives. The possible effects of chronic conditions can guide nursing assessment and interventions for the patient who has a chronic illness.

Definitions of Chronic Diseases or Conditions

Chronic diseases or conditions are often defined as medical conditions or health problems with associated symptoms or disabilities that require long-term management. Chronic diseases are those that persist for months or years rather than days or weeks (Larson, 2019). The National Center for Health Statistics defines chronic disease as a condition lasting 3 or more months; the CDC's National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP) (CDC, 2019a) defines it as a condition that lasts for a year or more and that can usually be controlled but not cured. Definitions of chronic disease or chronic illness share the characteristics of being irreversible, having a prolonged course, and remaining unlikely to resolve spontaneously (Larsen, 2019). The specific chronic condition may be a result of illness, genetic factors, or injury; it may be a consequence of conditions or unhealthy behaviors that began during childhood and young adulthood.

The social determinants of health (SDOH) provide a useful framework to identify factors that affect a person's or a population's health, including the prevalence of chronic disease, its management, the quality of health care that is available, and the outcomes of chronic disease. The main SDOH that have been identified include income and social status, employment and working conditions, education and literacy, childhood experiences, physical environment, social supports and coping skills, healthy behaviors, access to health services, biology and genetic makeup, gender, culture, race and ethnicity (Office of Disease Prevention and Health Promotion, 2019).

The effect of SDOH is illustrated by large discrepancies in life expectancy, up to a 48-year difference among countries and 20 years or more within countries. Deaths due to chronic disease are expected to increase globally, from 41 million deaths reported in 2016 (many of which were premature) to 52 million per year by 2030 (Raghupathi & Raghupathi, 2018; WHO, 2018c, 2019).

Management of chronic conditions includes learning to live with symptoms or resulting disabilities and coming to terms with identity changes resulting

from having a chronic condition. Management also consists of carrying out the lifestyle changes and regimens designed to control symptoms and prevent complications. Although some people assume what might be called a "sick role" identity, most people with chronic conditions do not consider themselves to be sick or ill and try to live as normal a life as possible. Only when complications develop or symptoms interfere with ADLs do most people with chronic health conditions think of themselves as being sick or having a disability.

Prevalence and Causes of Chronic Conditions

Chronic conditions occur in people of every age group, socioeconomic level, race, and culture. Six in 10 adults in the United States have a chronic disease. Chronic diseases are the most common causes of death in the United States; the most frequently occurring chronic diseases account for 7 of the 10 leading causes of death, with cancer and heart disease together accounting for nearly half of all deaths. Globally, chronic diseases are responsible for more than two thirds of deaths. Chronic diseases include cancers, cardiovascular disease, diabetes, and chronic lung diseases (CDC, 2019a).

Chronic diseases or disorders are one of the major health and development challenges of this century because of their global impact on human, social, and financial well-being and status. Although chronic diseases affect all countries, their impact is more severe in low- and middle-income countries, with devastating consequences in poor and vulnerable populations. Chronic diseases cause more deaths than all other causes combined, and lifespan is shortened by chronic illnesses in those countries.

It is predicted that by the year 2030, about half the population will have a chronic disease or disorder. One fifth of those with chronic disease also have an activity limitation. As the incidence of chronic diseases increases, the costs associated with these chronic conditions (e.g., hospital costs, equipment, medications, supportive services) also increase. These costs represent four of every five health care dollars expended. In the United States, chronic diseases are also leading drivers of the nation's $3.5 trillion in annual health care costs (NCCDPHP, 2020; Raghupathi & Raghupathi, 2018).

Although some chronic diseases are associated with nonmodifiable factors, including genetic and physiologic factors, many are the result of unhealthy lifestyles. Most chronic diseases are caused by four major behaviors: use of tobacco, electronic nicotine delivery systems (ENDS), and exposure to secondhand smoke; poor nutrition (diets high in sodium and saturated fats and low in fruits and vegetables); lack of physical activity; and excessive consumption of alcohol (CDC, 2019a; WHO, 2018c). Because these behaviors are modifiable, nurses have a major role in the prevention of chronic disorders

associated with these behaviors (for more detailed information, see later discussion in section on Prevention of Chronic Disease).

Some chronic health conditions cause little or no inconvenience; others are severe enough to cause major activity limitations that may prevent people from meeting their needs for health care and personal services. For example, they may be unable to carry out their therapeutic regimens or have their prescriptions filled on time, may miss appointments and office visits with their health care providers, and may be unable to manage ADLs.

Chronic diseases are a global issue that affects both rich and poor nations. The total number of people dying from chronic disease is twice that of patients dying from infectious (including human immunodeficiency virus infection), maternal, and perinatal conditions, and nutritional deficiencies combined (WHO, 2019). Most of these chronic diseases and complications of chronic illness are preventable, emphasizing the importance of health promotion across the globe. Although chronic diseases or illnesses are common, people have many myths or misunderstandings about them (Table 7-1).

Causes of the increasing number of people with chronic conditions include the following:

- A decrease in mortality from infectious diseases (e.g., smallpox, diphtheria, acquired immune deficiency syndrome [AIDS]–related infections) because of immunizations and new drug development and from acute conditions (e.g., myocardial infarction, trauma) because of prompt and aggressive management.
- Lifestyle factors such as smoking, chronic stress, poor nutrition, and sedentary lifestyle that increase the risk of chronic health problems such as respiratory disease, hypertension, cardiovascular disease, and obesity. Although signs and symptoms of chronic illness often first appear during older age, risks typically begin earlier in life, even during fetal development.
- Obesity, often due to lifestyle issues, has become a major health issue across the lifespan and across the globe with about 2.1 billion people overweight and one third of them having obesity. Obesity is no longer limited to high-income countries but increasingly occurs in low- and middle-income countries. The proportion of adults with a body mass index (BMI) of 25 or greater increased between 1980 and 2013 from about 29% to 37% in men and about 30% to 38% in women (Kushner & Kahan, 2018). It is estimated that unless this trend is reversed, almost half of the world's population will be overweight or have obesity by 2030. Approximately 5% of deaths worldwide are due to obesity (Tremmel, Gerdtham, Nilsson, et al., 2017). The increasing prevalence of obesity has increased the incidence of heart disease, strokes, diabetes,

and hypertension. Obesity also affects one's self-esteem, achievement, and emotional state. In 2015, high BMI contributed to four million deaths globally, which was over 7% of deaths from any cause (Kushner & Kahan, 2018).

TABLE 7-1 Myths and Truths About Chronic Disease

Common Misconceptions About Chronic Disease	The Reality About Chronic Disease
1. Everyone dies of something.	Chronic illnesses typically do not result in sudden death but often result in progressive illness and disability. People with chronic disease often die slowly, painfully, and prematurely.
2. People can live to old age even if they lead unhealthy lives (smoke, have obesity).	While there are exceptions (some people who live unhealthy lives live to old age, and some people who live healthy lives develop chronic illnesses), most chronic illnesses can be traced to modifiable risk factors and can be prevented by eliminating these risks.
3. Solutions for chronic disease prevention and control are expensive and not feasible for low- and middle-income countries.	A full range of chronic disease interventions are very cost-effective for all regions of the world, including the poorest. Many of these interventions are inexpensive to implement.
4. Nothing can be done to prevent chronic diseases.	The major causes of chronic diseases are known, and if these risk factors were eliminated, at least more than 80% of heart disease, stroke, and type 2 diabetes and more than 40% of cancers would be prevented.
5. If individuals develop chronic disease as a result of unhealthy "lifestyles," they have only themselves to blame.	Individual responsibility can have its full effect only if individuals have equal access to a healthy life and are supported to make healthy choices. People who are poor often have limited choices about the food they eat, their living conditions, and access to education and health care.
6. Certain chronic diseases primarily affect men.	Chronic diseases, including heart disease, affect women and men almost equally. Almost half of all deaths attributed to chronic illness occur in women.
7. Chronic diseases primarily affect people who are old.	Almost half of chronic disease deaths occur prematurely in people younger than 70 years of age.
8. Chronic diseases mainly affect people who are rich (affluent).	People who are poor are much more likely than those who are wealthy to develop chronic diseases and as a result are more likely to die prematurely. Chronic diseases cause substantial financial burden and result in extreme poverty.
9. The priority of low- and middle-income countries should be on control of infectious diseases.	Although infectious diseases are an issue, low- and middle-income countries are experiencing a dramatic increase in chronic disease risk factors and deaths, especially in urban settings.
10. Chronic diseases affect mostly high-income countries.	Eighty percent of deaths attributed to chronic disease are in low- and middle-income countries. The prevalence of chronic diseases in low- and middle-income countries is rapidly growing.

Adapted from World Health Organization (WHO). (2005). Face the facts #2: Widespread misunderstandings about chronic disease—and the reality. Retrieved on 7/15/2019 at: www.who.int/chp/chronic_disease_report/media/Factsheet2.pdf

- Longer lifespans because of advances in technology and pharmacology, improved nutrition, safer working conditions, and greater access (for some people) to health care.
- Improved screening and diagnostic procedures enabled early detection and treatment of diseases, resulting in improved outcomes of management of cancer and other disorders.

Physiologic changes in the body often occur before the appearance of symptoms of chronic disease. Therefore, the goal of emphasizing healthy lifestyles early in life is to improve overall health status and slow the development of such disorders. In addition, serious psychiatric or mental illness disorders puts people at greater risk for chronic illness than the general population and leads to higher morbidity and mortality rates of chronic diseases (National Prevention Council, 2016).

Prevention of Chronic Disease

The CDC (2019a) has identified risk factors for common chronic diseases and pointed out that most American adults have more than one of the following risk factors:

- Hypertension (high blood pressure)
- Tobacco and ENDS use or exposure to secondhand smoke
- Overweight or obesity (high BMI)
- Lack of physical activity
- Excessive alcohol use
- Consumption of diets low in fruits and vegetables
- Consumption of food high in sodium and saturated fats

The WHO (2005, 2013) has identified high-impact, cost-effective interventions to prevent premature death due to chronic disease or chronic conditions that can be implemented even in settings with limited resources. These interventions, summarized in Chart 7-9, are consistent with the risk factors for chronic disease identified by the CDC.

Patient education to prevent chronic disease or reduce its severity or effects is another important component of the nurse's role in working with patients to identify risks for chronic disease and to identify strategies to reduce those risks. Health promotion and patient education are discussed in detail in Chapter 3 in this book.

Characteristics of Chronic Conditions

Sometimes it is difficult for people who are disease free to understand the profound effect that chronic illness often has on the lives of patients and their families. It is easy for health professionals to focus on the illness or disability itself while overlooking the person who has the disorder. In all illnesses, but even more so with chronic conditions, the illness cannot be separated from the person. People with chronic illness must contend with it daily (Larsen, 2019). To properly manage their chronic condition, individuals often have to find the time, as well as the social and financial resources, to participate in physically and psychologically beneficial activities, work with health care professionals to follow treatment guidelines, monitor their health and make decisions about their health and lifestyle and those of their family, and manage the effects of the illness on their physical, psychological, and social well-being. To relate to what people must cope with or to plan effective interventions, nurses must understand the multiple characteristics of a chronic illness.

Chart 7-9

Interventions According to Risk Factors

Tobacco

- Reduce affordability of tobacco and electronic nicotine delivery systems (ENDS) including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars by increasing their costs.
- Legally mandate smoke-free environments in all indoor workplaces, public places, and public transport.
- Disseminate warnings about dangers of tobacco, tobacco smoke, and ENDS through mass media campaigns and ban all forms of tobacco advertising, promotion, and sponsorship.

Harmful Use of Alcohol

- Reduce affordability of alcohol by increasing its costs.
- Limit availability of alcohol.
- Ban all forms of alcohol advertising and promotions.

Diet and Physical Activity

- Promote reduction of dietary salt intake and replacement of trans fats with unsaturated fats.
- Implement public awareness programs on diet and physical activity.
- Promote and protect breast-feeding (reduces risk of obesity later in life).

Cardiovascular Disease and Diabetes

- Promote glycemic control for diabetes and control of hypertension using medication therapy.
- Counsel individuals who have had a heart attack or stroke and those people at high risk of a fatal and nonfatal cardiovascular event in the next 10 years.
- Initiate acetylsalicylic acid (aspirin) use for acute myocardial infarction.

Cancer

- Promote hepatitis B immunization to prevent liver cancer.
- Promote screening, immunization with the HPV vaccine, and early treatment of precancerous lesions to prevent cervical cancer.

Adapted from World Health Organization (WHO). (2013). Global action plan for the prevention and control of noncommunicable diseases, 2013–2020. Geneva, Switzerland: Author.

- Psychological and social issues: Managing chronic illness involves more than treating medical problems. Associated psychological and social issues must also be addressed, because living for long periods

with illness symptoms and disability can threaten identity, bring about role changes, alter body image, and disrupt lifestyles, work, and family life. These changes require continuous adaptation and accommodation, depending on the patient's age and situation in life. Each change or decline in functional ability requires physical, emotional, and social adaptation for patients and their families (Corbin, 2003; Larsen, 2019).

- Course of chronic disease: Chronic health conditions usually involve many different phases over the course of a person's lifetime. There can be acute periods, stable and unstable periods, flare-ups, and remissions. Each phase brings its own set of physical, psychological, and social problems, and each requires its own regimens and types of management. Individuals with chronic illnesses may experience high levels of stress or anxiety with each change in the course of their illness.
- Progression of chronic disease: The rate of progression of chronic diseases can vary from a rapid downhill course leading quickly to disability and death within a few months of onset to those with a slow downhill progression over years. Others may be characterized by disappearance of signs and symptoms with a return to "normal" with later return of symptoms, or relapses.
- Therapeutic regimens: Keeping chronic conditions under control requires persistent adherence to therapeutic regimens that may be complex and may interfere with usual activities or even life goals. Failing to adhere to a treatment plan or to do so consistently increases the risks of developing complications and accelerating the disease process. However, the realities of daily life, including the impact of culture, values, and socioeconomic factors, affect the degree to which people adhere to a treatment regimen. Managing a chronic illness takes time, requires knowledge and often planning, and can be uncomfortable and inconvenient. It is not unusual for patients to stop taking medications or alter dosages because of side effects that are more disturbing or disruptive than symptoms of the illness, or to cut back on regimens they consider overly time-consuming, fatiguing, or costly (Corbin, 2003; Larsen, 2019).
- Development of other chronic conditions: One chronic disease can lead to the development of other chronic conditions. Diabetes, for example, can lead to neurologic and vascular changes that may result in visual, cardiac, and kidney diseases and erectile dysfunction. The presence of a chronic illness also contributes to a higher risk of morbidity and mortality in patients admitted to the intensive care unit with acute health conditions as well as greater utilization of clinical services during hospitalization.

- Family life: Chronic illness affects the entire family. Family life can be dramatically altered as a result of role reversals, unfilled roles, loss of income, time required to manage the illness, decreases in family socialization activities, and the costs of treatment. Family members often become caregivers for the person with chronic illness while trying to continue to work and keep the family intact. Over 16.6% of the U.S. adult population are considered caregivers for a family member with a chronic illness, or with a disability, or who is an older adult. Although many caregivers derive positive effects from providing care, many are employed and attempting to maintain as normal a life as possible for their families. Stress, depression, fatigue, and loss of sleep as well as missed days of work are not uncommon. Thus, the wellbeing of caregivers merits attention by nurses and other health care providers (Hopps, Iadeluca, & McDonald, 2017).
- Home life: The day-to-day management of illness is largely the responsibility of people with chronic disorders and their families. As a result, the home, rather than the hospital, is the center of care in chronic conditions. Hospitals, clinics, primary care providers' offices, nursing homes, nursing centers, and community agencies (home care services, social services, and disease-specific associations and societies) are considered adjuncts or backup services to daily home management.
- Self-management: The management of chronic conditions is a continual process. People can be taught how to manage their conditions. However, each patient must discover how his or her own body reacts under varying circumstances—for example, what it is like to be hypoglycemic, what activities are likely to bring on angina, and how these or other conditions can best be prevented and managed.
- Collaborative process: Managing chronic conditions must be a collaborative process that involves many different health care professionals working together with patients and their families to provide the services and supports that are often needed for management at home. The medical, social, and psychological aspects of chronic health problems are often complex, especially in severe conditions.
- Health care costs: The management of chronic conditions is expensive. Many expenses incurred by an individual patient (e.g., costs for hospital stays, diagnostic tests, equipment, medications, and supportive services) may be covered by health insurance and by federal and state agencies. The Patient Protection and Affordable Care Act (ACA), passed in 2010, the most significant change to health care policy in the United States since the establishment of

Medicare and Medicaid, has made available health insurance for many previously uninsured individuals who were unable to obtain health insurance. The ACA has ended lifetime and most annual limits on health care, provided patients with access to recommended preventive services, and banned the practice of denying coverage because of the presence of a preexisting health condition (Krahn et al., 2015).

- Lost income: Direct out-of-pocket expenses can represent a significant percent of income, especially in low- and middle-income families. These expenses include high copays and deductibles that must be paid out of pocket. Those with serious chronic disorders may have difficulty paying for care, resulting in bankruptcy or having to rely on family or friends to pay for health insurance or health care. People from low-income groups who do not receive adequate health care get sicker and die sooner from chronic diseases than those from groups with higher levels of education, greater financial resources, and access to care (WHO, 2017a). If a family's primary income earner becomes ill, chronic diseases can result in drastic loss in income with inadequate funds for food, education, and health care. Furthermore, affected families may become unstable and impoverished.
- Ethical issues: Chronic conditions raise difficult ethical issues for patients, families, health care professionals, and society. Issues include how to control costs, how to allocate scarce resources (e.g., organs for transplantation), what constitutes quality of life, and if and when life support should be withdrawn.
- Living with uncertainty: Having a chronic illness means living with uncertainty. Although health care providers may be aware of the usual progression of a chronic disease such as Parkinson's disease or multiple sclerosis, no one can predict with certainty the course of a person's illness. Even when a patient is in remission or symptom free, the person often fears that symptoms will reappear.

Implications of Managing Chronic Conditions

Chronic conditions have implications for everyday living and management for people and their families as well as for society at large (Larsen, 2019). Most importantly, individual efforts should be directed at preventing chronic conditions, because many—but not all—chronic illnesses or disorders are linked to unhealthy lifestyles or behaviors such as smoking and overeating. Therefore, changes in lifestyle can prevent some chronic disorders or at least delay onset until a later age. Because most people resist change, bringing about alterations in people's lifestyles is a major challenge for nurses.

Once a chronic condition has occurred, the focus shifts to managing symptoms, avoiding complications (e.g., eye complications in a person with diabetes), and preventing other acute illnesses (e.g., pneumonia in a person with chronic obstructive lung disease). Quality of life—often overlooked by health care professionals in their approach to people with chronic conditions—is also important. Health-promoting behaviors, such as exercise, are essential to quality of life even in people who have chronic illnesses or disabilities, because it helps maintain functional status (Larsen, 2019).

Although coworkers, extended family, and health care professionals are affected by chronic illnesses, the problems of living with chronic conditions are most acutely experienced by individuals and their immediate families. They experience the greatest impact, with lifestyle changes that directly affect quality of life. Nurses provide not only direct care, especially during acute episodes, but also education and they help secure the resources and other supports that enable people to integrate their illness into their lives and to have an acceptable quality of life despite their chronic condition. To understand essential nursing care, it is important to recognize and appreciate the issues that people with chronic illness and their families contend with and manage, often on a daily basis (Larsen, 2019). Ultimately the course of the chronic illness and its outcomes, including end-of-life decisions, are determined in large part by the patient and family.

Many people with chronic disease or chronic illness must face an additional challenge: the need to deal with more than one chronic condition at a time (CDC, 2019b; Raghupathi & Raghupathi, 2018). The symptoms or treatment of a second chronic condition may aggravate the first chronic condition. Patients need to be able to deal with their various chronic conditions separately as well as in combination and to coordinate the health care and directions they receive, often from more than one health care professional.

Often challenging for many people with chronic illness is the need to hire and oversee caregivers who come into their homes to assist with ADLs and IADLs, such as shopping for food, doing laundry, housekeeping, and handling financial matters. It is difficult for many people to be in a position of hiring, supervising, and sometimes firing people who may provide them with intimate physical care. The need to balance the role of recipient of care and oversight of the person providing care may lead to blurring of role boundaries.

The challenges of living with and managing a chronic illness are well known, and people with chronic illnesses often report receiving inadequate care, information, services, and counseling. This provides an opportunity for nurses to assume a more active role in addressing many of the issues experienced, coordinating care, and serving as advocates for patients who need additional assistance to manage their illness while maintaining a quality of life that is acceptable to them.

Veterans Considerations

Gulf War Illness (GWI) is a chronic illness or syndrome that has been reported in veterans who served in the U.S. military in the Gulf War following the September 11, 2001 ("911") terrorist attacks (Baldwin, Rudquist, Lava-Parmele, et al., 2019). Similar to GWI, the term chronic multisymptom illness (CMI) defines a set of nonspecific symptoms experienced by veterans who served in the Gulf War in 1990–1991 and report one or more symptom lasting more than 6 months in at least two of three categories: fatigue, depressed mood and altered cognition, and musculoskeletal pain. The term, CMI, may be employed when the symptoms are moderate to severe and have no other explanation. There is speculation that GWI and CMI may be a consequence of exposure of veterans to biologic and chemical toxins during their military service. Veterans with symptoms of both GWI and CMI want and need to be taken seriously by health care professionals.

Gerontologic Considerations

The U.S. demographic profile reflects an increased number of older adults with chronic illnesses and those with MCC. By 2060, the number of older adults is expected to more than double to 98.2 million; the number of people 85 years of age and older is expected to triple to 19.7 million. The ratio of women and men who are 65 years of age and older is 127 women for every 100 men. In 2014, there were 75.4 million baby boomers (people born between 1946 and 1964) accounting for almost one quarter of the population. Baby boomers began turning 65 years old in 2011, contributing to the increase in numbers of older adults. Most older adults have at least one chronic condition and three in every four older Americans have MCC (AARP, 2017; Raghupathi & Raghupathi, 2018). Some of the most frequently occurring conditions among older Americans are arthritis, cancer, cardiac disease, type 2 diabetes, and hypertension.

Treatment for older adults with chronic illness accounts for 66% of total U.S. health care expenditures (CDC, 2018). The cost of providing health care for a person 65 years of age or older is estimated to be three to five times higher than costs for someone younger than 65 years. Chronic conditions increase the risk for death due to influenza and pneumonia among older adults, although effective vaccines for them exist. The WHO (2017b) has issued guidelines for community-level interventions aimed at preventing declines in older people as they age.

In 2014, about 28% (12.6 million) of all older adults in the United States lived alone (8.8 million women, 3.8 million men). They represented 35% of older women and 19% of older men. Almost half of women aged 75 and older

live alone; many of them live below the poverty level (Administration for Community Living, 2018). The living arrangements of older adults with chronic illness have important nursing implications for preparing those who are hospitalized for discharge and for ensuring coordination of services.

Nursing Care of Patients with Chronic Conditions

Nursing care of patients with chronic conditions is varied and occurs in a variety of settings. Care may be direct or supportive. Direct care may be provided in the clinic or primary care provider's office, a nurse-managed center or clinic, a hospital, long-term care facility, or the patient's home. Direct care includes assessing the patient's physical status, providing wound care, managing and overseeing medication regimens, providing education to the patient and family, and performing technical tasks. The availability of this type of nursing care may allow the patient to remain at home and return to a more normal life after an acute episode of illness.

Because much of the day-to-day responsibility for managing chronic conditions rests with the patient and the family, nurses often provide supportive care at home. Supportive care may include ongoing monitoring, education, counseling, serving as an advocate for the patient, making referrals, and case management. Giving supportive care is just as important as giving direct physical care. For example, through ongoing monitoring either in the home or in a clinic, a nurse might detect early signs of impending complications and make a referral (e.g., contact the primary health care clinician or consult the medical protocol in a clinic) for medical evaluation, thereby preventing a lengthy and costly hospitalization.

Keeping in mind the many facets and implications of chronic health conditions and their potential impact on patients and families will enable the nurse to provide direct physical care to the patient when warranted, to address the emotional and psychological needs of the patient and family, and to prepare and assist patients and family caregivers to assume management of the condition. By doing so, the nurse can help patients and families maintain as normal a life as possible and as they desire.

Working with people with chronic illness requires not only dealing with the medical aspects of their disorder but also working with the whole person—physically, emotionally, and socially. This holistic approach to care requires nurses to draw on their knowledge and skills, including knowledge from the social sciences and psychology, in particular. People often respond to illness, health education, and regimens in ways that differ from the expectations of health care providers. Although quality of life is usually affected by chronic illness, especially if the illness is severe, patients' perceptions of what constitutes quality of life often drive their management behaviors or affect how

they view advice about health care. Nurses and other health care professionals need to recognize this, even though it may be difficult to see patients make unwise choices and decisions about lifestyles and disease management. People have the right to receive care without fearing ridicule or refusal of treatment, even if their behaviors (e.g., smoking, substance abuse, overeating, failure to follow health care providers' recommendations) may have contributed to their chronic disorder.

Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

Because chronic conditions are so costly to people, families, and society, two of the major goals of nursing are the prevention of chronic conditions and the care of people with them. This requires promoting healthy lifestyles and encouraging the use of safety and disease prevention measures, such as wearing seat belts and obtaining immunizations. Prevention should also begin early in life and continue throughout life. Education on self-care may need to address interactions among the patient's chronic conditions as well as skills necessary to manage the individual diseases and their interactive effects.

Patient and family education is an important nursing role that may make the difference in the ability of the patient and the family to adapt to chronic conditions. Well-informed, educated patients are more likely than uninformed patients to be concerned about their health and do what is necessary to maintain it. They are also more likely to manage symptoms, recognize the onset of complications, and seek health care early. Knowledge is the key to making informed choices and decisions during all phases of the chronic illness trajectory.

Despite the importance of educating the patient and the family, the nurse must recognize that patients recently diagnosed with serious chronic conditions and their families may need time to understand the significance of their condition and its effect on their lives. Education must be planned carefully so that it is not acute. Furthermore, it is important to assess the impact of a new diagnosis of chronic illness on a patient's life and the meaning of self-management to the patient.

The nurse who cares for patients with chronic conditions in the hospital, clinic, home, or any other setting should assess patient's knowledge about their illness and its management; the nurse cannot assume that patients with a long-standing chronic condition have the knowledge necessary to manage the condition. Patients' learning needs change as the chronic condition changes and their personal situations change. The nurse must also recognize that patients may know how their body responds under certain conditions and how

best to manage their symptoms. Contact with patients in any setting offers nurses the ideal opportunity to reassess patients' learning needs and provide additional education about a chronic condition and its management.

Educational strategies and materials should be adapted to the individual patient so that the patient and the family can understand and follow recommendations from health care providers. For instance, educational materials should be tailored for people with low literacy levels and available in several languages and in various alternative formats (e.g., Braille, large print, audiotapes). It may be necessary to provide sign language interpreters.

Continuing and Transitional Care

Chronic illness management is a collaborative process between the patient, family, nurse, and other health care providers. Collaboration extends to all settings and throughout the illness trajectory. Keeping an illness stable over time requires careful monitoring of symptoms and attention to management regimens. Detecting problems early and helping patients develop appropriate management strategies can make a significant difference in outcomes.

Most chronic conditions are managed in the home. Therefore, care and education during hospitalization should focus on essential information about the condition so that management can continue once the patient is discharged home. Nurses in all settings should be aware of the resources and services available in a community and should make the arrangements (before hospital discharge, if the patient is hospitalized) to secure those resources and services. When appropriate, home care services are contacted directly. The home health nurse reassesses how the patient and the family are adapting to the chronic condition and its treatment and continues or revises the plan of care accordingly.

Because chronic conditions occur worldwide and the world is increasingly interconnected, nurses should think beyond the personal level to the community and global levels. In terms of illness prevention and health promotion, this entails wide-ranging efforts to assess people for risks of chronic illness (e.g., blood pressure and diabetes screening, stroke risk assessments) and group education related to illness prevention and management. In addition, nurses should remind patients with chronic illnesses or disabilities and their families about the need for ongoing health promotion and preventive health screening recommended for all people, because chronic illness and disability are often considered the main concern while other health-related issues are ignored (see Chart 7-6).

Telehealth or telehomecare (use of electronic data and telecommunications technologies to support long-distance clinical health care, patient and professional health-related education, public health, and health administration) has been used effectively to provide care for patients with chronic illness. It is particularly useful in monitoring patients with chronic conditions living in

rural areas (Health Resources & Services Administration, 2013). It has also been used to deliver select medical and nursing interventions (e.g., counseling) and provide ongoing education and support.

Transitional care, if available, should be considered and implemented when the patient has MCC, has impaired cognitive status as well as physical limitations, has complex therapies, or is frail or unstable prior to discharge from the hospital to home. Transitional care nurses serve as the primary coordinator of care. These nurses conduct assessments of the patient as well as the family caregivers' ability to assist in management of the patient in the home. Nurses in this role help the patient and the family set goals during hospitalization, identify the reasons for the patient's current health status, design a plan of care that addresses them, make home visits, provide telephone support, and coordinate various care providers and services (Naylor et al., 2017) (see Chapter 2).

Nursing Care for Special Populations with Chronic Illness

When providing care and education, the nurse must consider multiple factors (e.g., age; gender; culture and ethnicity; cognitive status; the presence of physical, sensory, and cognitive limitations; health literacy) that influence susceptibility to chronic illness and the ways patients respond to chronic disorders. Certain populations, for example, tend to be more susceptible to certain chronic conditions. Populations at high risk for specific conditions can be targeted for special education and monitoring programs; this includes those at risk because of their genetic profile (see Chapter 6 for further discussion of genomics and genetics). People of different cultures and genders may respond to illness differently, and being aware of these differences is essential. For cultures in which patients rely heavily on the support of their families, the families must be involved and made part of the nursing plan of care. As the United States becomes more multicultural and ethnically diverse, and as the general population ages, nurses need to be aware of how a person's culture and age affect chronic illness management and be prepared to adapt their care accordingly.

It is important to consider the effect of a preexisting disability, or a disability associated with recurrence of a chronic condition, on the patient's ability to manage ADLs, self-care, and the therapeutic regimen. These issues were discussed earlier in this chapter.

CRITICAL THINKING EXERCISES

1 ebp A 70-year-old man is hospitalized for congestive heart failure. He has an above-the-knee amputation because of an injury that occurred 40 years ago as well as significant hearing loss due to exposure to loud noise in his work and lack of ear protection. In providing discharge planning for him, what evidence-based education is warranted to ensure that he is able to monitor his cardiac status? What evidence-based safety precautions are warranted? How would you modify education because of his hearing loss?

2 ipc A 28-year-old woman with paraplegia experienced since she was 14 years of age is hospitalized with a large sacral pressure injury due to her failure to relieve pressure points when in her wheelchair. She is scheduled for surgery to débride the pressure injury followed by placement of a graft to the area. She acknowledges that she has difficulty following medical advice and is eager to be discharged from the hospital as soon as possible to return home because she becomes depressed when she is away from her home and her boyfriend. What nursing and interprofessional assessments are indicated during your initial interactions with her? What interventions, including education, will you implement during her postoperative recovery? What other interprofessional services might you try to engage so she can make the best transition back to her home setting?

3 pq A 48-year-old woman with multiple sclerosis has experienced frequent relapses, increasing mobility limitations with each relapse, and mild cognitive impairment. She is now hospitalized with a diagnosis of possible pneumonia and a urinary tract infection. Her daughter has asked you, her mother's primary nurse, for assistance in making alternative living arrangements for her mother; the daughter tells you she is exhausted and frustrated by providing care for her mother and her own two children while trying to maintain her full-time job as an administrative assistant. How would you approach this situation? What is your priority in assessing the situation and taking action to assist this family?

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

AbleData, www.abledata.com or www.healthfinder.gov/FindServices/Organizations/Organization.aspx?code=HR2423
Advancing Care Excellence for Persons with Disabilities (ACE.D) (National League for Nursing), www.nln.org/professional-development-programs/teaching-resources/ace-d
Alliance for Disability in Health Care Education, Inc., www.ADHCE.org
American Academy of Developmental Medicine & Dentistry (AADMD), www.aadmd.org
American Association of the DeafBlind, www.aadb.org
American Association on Intellectual and Developmental Disabilities, www.aaidd.org
American Foundation® for the Blind, www.afb.org
American Speech-Language-Hearing Association, www.asha.org
Americans With Disabilities Act | National Network, www.adata.org
Arc of the United States, www.thearc.org
Association of Late-Deafened Adults, ALDA, Inc., www.alda.org
Center for Research on Women with Disabilities (CROWD), www.bcm.edu/crowd
Centers for Medicare & Medicaid Services (CMS), www.cms.gov
Developmental Disabilities Nurses Association (DDNA), www.ddna.org
Fact Sheet: The Affordable Care Act and The Disability Community, www.advocacymonitor.com/fact-sheet-the-affordable-care-act-and-the-disability-community
National Aphasia Association (NAA), www.aphasia.org
National Center for Learning Disabilities, www.ncld.org
National Organization for Rare Disorders (NORD), Through the Looking Glass, www.rarediseases.org/organizations/through-the-looking-glass

The Lurie Institute for Disability Policy | The Heller School for Social Policy and Management. Brandeis University, www.lurie.brandeis.edu
United Cerebral Palsy (UCP), www.ucp.org
United Spinal Association, www.unitedspinal.org
U.S. Department of Labor, Office of Disability Employment Policy, www.dol.gov/odep/topics/disability.htm

8 Management of the Older Adult Patient

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Specify the demographic trends and the physiologic aspects of aging in the United States.
2. Describe the significance of preventive health care and health promotion for the older adult.
3. Compare and contrast the common physical and mental health problems of aging and their effects on the functioning of older adults and their families.
4. Identify the role of the nurse in meeting the health care needs of the older patient.
5. Examine common health issues of older adults and their families in the home and the community, in the acute care setting, and in the long-term care facility.

NURSING CONCEPTS

Development
Ethics and Legal Issues
Family
Health, Wellness, and Illness

GLOSSARY

activities of daily living (ADLs): personal care activities such as bathing, dressing, grooming, eating, toileting, and transferring

ageism: a bias that discriminates, stigmatizes, and disadvantages older adults based solely on their chronologic age

comorbidity: having more than one illness at the same time (e.g., diabetes, congestive heart failure)

depression: the most common affective (mood) disorder of old age; results from changes in reuptake of the neurochemical serotonin in response to chronic illness and emotional stresses

durable power of attorney: a formal, legally endorsed document that identifies a proxy decision maker who can make decisions if the signer becomes incapacitated

elder abuse: the physical, emotional, or financial harm to an older person by one or more of the person's children, caregivers, or others; includes neglect

geriatric syndromes: common conditions found in older adults that tend to be multifactorial and do not fall under discrete disease categories; these conditions include falls, delirium, frailty, dizziness, and urinary incontinence

geriatrics: a field of practice that focuses on the physiology, pathology, diagnosis, and management of the disorders and diseases of older adults

gerontologic/geriatric nursing: the field of nursing that relates to the assessment, planning, implementation, and evaluation of older adults in all environments, including acute, intermediate, and skilled care, as well as within the community

gerontology: the combined biologic, psychologic, and sociologic study of older adults within their environment

instrumental activities of daily living (IADLs): complex skills needed for independent living, such as shopping, cooking, housework, using the telephone, managing medications and finances, and being able to travel by car or public transportation

orientation: a person's ability to recognize who and where they are in a time continuum; used to evaluate one's basic cognitive status

polypharmacy: the use of multiple prescription and over-the-counter (OTC) medications

presbycusis: decreased ability to hear high-pitched tones that naturally begins in midlife as a result of irreversible inner ear changes

presbyopia: decrease in visual accommodation that occurs with advancing age

urinary incontinence: unplanned, involuntary, or uncontrolled loss of urine

Aging, the normal process of time-related change, begins with birth and continues throughout life. Americans are living longer than any previous generation. With the baby boomers turning 65 years of age beginning in 2010, older Americans are the most rapidly expanding portion of the population. In 2016, 3.5 million people celebrated their 65th birthdays. It is projected that 10,000 older adults will celebrate their 65th birthday each year until the year 2030 (Administration on Aging [AoA], 2020). Whenever nurses work with adults, they are likely to encounter older adult patients. This chapter presents demographics of aging, normal age-related changes, health problems associated with aging, and ways that nurses can influence the quality of life and address the health issues of older adults.

Overview of Aging

Demographics of Aging

The proportion of Americans 65 years of age and older has increased from 37 million in 2006 to 49.2 million in 2016 (a 33% increase). It is projected that by 2060, the older adult population will double to 98 million. Currently one in every seven persons is an older adult, or 15.2% of the population. As the older adult population increases, the number of people who live to a very old age is also dramatically increasing. The greatest growth in the older adult population is for those aged 85 years and older; this population is projected to more than double from 6.4 million in 2016 to 14.6 million in 2040, a 129% increase (AoA, 2020). Life expectancy—the average number of years that a person can expect to live—varies by gender and race, with women living longer than men and White women having the longest life expectancy. The difference in life expectancy between the genders is a full 5 years. Life expectancy has risen dramatically in the past 100 years. In 1900, average life expectancy was 47 years and by 2009, that figure had increased to 78.8 years. In 2016, life expectancy decreased by 0.2% to 78.6% (Xu, Murphy, Kochanek, et el., 2018).

The older adult population is becoming more diverse, reflecting changing demographics in the United States. Although this population will increase in number for all minority groups, the rate of growth is projected to be fastest in the Hispanic population, which is expected to increase by 112% between 2016 and 2030. Proportionally, there will be a significant decline in the percentage of the White non-Hispanic population, which is anticipated to increase only by 39% by 2030 (AoA, 2020).

Health Status of the Older Adult

Although many older adults enjoy good health, most have at least one chronic illness, and many have multiple health conditions. Chronic conditions, many of which are preventable or treatable, are the major cause of disability and pain among older adults (see Fig. 8-1).

Most deaths in the United States occur in people 65 years of age and older. However, improvements in the prevention, early detection, and treatment of diseases have impacted the health of people in this age group. In the past 60 years, there has been a significant decline in overall deaths—specifically, deaths from heart disease and cancer, the two leading causes of deaths. In addition, deaths from chronic lower respiratory diseases, stroke, influenza, pneumonia, and sepsis, have declined (Xu et al., 2018). Deaths from unintentional injuries and chronic lower pulmonary diseases exchanged places, making unintentional injuries the third leading cause of death. Deaths from Alzheimer's disease (AD) have risen and are projected to quadruple by the year 2050, affecting 14 million U.S. adults aged 65 years and older (Centers for Disease Control and Prevention [CDC], 2017).

Between the years 2012 and 2014, 78% of noninstitutionalized Americans aged 65 years and older rated their health as good, very good, or excellent (AoA, 2020). Men and women reported comparable levels of health; however, positive health reports declined with advancing age. Even at the age of 85 years and more, the majority of Americans reported good or better health. Blacks, Hispanics, and Latinos appeared less likely to report good health than their White counterparts. Most Americans 75 years of age and older remained functionally independent regardless of how they perceived their health. The proportion of older Americans reporting a limitation in activities declined from 49% in 1992 to 44% in 2013 (AoA, 2020). These declines in limitations may reflect trends in health promotion and disease prevention activities, such as improved nutrition, decreased smoking, increased exercise, and early detection and treatment of risk factors such as hypertension and elevated serum cholesterol levels.

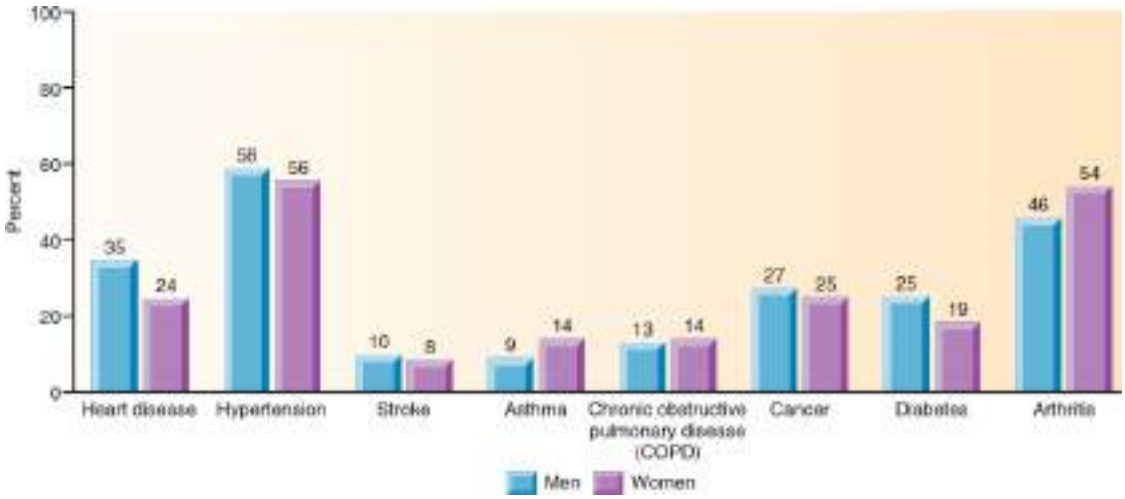

Figure 8-1 • Percentage of people 65 years of age and older who reported having selected chronic health conditions, by sex, 2018. From National Center for Health Statistics. (2020). Older Americans 2020: Key indicators of well-being. Washington, DC: U.S. Government Printing Office. Retrieved 11/30/2020 at: https://www.agingstats.gov/data.html

Many chronic conditions commonly found among older people can be managed, limited, and even prevented. Older people are more likely to maintain good health and functional independence if encouraged to do so and if appropriate community-based support services are available (Miller, 2019). Nurses need to promote positive lifelong health behaviors, because the impact of unhealthy behaviors and choices can result in chronic disease.

Nursing Care of the Older Adult

Gerontology, the study of the aging process, is a multidisciplinary field that draws from the biologic, psychologic, and sociologic sciences. **Geriatrics** is the practice (medical or nursing) that focuses on the physiology, pathology, diagnosis, and management of the disorders and diseases of older adults. Care for older adults should not be limited to one discipline but is best provided through a cooperative effort. An interdisciplinary approach to providing care combines expertise and resources to provide comprehensive geriatric assessment and intervention. Nurses collaborate with the team to obtain appropriate services for patients and provide a holistic approach to care.

Gerontologic/geriatric nursing is the field of nursing that specializes in the care of older adults. The Scope and Standards of Gerontological Nursing Practice was originally developed in 1969 by the American Nurses Association (ANA) and revised in 2010 (ANA, 2010). The nurse gerontologist can be either a specialist or a generalist providing comprehensive nursing care to older adults by combining the basic nursing process with a specialized

knowledge of aging. Gerontologic nursing is provided in acute care, skilled and assisted living, the community, and home settings. The goals of care include promoting and maintaining functional status as well as helping older adults identify and use their strengths to achieve optimal independence.

Nurses who are certified in geriatric nursing have specialized knowledge of the acute and chronic challenges specific to older adults. The use of advanced practice nurses who have been educated in geriatric nursing concepts has proved to be very effective when dealing with the complex care needs of an older patient. When best practices are used and current scientific knowledge applied to clinical problems, there is significantly less deterioration in the overall health of aging patients (ANA, 2010).

In addition to specialists, nurses who work in all areas of adult medical-surgical nursing encounter older adult patients. Nurses must be knowledgeable and skilled in meeting the complex needs of these patients. Nurses and caregivers who work with older patients must understand that aging is not synonymous with disease and that the effects of the aging process alone are not the only or even the primary contributors to disability and disease. Aging is a highly individualized and multifaceted process (Sommerlad, Sabia, Singh-Manoux, et al., 2019).

Functional assessment is a common framework for assessing older adults. Age-related changes, as well as additional risk factors such as disease and the effects of medications, can reduce function. Assessing the functional consequences of aging and proposing practical interventions helps to maintain and improve the health of older adults (Miller, 2019). The goal is to help older adults sustain maximum functional level and dignity despite physical, social, and psychological losses. Early intervention can prevent complications of many health problems and help maximize the quality of life.

Theories of Aging

Aging has been defined chronologically by the passing of time—subjectively, as in how a person feels, and functionally, as in changes in physical or mental capabilities. Many theories attempt to provide a framework in which to understand aging from different perspectives. Clinicians can use each theory to gain insight into different aspects of aging.

In addition to the biologic, developmental, and sociologic theories of aging, Miller (2019) developed the Functional Consequences Theory, which encourages nurses to consider the effects of normal age-related changes as well as the damage incurred through disease or environmental and behavioral risk factors when planning care. This theory suggests that nurses can alter the outcome for patients through nursing interventions that address the consequences of these changes. Age-related changes and risk factors may negatively interfere with patient outcomes and impair patient activity and

quality of life. For example, normal age-related changes in vision may increase sensitivity to glare. Alterations in the environment that reduce glare may enhance patient comfort and safety. In contrast, the development of cataracts, which is not a normal age-related change, also may increase sensitivity to glare. The nurse must differentiate between normal, irreversible age-related changes and modifiable risk factors. Doing so helps the nurse design appropriate nursing interventions that have a positive impact on outcomes for older patients—most importantly, for their quality of life.

Age-Related Changes

The well-being of older adults depends on physical, psychosocial, mental, social, economic, and environmental factors. A total assessment includes an evaluation of all major body systems, social and mental status, the person's ability to function independently, and their quality of life.

Physical Aspects of Aging

Intrinsic aging (from within the person) refers to those changes caused by the normal aging process that are genetically programmed and essentially universal within a species. Universality is the major criterion used to distinguish normal aging from pathologic changes associated with illness. However, people age quite differently and at different rates; thus, chronologic age is often less predictive of obvious age characteristics than other factors, such as one's genetics (see Chart 8-1) and lifestyle factors (Frishman, 2019; Seah, Kowitlawakul, Jiang, et al., 2019; Sommerlad et al., 2019).

Cellular and extracellular changes that occur with aging cause functional decline and measurable changes in physical appearance, including changes in shape and body makeup. Cellular aging and tissue deficits also diminish the body's ability to maintain homeostasis and prevent organ systems from functioning at full efficiency. As cells become less able to replace themselves, they accumulate a pigment known as lipofuscin. A degradation of elastin and collagen causes connective tissue to become stiffer and less elastic. These changes result in diminished capacity for organ function and increased vulnerability to disease and stress. Age-related changes in the hematopoietic system influence red blood cell production, leading to increased rates of anemia (Norris, 2019).

Chart 8-1 **GENETICS IN NURSING PRACTICE**

Genetics Concepts and the Older Adult

Genetic conditions in the older adult may occur from a specific gene mutation or arise as a result of a genetic predisposition combined with other factors (multifactorial). The following are examples of some adult-onset genetic conditions:

- Colon cancer
- Hemochromatosis
- Huntington disease
- Polycystic kidney disease
- Alzheimer's disease

The following are some examples of diseases with multifactorial components, which may include a genetic predisposition, in the older adult:

- Diabetes
- Emphysema
- Heart disease

Nursing Assessments

Refer to Chapter 4, Chart 4-2: Genetics in Nursing Practice: Genetic Aspects of Health Assessment

Family History Assessment Specific to the Older Adult

- Collect and assess family history on both maternal and paternal sides of the family for three generations.
- Determine whether genetic testing has occurred with other family members.
- Assess for individual and family perceptions and beliefs around topics related to genetics.

Patient Assessment Specific to the Older Adult and Genetic Illness

- Assess older adult patient's knowledge and understanding of genetics, genetic testing, and gene-based therapies.
- Assess the patient's understanding of genetic information and decipher health literacy needs.
- Perform cultural, social, and spiritual assessment.
- Assess patient's communication capacities so that communication strategies about genetics are tailored to their needs and abilities.
- Identify patient's support system.

Management Issues Specific to Genetics and the Older Adult

- Refer for further genetic counseling and evaluation as warranted so that family members can discuss inheritance, risk to other family members, and availability of genetic testing and gene-based interventions.

- Offer appropriate genetic information and resources that take into consideration older patient's literacy needs.
- Evaluate older patient's understanding before, during, and after the introduction of genetic information and services.
- Take the time to clearly explain the concepts of genetic testing to older patients and provide written information that reinforces the topic of discussion.
- Participate in the management and coordination of care of older patients with genetic conditions and individuals predisposed to develop or pass on a genetic condition.

Genetics Resources

See Chapter 6, Chart 6-7: Components of Genetic Counseling for additional resources.

Table 8-1 summarizes subjective and objective findings related to age-related changes in the body systems. More in-depth information about age-related changes can be found in the chapters pertaining to each organ system.

When assessing the physical aspects of aging, nurses should know that tactile sensation is reduced and changes in the ability to sense pressure, pain, and temperature all lead to a decreased ability to identify and attend to physical symptoms (Kennedy-Malone, Martin-Plank, & Duffy, 2019)

Cardiovascular System

Heart disease is the leading cause of death in older adults. Age-related changes reduce the efficiency of the heart and contribute to decreased compliance of the heart muscle. These changes include myocardial hypertrophy, which changes left ventricular strength and function; increased fibrosis and calcified tissues that infiltrate muscles and conductive tissues causing stenosis of the valves; and decreased pacemaker cells. As a result, the heart valves become thicker and stiffer, and the heart muscle and arteries lose their elasticity, resulting in a reduced stroke volume. Calcium and fat deposits accumulate within arterial walls, and veins become increasingly stiff and tortuous, increasing arterial resistance; this leads to hypertension and increases the workload of the heart (Capriotti & Frizzell, 2016).

It is difficult to differentiate between age- and disease-related changes in cardiovascular function because of the significant influence of behavioral factors on cardiovascular health. When cross-cultural studies are conducted, cardiovascular changes that in the past were thought to be age related do not consistently appear. For example, the higher blood pressure found in older adults in Western societies does not occur in less-developed societies and may be a result of different lifestyle behaviors rather than normal age-related changes (Miller, 2019). The cardiovascular system can adapt to many normal

age-related changes and often an older person is unaware of any significant decline in cardiovascular performance. However, when challenged, for instance, during exercise or stress, the cardiovascular system of an older person is less efficient and may be unable to respond sufficiently when life-sustaining activities are needed.

Careful assessment of older adults is necessary because they often present with different symptoms than those seen in younger patients. Older adults are more likely to have dyspnea or neurologic symptoms associated with heart disease, and they may experience mental status changes or report vague symptoms such as fatigue, nausea, and syncope. Rather than the typical substernal chest pain associated with myocardial ischemia, older patients may report burning or sharp pain or discomfort in an area of the upper body. Complicating the assessment is the fact that many older patients have more than one underlying disease. When a patient complains of symptoms related to digestion and breathing and upper extremity pain, cardiac disease must be considered. The absence of chest pain in an older patient is not a reliable indicator of the absence of heart disease.

TABLE 8-1 Age-Related Changes in Body Systems and Health Promotion Strategies

Changes	Subjective and Objective Findings	Health Promotion Strategies
Cardiovascular System		
Decreased cardiac output; diminished ability to respond to stress; heart rate and stroke volume do not increase with maximum demand; slower heart recovery rate; increased blood pressure	Complaints of fatigue with increased activity Increased heart rate recovery time *Optimal blood pressure:* <130/80 mm Hg	Exercise regularly; pace activities; avoid smoking; eat a low-fat, low-salt diet; participate in stress-reduction activities; check blood pressure regularly; adherence to medications; weight control (body mass index <25 kg/m^2)
Respiratory System		
Increase in residual lung volume; decrease in muscle strength, endurance, and vital capacity; decreased gas exchange and diffusing capacity; decreased cough efficiency	Fatigue and breathlessness with sustained activity; decreased respiratory excursion and chest/lung expansion with less effective exhalation; difficulty coughing up secretions	Exercise regularly; avoid smoking; take adequate fluids to liquefy secretions; receive yearly influenza immunization and pneumonia vaccine at 65 years of age; avoid exposure to upper respiratory tract infections
Integumentary System		
Decreased subcutaneous fat, interstitial fluid, muscle tone, glandular activity, and sensory receptors, resulting in atrophy and decreased protection against trauma, sun exposure, and temperature extremes; diminished secretion of natural oils and perspiration; capillary fragility	Thin, wrinkled, and dry skin; increased fragility, more easily bruised, and sunburned; complaints of intolerance to heat; prominent bone structure	Limit sun exposure to 10–15 min daily for vitamin D (use protective clothing and sunscreen); dress appropriately for temperature; stay hydrated; maintain a safe indoor temperature; take shower rather than hot tub bath if possible; lubricate skin with lotions that contain petroleum or mineral oil
Reproductive System		
Female: Vaginal narrowing and decreased elasticity; decreased vaginal secretions *Male:* Gradual decline in fertility, less firm testes, and decreased sperm production *Male and female:* Slower sexual response	*Female:* Painful penile-vaginal intercourse; vaginal bleeding following intercourse; vaginal itching and irritation; delayed orgasm *Male:* Less firm erection and delayed erection and	*Female:* May require vaginal estrogen replacement; gynecology/urology follow-up; use a lubricant with sexual intercourse

	achievement of orgasm	
Musculoskeletal System		
Loss of bone density; loss of muscle strength and size; degenerated joint cartilage	Height loss; prone to fractures; kyphosis; back pain; loss of strength, flexibility, and endurance; joint pain	Weight-bearing exercise regularly (3 times a week); recommend bone density screening; take calcium and vitamin D supplements as prescribed
Genitourinary System		
Decrease in detrusor muscle contractility, bladder capacity, flow rate, ability to withhold voiding; increase in residual urine *Male:* Benign prostatic hyperplasia *Female:* Relaxed perineal muscles; detrusor instability leads to urge incontinence; urethral dysfunction (stress urinary incontinence)	Urinary retention; irritative voiding symptoms including frequency, feeling of incomplete bladder emptying, multiple nighttime voiding Urgency/frequency syndrome; decreased "warning time"; drops of urine lost with cough, laugh, position change	Drink adequate fluids but limit drinking in evening; avoid bladder irritants (e.g., caffeinated beverages, alcohol, artificial sweeteners); do not wait long periods between voiding; empty bladder completely when voiding; wear easily manipulated clothing; consider urologic workup. Women: perform pelvic floor muscle exercises, preferably learned via biofeedback
Gastrointestinal System		
Decreased sense of thirst, smell, and taste; decreased salivation; difficulty swallowing food; delayed esophageal and gastric emptying; reduced gastrointestinal motility	Risk of dehydration, electrolyte imbalances, and poor nutritional intake; complaints of dry mouth; complaints of fullness, heartburn, and indigestion; constipation, flatulence, and abdominal discomfort; risk for aspiration	Use ice chips, mouthwash; brush, floss, and massage gums daily; receive regular dental care; eat small, frequent meals; sit up while and after eating and avoid heavy activity after eating; limit antacids; eat a high-fiber, low-fat diet; limit laxatives; toilet regularly; drink adequate fluids
Nervous System		
Decrease in brain volume and cerebral blood flow. Reduced speed in nerve conduction	Slower to respond and react; learning may take longer; increased vulnerability to delirium with illness, anesthesia, even changes in	Pace education; with hospitalization, encourage visitors; enhance sensory stimulation; with sudden confusion, look for cause; encourage slow rising from a resting position and practice fall prevention measures

	environmental cues such as a room change; increased risk of fainting and falls	
Special Senses		
Vision: Presbyopia; diminished ability to focus on close objects; decreased ability to tolerate glare; pupils become more rigid and lenses more opaque; decreased contrast sensitivity; decrease in aqueous humor	Holds objects far away from face; complains of glare; poor night vision and "dry" eye; difficulty adjusting to changes in light intensity; decreased ability to distinguish colors	Wear eyeglasses and use sunglasses outdoors; avoid abrupt changes from dark to light; use adequate indoor lighting with area lights and nightlights; use large-print books; use magnifier for reading; avoid night driving; use contrasting colors for color coding; avoid glare of shiny surfaces and direct sunlight
Hearing: Presbycusis; decreased ability to hear high-frequency sounds; tympanic membrane thinning and loss of resiliency; difficulty with sound discrimination especially in noisy environment	Gives inappropriate responses; asks people to repeat words; strains forward to hear; can result in social isolation and increases vulnerability for delirium during hospitalization	Recommend a hearing examination; reduce background noise; face person; enunciate clearly; speak with a low-pitched voice; use nonverbal cues; rephrase questions
Taste and smell: Decreased ability to taste and smell	Decreased recognition of familiar smells including recognizing spoiled food or a gas stove left on; decreased enjoyment of food; uses excessive sugar and salt	Encourage use of lemon, spices, herbs; recommend smoking cessation

Adapted from Weber, J. R., & Kelley, J. H. (2019). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Wolters Kluwer.

Orthostatic and postprandial hypotension may be a concern as well because of decreased baroreflex sensitivity and risk factors such as medications (Miller, 2019). Therefore, it is important to assess blood pressure in two positions. A patient experiencing hypotension should be counseled to rise slowly (from a lying, to a sitting, to a standing position), avoid straining when having a bowel movement, and consider having five or six small meals each day, rather than

three, to minimize the hypotension that can occur after a large meal. Extremes in temperature, including hot showers and whirlpool baths, should be avoided.

Respiratory System

The respiratory system compensates well for the functional changes of aging. In general, healthy, nonsmoking older adults show very little decline in respiratory function; however, there are substantial individual variations and aerobic capacity declines with each decade by about 10% from peak performance in the early to mid-20s (Capriotti & Frizzell, 2016). The age-related changes that do occur are subtle and gradual, and healthy older adults are able to compensate for these changes. Diminished respiratory efficiency and reduced maximal inspiratory and expiratory force may occur as a result of calcification and weakening of the muscles of the chest wall. Lung mass decreases and residual volume increases (Norris, 2019).

Conditions of stress, such as illness, may increase the demand for oxygen and affect the overall function of other systems. Like cardiovascular diseases, respiratory diseases manifest more subtly in older adults than in younger adults and do not necessarily follow the typical pattern of cough, chills, and fever. Older adults may exhibit fatigue, lethargy, anorexia, dehydration, and mental status changes (Miller, 2019).

Smoking is the most significant risk factor for respiratory diseases and older adults have a higher rate of smoking, about 20%, compared to the national average of 18% (Bowler, Hansel, Jacobson, et al., 2017). Therefore, a major focus of health promotion activities should be on smoking cessation and avoidance of environmental smoke. Despite marketing by manufacturers, e-cigarettes are not an effective smoking cessation aid nor do they promote health (Bowler et al., 2017).

Additional activities that help older adults maintain adequate respiratory function include regular exercise, appropriate fluid intake, pneumococcal vaccination, yearly influenza immunizations, and avoidance of people who are ill. Hospitalized older adults should be frequently reminded to cough and take deep breaths, particularly postoperatively, because their decreased lung capacity and decreased cough efficiency predispose them to atelectasis and respiratory infections.

Integumentary System

The functions of the skin include protection, temperature regulation, sensation, and excretion. Aging can interrupt all functions of the skin and affect appearance (Norris, 2019). Epidermal proliferation decreases, and the dermis becomes thinner. Elastic fibers are reduced in number and collagen becomes stiffer. Subcutaneous fat diminishes, particularly in the extremities, and less vasodilation renders the body less able to produce or conserve body heat.

These changes lead to lack of fever in circumstances in which fever would normally be present in younger individuals and reduced tolerance to temperature extremes, which increases the likelihood of hypothermia and hyperthermia (Capriotti & Frizzell, 2016). There is also a loss of resiliency with wrinkling and sagging of the skin. The skin becomes drier and more susceptible to burns, injury, and infection. Hair pigmentation may change and balding may occur; genetic factors strongly influence these changes. These changes in the integument reduce tolerance to temperature extremes and sun exposure.

Lifestyle practices have a large impact on skin changes. Strategies to promote healthy skin function include not smoking, limiting alcohol consumption, avoiding exposure to the sun, using a sun protection factor of 15 or higher, wearing protective clothing, using emollient skin cream containing petrolatum or mineral oil, avoiding hot soaks in the bathtub, and maintaining optimal nutrition and hydration (Farage, Miller, & Maibach, 2017). Older adults should be encouraged to have any changes in the skin examined, because early detection and treatment of precancerous or cancerous lesions are essential for the best outcome.

Reproductive System

An outdated perception is that older adults are asexual, but older adults report that a fairly stable and active sex life is an important quality of life issue. Sexual activity declines with the loss of a partner, primarily for women as a result of widowhood and for men as a result of poor heath, poor sleep, erectile dysfunction, medications, and emotional factors. However, although good health is a predictor of sexual activity, older adults with chronic illnesses may be able to have a sexually active life as well. Because of the many factors that influence the ability to be sexually active, nurses and the older person need to understand the physiologic, psychologic, and social factors that affect reproductive and sexual functioning as aging progresses (Bozorgmehri, Fink, Parimi, et al., 2017; Kennedy-Malone et al., 2019; Miller, 2019).

Ovarian production of estrogen and progesterone declines with menopause. Changes that occur in the female reproductive system include thinning of the vaginal wall, along with a shortening of the vagina and a loss of elasticity; decreased vaginal secretions, resulting in vaginal dryness, itching, and decreased acidity; involution (atrophy) of the uterus and ovaries; and decreased pubococcygeal muscle tone, resulting in a relaxed vagina and perineum. Without the use of water-soluble lubricants, these changes may contribute to vaginal bleeding and painful penile-vaginal intercourse.

In older men, the testes become less firm but may continue to produce viable sperm up to 90 years of age. At about 50 years of age, production of testosterone begins to diminish (Mark, 2017). Decreased libido and erectile dysfunction may develop but are more likely to be associated with factors

other than age-related changes. These risk factors include obesity, smoking, cardiovascular disease, neurologic disorders, diabetes, respiratory disease, chronic pain, and many medications (i.e., vasodilators, antihypertensive agents, and tricyclic antidepressants) (Bozorgmehri et al., 2017; Miller, 2019).

In both older men and women, it may take longer to become sexually aroused, longer to complete sexual intercourse, and longer before sexual arousal can occur again. Although a less intense response to sexual stimulation and a decline in sexual activity occurs with increasing age, sexual desire does not disappear. Many couples are unaware of the causes of decreased libido or erectile dysfunction and are often reluctant to discuss decreased sexual function. Many nonpharmacologic, pharmacologic, and surgical methods are available to improve sexual relationships. Assessment and communication require sensitivity and expert knowledge in the field of sexual dysfunction. If sexual dysfunction is present, referral to a gynecologist, urologist, or sex therapist may be warranted.

Genitourinary System

The genitourinary system continues to function adequately in older adults, although kidney mass is decreased, primarily because of a loss of nephrons. However, the loss of nephrons does not typically become significant until about 90 years of age, and changes in kidney function vary widely; approximately one third of older adults show no decrease in renal function (Mark, 2017). Changes in renal function may be attributable to a combination of aging and pathologic conditions such as hypertension. The changes most commonly seen include a decreased filtration rate, diminished tubular function with less efficiency in reabsorbing and concentrating the urine, and a slower restoration of acid–base balance in response to stress. In addition, older adults who take medications may experience serious consequences owing to decline in renal function because of impaired absorption, decreased ability to maintain fluid and electrolyte balance, and decreased ability to concentrate urine.

Certain genitourinary disorders are more common in older adults than in the general population. In the United States, **urinary incontinence** (i.e., unplanned, involuntary, or uncontrolled loss of urine) affects women more than men at a ratio of 2:1 until after age 80, when both are equally affected. This condition should not be mistaken as a normal consequence of aging (Resnick, 2019). Costly and often embarrassing, it should be evaluated, because in many cases it is reversible or can be treated. When treatable, this condition needs to be addressed as the risk of mortality associated with urinary incontinence can be as high as 44% in patients living in long-term care facilities (Damián, Pator-Barriuso, Garcia López, et al., 2017). See Chapter 49 for further discussion of urinary incontinence. Benign prostatic hyperplasia (enlarged prostate gland), a common finding in older men, causes a gradual increase in urine retention and overflow incontinence. Changes in the urinary

tract increase the susceptibility to urinary tract infections (UTIs). Adequate consumption of fluids is an important nursing intervention that reduces the risk of bladder infections and also helps decrease urinary incontinence.

Gastrointestinal System

Digestion of food is less influenced by changes associated with aging than by the risk of poor nutrition. Older adults can adjust to changes in the gastrointestinal (GI) system but may have difficulty purchasing, preparing, and enjoying their meals. The sense of smell diminishes as a result of neurologic changes and environmental factors such as smoking, medications, and vitamin B_{12} deficiencies. The ability to recognize sweet, sour, bitter, or salty foods diminishes over time, altering satisfaction with food. Salivary flow does not decrease in healthy adults; however, approximately one third of older adults may experience a dry mouth as a result of medications and diseases (Miller, 2019). Difficulties with chewing and swallowing are generally associated with lack of teeth and diseases.

Experts disagree on the extent of gastric changes that occur as a result of normal aging. However, gastric motility appears to slow modestly, which results in delayed emptying of stomach contents and early satiety (feeling of fullness). Diminished secretion of gastric acid and pepsin, seemingly the result of pathologic conditions rather than normal aging, reduces the absorption of iron, calcium, and vitamin B_{12}. Absorption of nutrients in the small intestine, particularly calcium and vitamin D, appears to diminish with age. Functions of the liver, gallbladder, and pancreas are generally maintained, although absorption and tolerance to fat may decrease. The incidence of gallstones and common bile duct stones increases progressively with advancing years.

Dysphagia, or difficulty swallowing, increases with age and is a major health care problem in older patients. Normal aging alters some aspects of the swallowing function. In addition, dysphagia is a frequent complication of stroke and a significant risk factor for the development of aspiration pneumonia that can be life-threatening. Dysphagia is caused by interruption or dysfunction of neural pathways. It may also result from dysfunction of the striated and smooth muscles of the GI tract in patients with Parkinson's disease. Aspiration of food or fluid is the most serious complication and can occur in the absence of coughing or choking.

Constipation is a common condition affecting many older adults; it is influenced by multiple risk factors rather than age-related changes alone. Symptoms of mild constipation are abdominal discomfort and flatulence; more serious constipation leads to fecal impaction that contributes to diarrhea around the impaction, fecal incontinence, and obstruction. Predisposing factors for constipation include lack of dietary bulk, prolonged use of laxatives, some medications, inactivity, insufficient fluid intake, and excessive dietary fat. Ignoring the urge to defecate may also be a contributing factor (Miller, 2019).

Practices that promote GI health include regular tooth brushing and flossing; receiving regular dental care; drinking sufficient fluids; eating small, frequent meals that are high in fiber and low in fat; avoiding heavy activity or lying flat after eating; and avoiding the use of laxatives and antacids. Understanding that there is a direct correlation between loss of smell and taste perception and food intake helps caregivers intervene to maintain the nutritional health of older patients.

Nutritional Health

The social, psychologic, and physiologic functions of eating influence the dietary habits of older adults. Increasing age alters nutrient requirements; older adults require fewer calories and a more nutrient-rich, healthy diet in response to alterations in body mass and a more sedentary lifestyle. Recommendations include reducing fat intake while consuming sufficient protein, vitamins, minerals, and dietary fiber for health and prevention of disease. Decreased physical activity and a slower metabolic rate reduce the number of calories needed by older adults to maintain an ideal weight. As stated previously, age-related changes that alter pleasure in eating include a decrease in taste and smell. Older adults are likely to require more sugar to achieve a sweet flavor due to blunted taste. They also may lose the ability to differentiate sour, salty, and bitter tastes. Apathy, immobility, depression, loneliness, poverty, inadequate knowledge, and poor oral health also contribute to suboptimal nutrient intake. Budgetary constraints and physical limitations may interfere with food shopping and meal preparation.

Health promotion for older adults is based on the person's physical, emotional, social, spiritual, and intellectual health. The main focus of health promotion is engaging the older adult in improving their health (Meiner & Yeager, 2019). The goals of nutrition therapy are to maintain or restore maximal independent functioning and health and to maintain the sense of dignity and quality of life by imposing as few restrictions as possible. Dietary changes should be incorporated into the older adult's existing food pattern as much as possible. Figure 8-2 lists modified dietary guidelines for older adults.

Women older than 50 years and men older than 70 years should have a daily calcium intake of 1200 mg. To foster the absorption of calcium, adults should have 600 IU of vitamin D until 70 years of age and 800 IU after 70 years of age to maintain bone health (National Institutes of Health [NIH], 2018a).

Undernutrition, which can lead to malnutrition, may be a problem for older adults. Hospitalized older adults are at particular risk of malnutrition, especially those with cognitive impairment or dementia (Tatum, Talebreza, & Ross, 2018). A recent unintentional weight loss may be a result of an illness or other factors, such as depression, that may have serious consequences and affect a person's ability to maintain health and fight illness (Norris, 2019). Many people are unaware of dietary deficits. Nurses are in an ideal position to

identify nutritional problems among their patients and to work within the patient's own framework of knowledge of their health status to improve health behaviors. (See Chapter 4 for more information on nutritional assessment.)

Sleep

Older adults have increased complaints about their sleep as they age, and as many as 50% of those living at home and 65% of those living in nursing homes complain of sleep disturbances (Devlin, Skrobik, Gelinas, et al., 2018; Štefan, Vrgoč, Rupčić, et al., 2018). Many factors affect sleep quality in older adults including respiratory problems during sleep, restless leg syndrome, nocturia, pain, osteoarthritis, heart failure, incontinence, prostatic hyperplasia, menopause-related problems, pruritus, allergies, AD, depression, dementia, social isolation, loneliness, being bedridden, experiences of loss, drug use, and living in nursing homes (e.g., inadequate lighting, keeping light on during the night, noises). Some of the consequences of poor sleep quality in older adults include cognitive decline, increased risk of falls, daytime fatigue, reduced physical and mental health and health-related quality-of-life status, and poor ICU outcomes (Devlin et al., 2018; Štefan et al., 2018).

The incidence of sleep apnea (a sleep disorder characterized by brief periods in which respirations are absent) increases with age. Having insomnia symptoms and a sleep-related disorder (snoring, choking, or pauses in breathing) is associated with significantly impaired daytime functioning and longer psychomotor reaction times compared with having either condition. Sleep apnea is discussed in more detail in Chapter 18.

The nurse often observes patients while they are sleeping and can identify problems. Health education can be provided on sleep hygiene behaviors such as avoiding use of the bed for activities other than sleeping (or sex), maintaining a consistent bedtime routine, avoiding or limiting daytime napping, and limiting alcohol intake to one drink a day. Additional suggestions include avoiding stimulants such as caffeine and nicotine after noon; curbing the amount of liquids in the evening to avoid nocturia; and engaging in regular physical activity, preferably in bright outside light. Aromatherapy trials have reported that the use of lavender essential oil can improve the quality of sleep (Karadag, Samancioglu, Ozden, et al., 2017).

Figure 8-2 • MyPlate for older adults. Reprinted with permission from the Jean Mayer USDA Human Nutrition Research Center on Aging (HNRCA) at Tufts University (2020). Retrieved from hnrca.tufts.edu/myplate/

Musculoskeletal System

Intact musculoskeletal and neurologic systems are essential for the maintenance of safe mobility, performance of **activities of daily living (ADLs)** (basic personal care activities), and **instrumental activities of daily living (IADLs)** (complex skills such as shopping, cooking, housework, using the telephone, managing medications and finances, and being able to travel by car or public transportation), thus allowing older adults to remain safe and live independently in the community. Age-related changes that affect mobility include alterations in bone remodeling, leading to decreased bone density, loss of muscle mass, deterioration of muscle fibers and cell membranes, and degeneration in the function and efficiency of joints. These factors are discussed in detail in Unit 8.

Without exercise, a gradual, progressive decrease in bone mass begins before 40 years of age. The cartilage of joints also progressively deteriorates in middle age. Degenerative joint disease is found in most adults older than 70 years, and weight-bearing joint and back pain is a common complaint. Excessive loss of bone density results in osteoporosis, which leads to

potentially life-altering hip and vertebral fractures. Osteoporosis is preventable.

The axiom "use it or lose it" is very relevant to the physical capacity of older adults. Nurses play an important role by encouraging older adults to participate in a regular exercise program. The benefits of regular exercise cannot be overstated. Aerobic exercises are the foundation of programs of cardiovascular conditioning; however, resistance and strength training and flexibility exercises are essential components of an exercise program. Even late in life, in adults who may be frail, it is believed that exercise has benefits of increasing strength, aerobic capacity, flexibility, and balance. In addition, older adults who are hospitalized benefit from getting out of bed as soon as possible and in-hospital physical activity.

Nervous System

Homeostasis is difficult to maintain with aging, but older people have a tremendous ability to adapt and function adequately, retaining their cognitive and intellectual abilities in the absence of pathologic changes. However, normal aging changes in the nervous system can affect all parts of the body. The structure, chemistry, and function of the nervous system change with advanced age. Nerve cells in the brain decrease but the decrease is compensated for by other neurons; there is high variability among individuals and the quantity of neuronal loss varies in different parts of the brain. Overall, the decreases contribute to a small loss of brain mass (Capriotti & Frizzell, 2016). Chemical changes include a decrease in the synthesis and metabolism of the major neurotransmitters. Because nerve impulses are conducted more slowly, older people take longer to respond and react (Miller, 2019). The autonomic nervous system performs less efficiently, and orthostatic hypotension, discussed earlier, may occur. Neurologic changes can affect gait and balance, which may interfere with mobility and safety. Nurses must advise older adults to allow a longer time to respond to a stimulus and to move more deliberately. Adequate nutrition and absorption of vitamin B_{12} is important for neurologic health. Nurses should advise older adults about proper nutrition and intake of vitamin B_{12}, especially for older adults who follow a vegetarian diet.

Slowed reaction time puts older adults at risk for falls and injuries, as well as driving errors. Although older adults spend less time driving than younger people, older adults are just as likely to be involved in motor vehicle crashes that result in serious injury or death. Older adults who are suspected of driving unsafely should receive a driving fitness evaluation (Miller, 2019). The evaluation is often performed by an occupational therapist in conjunction with a neuropsychologist, who conducts more detailed cognitive testing.

Mental function may be threatened by physical or emotional stresses. A sudden onset of confusion may be the first symptom of an infection or change

in physical condition (e.g., pneumonia, UTI, medication interactions, dehydration).

Sensory System

People interact with the world through their senses. Losses associated with old age affect all sensory organs, and it can be devastating not to be able to see to read or watch television, hear conversation well enough to communicate, or discriminate taste well enough to enjoy food. Nearly half of older men and one third of older women report difficulty hearing without a hearing aid. Most older adults have a decrease in visual acuity, a narrowing of the visual field, and may have trouble seeing at night. An uncompensated sensory loss negatively affects the functional ability and quality of life of the older adult. However, assistive devices such as visual and hearing aids can compensate for a sensory loss (Miller, 2019).

Sensory Loss Versus Sensory Deprivation

In contrast to sensory loss, sensory deprivation is the absence of stimuli in the environment or the inability to interpret existing stimuli (perhaps as a result of a sensory loss). Sensory deprivation can lead to boredom, confusion, irritability, disorientation, and anxiety. A decline in sensory input can mimic a decline in cognition that is in fact not present. Meaningful sensory stimulation provided to the older person is often helpful in correcting this problem. In some situations, one sense can substitute for another in observing and interpreting stimuli. Nurses can enhance sensory stimulation in the environment with colors, pictures, textures, tastes, smells, and sounds. The stimuli are most meaningful if they are appropriate for older adults and the stimuli are changed often. Cognitively impaired people tend to respond well to touch and to familiar music.

Vision

As new cells form on the outside surface of the lens of the eye, the older central cells accumulate and become yellow, rigid, dense, and cloudy, leaving only the outer portion of the lens elastic enough to change shape (accommodate) and focus at near and far distances. As the lens becomes less flexible, the near point of focus gets farther away. This common condition—**presbyopia**—usually begins in the fifth decade of life and requires the person to wear reading glasses to magnify objects (Miller, 2019). In addition, the yellowing, cloudy lens causes light to scatter and is sensitive to glare. The ability to distinguish colors decreases, particularly blue from green. The pupil dilates slowly and less completely because of increased stiffness of the muscles of the iris, thus the older person takes more time to adjust when going to and from light and dark settings and needs brighter light for close vision. Pathologic visual conditions are not a part of normal aging; however, the

incidence of eye disease (most commonly cataracts, glaucoma, diabetic retinopathy, and age-related macular degeneration) increases in older adults.

Age-related macular degeneration (AMD) is the leading cause of vision loss and blindness in older adults 65 and older. It is predicted that cases of AMD will double from 48 million to 88 million people by 2050 (CDC, 2017). Macular degeneration does not affect peripheral vision, which means that it does not cause blindness. However, it affects central vision, color perception, and fine detail, greatly affecting common visual skills such as reading, driving, and seeing faces. Risk factors include sunlight exposure, cigarette smoking, and heredity. People with fair skin and blue eyes may be at increased risk. Sunglasses and hats with visors provide some protection, and stopping smoking is paramount in preventing the disease. Although there is no definitive treatment and no cure that restores vision, several treatment options are available, depending on factors such as the location of the abnormal blood vessels. Laser photocoagulation and photodynamic therapy are commonly used (CDC, 2017). The earlier this condition is diagnosed, the greater the chances of preserving sight. See Chapter 58 for more information on altered vision.

Hearing

Auditory changes begin to be noticed at about 40 years of age. Environmental factors, such as exposure to noise, medications, and infections, as well as genetics, may contribute to hearing loss as much as age-related changes. **Presbycusis** is a gradual sensorineural loss that progresses from the loss of the ability to hear high-frequency tones to a generalized loss of hearing. It is attributed to irreversible inner ear changes. Older adults often cannot follow conversation because tones of high-frequency consonants (the sounds *f, s, th, ch, sh, b, t, p*) all sound alike. Hearing loss may cause older adults to respond inappropriately, misunderstand conversation, and avoid social interaction. This behavior may be erroneously interpreted as confusion. Wax buildup or other correctable problems may also be responsible for hearing difficulties. A systematic review reported the prevalence of under detection of hearing loss and the under use of hearing aids in long-term care facilities (Punch & Horstmanshof, 2019). A properly prescribed and fitted hearing aid may be useful in reducing some types of hearing deficits and increasing quality of life (Punch & Horstmanshof, 2019). See Chapter 59 for discussion of alterations in hearing.

Taste and Smell

The senses of taste and smell are reduced in older adults. Of the four basic tastes (sweet, sour, salty, and bitter), sweet tastes are particularly dulled in older adults. Blunted taste may contribute to the preference for salty, highly

seasoned foods, but herbs, onions, garlic, and lemon can be used as substitutes for salt to flavor food.

Changes in the sense of smell, generally greater than the loss of taste, are related to cell loss in the nasal passages and in the olfactory bulb in the brain (Norris, 2019). Environmental factors such as long-term exposure to toxins (e.g., dust, pollen, smoke) contribute to the cellular damage.

Psychosocial Aspects of Aging

Successful psychological aging is reflected in the ability of older adults to adapt to physical, social, and emotional losses and to achieve life satisfaction. Because changes in life patterns are inevitable over a lifetime, older adults need resiliency and coping skills when confronting stresses and change. A positive self-image enhances risk taking and participation in new, untested roles.

Although attitudes toward older adults differ in ethnic subcultures, a subtle theme of **ageism**—prejudice or discrimination against older adults—predominates in society, and many myths surround aging. Ageism is based on stereotypes—simplified and often untrue beliefs that reinforce society's negative image of older adults. Although older adults make up an extremely heterogeneous and increasingly a racially and ethnically diverse group, these negative stereotypes are sometimes attributed to all older adults.

Fear of aging and the inability of many to confront their own aging process may trigger ageist beliefs. Retirement and perceived nonproductivity are also responsible for negative feelings, because a younger working person may falsely see older people as not contributing to society, as draining economic resources, and may actually feel that they are in competition with children for resources. Concern about the large numbers of older people leaving the workforce (baby boomers began to turn 65 years of age in 2010) is fueling this debate.

Negative images are so common in society that older adults themselves often believe and perpetuate them. An understanding of the aging process and respect for each person as an individual can dispel the myths of aging. Nurses can facilitate successful aging by recommending health promotion strategies such as anticipatory planning for retirement, including ensuring adequate income, developing routines not associated with work, replacing work-related friends with new acquaintances, and relying on other people and groups in addition to spouse to fill leisure time (Meiner & Yeager, 2019).

Stress and Coping in the Older Adult

Coping patterns and the ability to adapt to stress develop over the course of a lifetime and remain consistent later in life. Experiencing success in younger adulthood helps a person develop a positive self-image that remains solid

through old age. A person's abilities to adapt to change, make decisions, and respond predictably are also determined by past experiences. A flexible, well-functioning person will probably continue as such. However, losses may accumulate within a short period of time and become acute. The older person often has fewer choices and diminished resources to deal with stressful events. Common stressors of old age include normal aging changes that impair physical function, activities, and appearance; disability from injury or chronic illness; social and environmental losses related to loss of income and decreased ability to perform previous roles and activities; and the deaths of significant others. Many older adults rely strongly on their families and spiritual beliefs for comfort during stressful times.

An additional aspect of coping that nurse researchers have examined is self-efficacy, which is the confidence to perform well at a particular task or life domain (Hladek, Gill, Bandeen-Roche, et al., 2019). Chart 8-2 is a Nursing Research Profile about the associations between coping self-efficacy and frailty in a group of community-dwelling older adults.

Living Arrangements

Many older adults have more than adequate financial resources and good health even until very late in life; therefore, they have many housing options. In 2017, 93% of older adults lived in the community, with a relatively small percentage (2.3%) residing in nursing homes and a comparable percentage living in some type of senior housing. Seventy-six percent of those older than 65 years own their homes. In 2018, 28% of noninstitutionalized older people lived alone, and widowed women predominated. In 2018, 70% of men older than 65 years were married compared with 40% of women in the same age group. This difference in marital status increases with age and is a result of several factors: Women have a longer life expectancy than men; women tend to marry older men; and women tend to remain widowed, whereas men often remarry (AoA, 2020).

Many older adults relocate in response to changes in their lives such as retirement or widowhood, a significant deterioration in health, or disability. The type of housing they choose depends on their reason for moving. With increasing disability and illness, older adults may move to retirement facilities or assisted living communities that provide some support such as meals, transportation, and housekeeping but otherwise allow them to live somewhat independently. If they develop a serious illness or disability and can no longer live independently or semi-independently, they may need to move to a setting where additional support is available, such as a relative's home or a long-term care or assisted living facility. Often they will seek a location near an adult child's home.

Living at Home or With Family

Most older adults want to remain in their own homes; in fact, they function best in their own environment. The family home and familiar community may have strong emotional significance for them, and this should not be ignored. However, with advanced age and increasing disability, adjustments to the environment may be required to allow older adults to remain in their own homes or apartments. Additional family support or more formal support may be necessary to compensate for declining function and mobility. Many services and organizations can assist older adults to successfully "age in place" in their own homes or in assisted living facilities (see Resources at the end of this chapter).

Chart 8-2 NURSING RESEARCH PROFILE

The Association Between Coping Self-efficacy and Frailty in Community-Dwelling Older Adults

Hladek, M.D., Gill, J., Bandeen-Roche, K., et al. (2019). High coping self-efficacy associated with lower odds of pre-frailty/ frailty in older adults with chronic disease. *Aging & Mental Health*. doi.org/10.1080/13607863.2019.1639136

Purpose

Self-efficacy is the confidence to perform well at a particular task or life domain while frailty is a state of decreased physiologic reserve and vulnerability to negative health outcomes. The purpose of this study was to evaluate associations between self-efficacy and frailty in a group of community-dwelling older adults.

Design

This quantitative study used a cross-sectional design to study 146 older adults who lived in retirement communities. Instruments included the five-item Fatigue, Resistance, Ambulation, Illness, and Loss of weight (FRAIL) scale as well as two self-efficacy instruments that measured confidence in one's ability to problem solve, emotionally regulate, and ask for support when problems in life occur. Additional variables measured included illness intrusiveness, depressive symptoms, financial strain, life events, social support, heart rate, tobacco use, and body mass index (BMI). Logistic regression was used for model development.

Findings

Approximately half of the participants were in the frail or pre-frail range on the FRAIL scale. High coping self-efficacy was associated with a 92% reduction in the odds of participants being in the frail or pre-frail range on the FRAIL scale after adjusting for age, race, comorbidities, heart rate, life events count, and BMI. This relationship remained a significant finding even after the inclusion of illness intrusiveness and depressive symptoms (OR: 0.10, *p*-value = 0.014). Higher age, number of comorbidities, heart rate, and BMI were also significantly associated with participants being in the frail or pre-frail range on the FRAIL scale.

Nursing Implications

When working with older adults, nurses should keep in mind the association of high self-efficacy with healthy aging. Nurses can be instrumental in developing interventions to help older adults increase self-efficacy, as measured by their confidence in their ability to problem solve, emotionally regulate, and ask for support when problems in life occur.

Sometimes older adults or couples move in with adult children. This can be a rewarding experience as the children, their parents, and the grandchildren

interact and share household responsibilities (see Fig. 8-3). It can also be stressful, depending on family dynamics. Adult children and their older parents may choose to pool their financial resources by moving into a house that has an attached "in-law suite." This arrangement provides security for the older adult and privacy for both families. Many older adults and their adult children make housing decisions in times of crisis, such as during a serious illness or after the death of a spouse. Caring for an older adult may also be stressful; older adults and their families often are unaware of the emotional and physical demands of shared housing and assuming care for an increasingly dependent person, especially given the uncertain and extended length of time that may be associated with caring for a person with a chronic illness. Families can be helped by anticipatory guidance and long-term planning before a crisis occurs. Older adults should participate in decisions that affect them as much as possible.

Figure 8-3 • Families are an important source of psychosocial and physical support for all people. Caring interaction among grandchildren, grandparents, and other family members typically contributes to the health of all.

Continuing Care Retirement Communities

Continuing care retirement communities (CCRCs) offer three levels of living arrangements and care that provide for aging in place (Miller, 2019). CCRCs consist of independent single-dwelling houses or apartments for people who can manage their day-to-day needs, assisted living apartments for those who

need limited assistance with their daily living needs, and skilled nursing services when continuous nursing assistance is required. CCRCs usually contract for a large down payment before the resident moves into the community. This payment gives a person or couple the option of residing in the same community from the time of total independence through the need for assisted or skilled nursing care. Decisions about living arrangements and health care can be made before any decline in health status occurs. CCRCs also provide continuity at a time in an older adult's life when many other factors, such as health status, income, and availability of friends and family members, may be changing.

Assisted Living Facilities

Assisted living facilities are an option when an older person's physical or cognitive changes necessitate at least minimal supervision or assistance. Assisted living allows for a degree of independence while providing minimal nursing assistance with administration of medication, assistance with ADLs, or other chronic health care needs. Other services, such as laundry, cleaning, and meals, may also be included. Both assisted living and CCRCs are costly and primarily paid out-of-pocket.

Long-Term Care Facilities

Many types of nursing homes, nursing facilities, or long-term care facilities offer continuous nursing care. Contrary to the myth of family abandonment and the fear of "ending up in a nursing home," the actual percentage of older adults residing in long-term care facilities has declined, from 5.4% in 1985 to 2.3% in 2018 (AoA, 2020). However, the actual number of older people who reside in long-term care facilities has risen owing to the large increase in the population of older adults and the use of nursing homes for short-term rehabilitation.

Short-term nursing facility care is often reimbursed by Medicare if the patient is recovering from an acute illness such as a stroke, myocardial infarction (MI), or cancer and requires skilled nursing care or therapy for recuperation. Usually, if an older adult suffers a major health event and is hospitalized and then goes to a nursing facility, Medicare covers the cost of the first 30 to 90 days in a skilled nursing facility as long as ongoing therapy is needed. The requirement for continued Medicare coverage during this time is documentation of persistent improvement in the condition that requires therapy, most often physical therapy, occupational therapy, respiratory therapy, or cognitive therapy. Some adults choose to have long-term care insurance as a means of paying, at least in part, for the cost of these services should they become necessary. Costs of long-term care for older adults who are living in nursing homes and are medically stable, despite having multiple chronic and debilitating health issues, are primarily paid out-of-pocket by the patient.

When a person's financial resources become exhausted as a result of prolonged nursing home care, the patient, the institution, or both may apply for Medicare and Medicaid reimbursement depending on the situation. Family members are not responsible for nursing home costs.

An increasing number of skilled nursing facilities offer subacute care. This area of the facility offers a high level of nursing care that may either avoid the need for a resident to be transferred to a hospital from the nursing home or allow a hospitalized patient to be transferred back to the nursing facility sooner.

The Role of the Family

Planning for care and understanding the psychosocial issues confronting older adults must be accomplished within the context of the family. If dependency needs occur, the spouse often assumes the role of primary caregiver. In the absence of a surviving spouse, an adult child may assume caregiver responsibilities and need help in providing or arranging for care and support.

Two common myths in American society are that adult children and their aged parents are socially alienated, and that adult children abandon their parents when health and other dependency problems arise. In reality, the family has been and continues to be an important source of support for older adults; similarly, older family members provide a great deal of support to younger family members.

Although adult children are not financially responsible for their older parents, social attitudes and cultural values often dictate that adult children should provide services and assume the burden of care if their aged parents cannot care for themselves. It is estimated that in 2018, informal caregivers provided 18.5 billion hours of unpaid care (Alzheimer's Association, 2019). Caregiving, which may continue for many years, can become a source of family stress and is a well-known risk for psychiatric and physical morbidity. Evidence-based interventions to reduce distress and enhance well-being in caregivers have been identified. Three broad types of effective programs include psychoeducational skill building, cognitive behavioral therapy, and using a combination of at least two approaches such as education, family meetings, and skill building sessions (Bakas, McCarthy, & Miller, 2018). Researchers have reported that web-based interventions are effective, efficient, and a better fit for the hectic lives of families and caregivers (Wasilewski, Stinson, & Cameron, 2017).

Cognitive Aspects of Aging

Cognition can be affected by many variables, including sensory impairment, physiologic health, environment, sleep, and psychosocial influences. Older adults may experience temporary changes in cognitive function (i.e., delirium)

when hospitalized or admitted to skilled nursing facilities, rehabilitation centers, or long-term care facilities. These changes are related to differences in the environment or in medical therapy or to alteration in role performance. A commonly used assessment tool is the Mini-Mental State Examination (MMSE) (see Chart 8-3).

Good sleep hygiene can improve cognition, as can treatment of depression and anxiety. Several researchers are evaluating memory enhancement programs for older adults. In addition, researchers have found that eating a healthy balanced diet, being physically active for at least 30 minutes each day, and getting plenty of sleep can assist in preventing chronic illnesses as well as improving cognitive function (McDougall, 2017).

When intelligence test scores from people of all ages are compared, test scores for older adults show a progressive decline beginning in midlife. However, research has shown that environment and health have a considerable influence on scores, and that certain types of intelligence (e.g., spatial perceptions and retention of nonintellectual information) decline, whereas others (e.g., problem-solving ability based on past experiences, verbal comprehension, mathematical ability) do not. Cardiovascular health, a stimulating environment, and high levels of education, occupational status, and income all appear to have a positive effect on intelligence scores in later life.

Chart 8-3 ASSESSMENT

Assessing Mental Status: Mini-Mental State Examination Sample Items

Orientation to Time

"What is the date?"

Naming

"What is this?" (Point to a pencil or pen.)

Reading

"Please read this and do what it says." (Show examinee the words on the stimulus form.) CLOSE YOUR EYES.

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Significant age-related declines in intelligence, learning, and memory are not inevitable. Many factors affect the ability of older adults to learn and remember and to perform well in testing situations. Older adults who have higher levels of education, good sensory function, good nutrition, and jobs that require complex problem-solving skills continue to demonstrate intelligence, memory, and the capacity for learning. Part of the challenge in testing older adults is determining what is actually being tested (e.g., speed of response) and whether the test results are indicative of a normal age-related change, a sensory deficit, or poor health. However, age differences continue to emerge even with untimed tests and when the tests are controlled for variations in motor and sensory function. In general, fluid intelligence—the biologically determined intelligence used for flexibility in thinking and problem solving—declines. Preventing or managing circulatory and nervous system disorders may positively affect the decline in fluid intelligence. Crystallized intelligence—gained through education and lifelong experiences (e.g., verbal skills)—remains intact. These differences exemplify the classic aging pattern of intelligence. Despite these slight declines, many older adults continue to learn and participate in varied educational experiences. Good health and motivation are important influences on learning (see Chart 8-4).

Pharmacologic Aspects of Aging

Because an increasing number of chronic conditions affect older adults, they use more medications than any other age group. Although medications improve health and well-being by relieving pain and discomfort, treating chronic illnesses, and curing infectious processes, adverse drug reactions are common because of medication interactions, multiple medication effects, incorrect dosages, and the use of multiple medications.

Chart 8-4 HEALTH PROMOTION

Nursing Strategies for Promoting Cognitive Function

Nurses can support the processes by which older adults learn by using the following strategies:

- Supply mnemonics to enhance recall of related data.
- Encourage ongoing learning.
- Link new information with familiar information.
- Use visual, auditory, and other sensory cues.
- Encourage learners to wear prescription glasses and hearing aids.
- Provide glare-free lighting.
- Provide a quiet, nondistracting environment.
- Set short-term goals with input from the learner.
- Prioritize the most important information and focus on the priority information.
- Keep education periods short.
- Pace learning tasks according to the endurance of the learner.
- Encourage verbal participation by learners.
- Reinforce successful learning in a positive manner.

Drug Interactions and Adverse Effects

Polypharmacy is the use of multiple prescription or over-the-counter (OTC) medications. Over or incorrect prescribing occurs commonly in older adults (Miller, 2019). The potential for drug–drug interactions increases with increased medication use and with multiple coexisting diseases (**comorbidity**) that affect the absorption, distribution, metabolism, and elimination of the medications. Such interactions are responsible for numerous emergency department and primary provider visits, which cost billions of dollars annually.

Any medication is capable of altering nutritional status, and the nutritional health of an older adult may already be compromised by a marginal diet or by chronic disease and its treatment. Medications can affect the appetite, cause nausea and vomiting, irritate the stomach, cause constipation or diarrhea, and decrease absorption of nutrients. In addition, these medications may alter electrolyte balance as well as carbohydrate and fat metabolism. For example, antacids may cause thiamine deficiency; laxatives diminish absorption; antibiotics and phenytoin reduce utilization of folic acid; and phenothiazines, estrogens, and corticosteroids increase appetite and cause weight gain.

Combining multiple medications with alcohol, as well as with OTC and herbal medications, further complicates GI problems. For example, St. John's wort, a common herbal supplement effective for mild depression, decreases the anticoagulant effect of warfarin and interacts with many other medications metabolized in the liver (Miller, 2019).

Tools such as the American Geriatrics Society (AGS) Beers Criteria® are available to evaluate the patterns of drug use in older adults (Fick, Selma, Steinman, et al., 2019). The criteria rate the evidence for potentially harmful medications according to body systems. They are updated every 4 years in an attempt to improve the care of older adults by limiting their exposure to potentially inappropriate medications.

Altered Pharmacokinetics

Alterations in absorption, metabolism, distribution, and excretion occur as a result of normal aging and may also result from drug and food interactions (Comerford & Durkin, 2020). Absorption may be affected by changes in gastric pH and a decrease in GI motility. Drug distribution may be altered as a result of decrease in body water and increase in body fat. Normal age-related changes and diseases that alter blood flow, liver and renal function, or cardiac output (CO) may affect distribution and metabolism (see Table 8-2).

Nursing Implications

Principles that have been identified as appropriate for older patients include starting with a low dose, going slowly, keeping the medication regimen as simple as possible, and reconciling new and previous medication regimens at the time of discharge from an acute hospital stay (Comerford & Durkin, 2020; Fick et al., 2019). A comprehensive assessment that begins with a thorough medication history, including use of alcohol, recreational drugs, and OTC and herbal medications, is essential. It is best to ask the patient or reliable informants to provide all medications for review. Assessing the patient's understanding of when and how to take each prescription and OTC medication, as well as the purpose of each medication, allows the nurse to assess the patient's health literacy and adherence to the medication regimen. The patient's beliefs and concerns about the medications should be identified, including beliefs on whether a given medication is helpful.

TABLE 8-2 Altered Drug Responses in Older Adults

Age-Related Changes	Effect of Age-Related Changes	Applicable Medications
Absorption		
Reduced gastric acid; increased pH (less acid)	Rate of drug absorption—possibly delayed	Vitamins
Reduced gastrointestinal motility; prolonged gastric emptying	Extent of drug absorption—not affected	Calcium
Distribution		
Decreased circulating plasma proteins and total body water	Serious alterations in drug binding to plasma proteins (the unbound drug gives the pharmacologic response); highly protein-bound medications have fewer binding sites, leading to increased effects and accelerated metabolism and excretion	*Select highly protein-binding medications:* Oral anticoagulants (warfarin) Oral hypoglycemic agents (sulfonylureas) Barbiturates Calcium channel blockers Furosemide Nonsteroidal anti-inflammatory drugs (NSAIDs) Sulfonamides Quinidine Phenytoin
Reduced cardiac output	Decreased perfusion of many bodily organs	
Impaired peripheral blood flow	Decreased perfusion	
Increased or decreased percentage of body fat	Proportion of body fat increases with age, resulting in increased ability to store fat-soluble medications; this causes drug accumulation, prolonged storage, and delayed excretion	*Select fat-soluble medications:* Barbiturates Diazepam Lidocaine Phenothiazines (antipsychotics) Ethanol

		Morphine
Decreased lean body mass	Decreased body volume allows higher peak levels of medications	
Metabolism		
Decreased cardiac output; decreased size of the liver; diminished intestinal and portal vein blood flow	Decreased metabolism and delay of breakdown of medications, resulting in prolonged duration of action, accumulation, and drug toxicity	All medications metabolized by the liver
Excretion		
Decreased renal blood flow; loss of functioning nephrons; decreased renal efficiency	Decreased rates of elimination and increased duration of action; danger of accumulation and drug toxicity	*Select medications with prolonged action:* Aminoglycoside antibiotics Cimetidine Chlorpropamide Digoxin Lithium Procainamide

Adapted from Comerford, K. C., & Durkin, M. T. (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer.

Nonadherence with medication regimens can lead to significant morbidity and mortality among older adults. The many contributing factors include the number of medications prescribed, the complexity of the regimen, difficulty opening containers, inadequate patient education, financial cost, and the disease or medication interfering with the patient's life. Visual and hearing problems may make it difficult to read or to hear directions. Multifaceted interventions tailored to the individual patient are the most effective strategies in improving adherence. Allowing enough time for the older adult to learn new skills, particularly when technology is involved, is essential (see Chart 8-5).

Mental Health Problems in the Older Adult

Severe mood swings, uncontrolled laughing or crying, changes in cognitive ability, and excessive forgetfulness are not a part of normal aging. These symptoms should not be dismissed as age-related changes; a thorough assessment may reveal a treatable, reversible condition. Changes in mental status can be related to many factors, such as alterations in diet and fluid and electrolyte balance, fever, or low oxygen levels associated with many

cardiovascular and pulmonary diseases. Older adults are less likely than younger people to acknowledge or seek treatment for mental health symptoms. Changes may be reversible when the underlying condition is identified and treated. Nurses must recognize, assess, refer, collaborate, treat, and support older adults who exhibit signs and symptoms of depression, substance abuse, delirium, or dementia.

Chart 8-5

Nursing Strategies for Improving Medication Management and Adherence

The following strategies can help patients manage their medications and improve adherence:

- Assess self-management abilities, psychomotor skills, and current medication knowledge.
- Destroy or remove old, unused medications.
- Encourage the use of standard containers without safety lids (if there are no children in the household).
- Encourage the patient to inform the primary provider about the use of OTC medications and herbal agents, alcohol, and recreational drugs.
- Encourage the patient to keep a current list of all medications, including OTC and herbal medications, in their purse or wallet to share with the primary provider at each visit and in case of an emergency.
- Explain the purpose, adverse effects, and dosage of each medication, particularly those that are newly prescribed.
- If the patient's competence is doubtful, identify a reliable family member or friend who might assist the patient with adherence.
- Provide the medication schedule in writing.
- Reconcile medication schedule upon discharge from hospital or rehabilitation facility.
- Recommend using one supplier for prescriptions; pharmacies frequently track patients and are likely to notice a prescription problem such as duplication or contraindications in the medication regimen.
- Suggest the use of a multiple-day, multiple-dose medication dispenser to help the patient adhere to the medication schedule.

OTC, over-the-counter.

Adapted from Eliopoulos, C. (2018). *Gerontological nursing* (9th ed). Philadelphia, PA: Wolters Kluwer.

Depression

Depression is the most common affective or mood disorder of old age (Eliopoulos, 2018). The percentage of older adults with depressive symptoms

varies widely depending upon the measures used and the population studied. Estimates range from 15% to 25% in community-dwelling older adults, and up to 25% of those living in long-term care facilities (Eliopoulos, 2018). Depression among older adults can follow a major precipitating event or loss and is often related to chronic illness or pain. It may also be secondary to a medication interaction or an undiagnosed physical condition. Rather than obvious sadness, an older person may exhibit more subtle signs of depression such as fatigue, diminished memory and concentration, feelings of worthlessness, sleep disturbances, appetite disturbances with excessive weight loss or gain, restlessness, impaired attention span, and suicidal ideation. Mild depression with symptoms that do not meet the criteria for a major depression is often underrecognized and undertreated, which results in reduced quality of life and function (Eliopoulos, 2018).

The risk of suicide is increased in older adults. There is a need for routine assessment of patients for depression and risk for suicide. Geriatric depression may be confused with dementia. However, the cognitive impairment resulting from depression is related to apathy rather than decline in brain function. When depression and medical illnesses coexist, as they often do, neglect of the depression can impede physical recovery. Assessing the patient's mental status, including depression, is vital and must not be overlooked. A commonly used assessment tool is the Geriatric Depression Scale (GDS) (Yesavage, Brink, Rose, et al., 1983). (See Chart 8-6.)

Older adults with depression can respond appropriately to treatment. Initial management involves evaluation of the patient's medication regimen and eliminating or changing any medications that contribute to depression. Furthermore, treatment of underlying medical conditions that may produce depressive symptoms may alleviate the depression. For mild depression, nonpharmacologic measures such as exercise, bright lighting, increasing interpersonal interactions, cognitive therapy, and reminiscence therapy are effective. However, for major depression, antidepressants and short-term psychotherapy, particularly in combination, are effective in older adults. Antidepressants, such as bupropion hydrobromide, venlafaxine hydrochloride, and mirtazapine, as well as selective serotonin reuptake inhibitors, such as paroxetine hydrochloride, can be effective (Comerford & Durkin, 2020). Tricyclic antidepressants can be useful for treating major depression in some patients. Electroconvulsive therapy is highly effective when antidepressant medications are not tolerated, not effective, or pose a significant medical risk (Miller, 2019).

Most antidepressant medications have anticholinergic, cardiac, and orthostatic adverse effects (Comerford & Durkin, 2020). They also interact with other medications and, therefore, should be used with care to avoid medication toxicity, hypotensive events, and falls. Older patients prescribed antidepressants should be carefully monitored for side effects. Good patient

education is needed to make sure older adults understand that it may take even longer than the typical 4 to 6 weeks for symptoms to diminish. During this period, nurses should offer support, encouragement, and strategies to maintain safety, such as changing positions slowly and maintaining adequate hydration (Miller, 2019).

Substance Use Disorder

Substance use disorders caused by misuse of alcohol and drugs may be related to depression. A national survey indicated that between 7% and 14% of adults age 65 and older reported alcohol abuse, dependence, binge drinking, or were at least at risk for alcohol dependence (Miller, 2019). Approximately 50% of adults age 65 and older drink alcohol on a regular basis (Kennedy-Malone et al., 2019). Moderate alcohol consumption has shown to have positive health benefits, such as lowering the risks for cardiovascular disease. Alcohol abuse is especially dangerous in older adults because of age-related changes in renal and liver function as well as the high risk of interactions with prescription medications and the resultant adverse effects. Alcohol and drug misuse in older adults often remains hidden because many older adults deny their habit when questioned. Using screening tools may help provide a rapid, sensitive, and inexpensive method for screening alcohol misuse. Alcohol use should be addressed during routine physical examinations (Resnick, 2019). See Chapter 4 for more information and specific assessment tools.

Chart 8-6

Geriatric Depression Scale

Choose the best answer for how you felt this past week.

[a]1. Are you basically satisfied with your life?	YES NO
2. Have you dropped many of your activities and interests?	YES NO
3. Do you feel that your life is empty?	YES NO
4. Do you often get bored?	YES NO
[a]5. Are you hopeful about the future?	YES NO
6. Are you bothered by thoughts you can't get out of your head?	YES NO
[a]7. Are you in good spirits most of the time?	YES NO
8. Are you afraid that something bad is going to happen to you?	YES NO
[a]9. Do you feel happy most of the time?	YES NO
10. Do you often feel helpless?	YES NO
11. Do you often get restless and fidgety?	YES NO
12. Do you prefer to stay at home, rather than going out and doing new things?	YES NO
13. Do you frequently worry about the future?	YES NO
14. Do you feel you have more problems with memory than most?	YES NO
[a]15. Do you think it is wonderful to be alive now?	YES NO
16. Do you often feel downhearted and blue?	YES NO
17. Do you feel pretty worthless the way you are now?	YES NO
18. Do you worry a lot about the past?	YES NO
[a]19. Do you find life very exciting?	YES NO
20. Is it hard for you to get started on new projects?	YES NO
[a]21. Do you feel full of energy?	YES NO
22. Do you feel that your situation is hopeless?	YES NO
23. Do you think that most people are better off than you are?	YES NO
24. Do you frequently get upset over little things?	YES NO
25. Do you frequently feel like crying?	YES NO
26. Do you have trouble concentrating?	YES NO
[a]27. Do you enjoy getting up in the morning?	YES NO
28. Do you prefer to avoid social gatherings?	YES NO
[a]29. Is it easy for you to make decisions?	YES NO
[a]30. Is your mind as clear as it used to be?	YES NO

Score: _____ (*Number of "depressed" answers*)

Norms
Normal: 5 ± 4
Mildly depressed: 15 ± 6
Very depressed: 23 ± 5

[a]Appropriate (nondepressed) answers = yes; all others = no.

From Yesavage, J., Brink, T. L., Rose, T. L., et al. (1983). Development and validation of a geriatric screening scale: A preliminary report. *Journal of Psychiatric Research*, *17*(1), 37–49.

Delirium

Delirium occurs secondary to numerous causes, including physical illness, surgery, medication or alcohol toxicity, dehydration, fecal impaction, malnutrition, infection, head trauma, lack of environmental cues, and sensory deprivation or overload. Older adults are particularly vulnerable to acute confusion because of their decreased biologic reserve and the large number of medications they may take. Nurses must recognize the symptoms of delirium and report them immediately. The Confusion Assessment Method (CAM) is a commonly used screening tool (Inouye, van Dyck, Alessi, et al., 1990). (See Chart 8-7.) Because of the acute and unexpected onset of symptoms and the unknown underlying cause, delirium is a medical emergency. If the delirium goes unrecognized and the underlying cause is not treated, permanent, irreversible brain damage or death can follow.

Alzheimer's Disease

AD is the sixth leading cause of death in the United States. For adults 65 years of age and older it is the fifth leading cause of death. AD is a progressive, irreversible, degenerative neurologic disease that begins insidiously and is characterized by gradual losses of cognitive function and disturbances in behavior and affect. AD can occur in people as young as 40 years of age but is less common before 65 years of age. Although the prevalence of AD increases dramatically with increasing age, affecting as many as half of those 85 years and older, AD is not a normal part of aging. Without a cure or any preventive measures, it is estimated that 13.8 million Americans will have this disease by 2050 (Alzheimer's Association, 2019).

There are numerous theories about the cause of age-related cognitive decline. Although the greatest risk factor for AD is increasing age, many environmental, dietary, and inflammatory factors also may determine whether a person suffers from this cognitive disease. AD is a complex brain disorder caused by a combination of various factors that may include genetics, neurotransmitter changes, vascular abnormalities, stress hormones, circadian changes, head trauma, and the presence of seizure disorders.

AD can be classified into two types: familial or early-onset AD and sporadic or late-onset AD (see Chapter 6, Table 6-5). Familial AD is rare, accounting for less than 2% of all cases, and is frequently associated with genetic mutations. It can occur in middle-aged adults. If family members have at least two other relatives with AD, then there is a familial component, which may include both environmental triggers and genetic determinants (NIH, 2017).

Chart 8-7 ASSESSMENT

Confusion Assessment Method (CAM)

Acute Onset

1. Is there evidence of an acute change in mental status from the patient's baseline?

Inattention[a]

2. **A.** Did the patient have difficulty focusing attention, for example, being easily distractible, or having difficulty keeping track of:

What was being said?

Not present at any time during interview.

Present at some time during interview but in mild form.

Present at some time during interview, in marked form.

Uncertain.

B. (If present or abnormal) Did this behavior fluctuate during the interview, that is, tend to come and go or increase and decrease in severity?

Yes.

No.

Uncertain.

Not applicable.

C. (If present or abnormal) Please describe this behavior:

Disorganized Thinking

3. Was the patient's thinking disorganized or incoherent, such as rambling or irrelevant conversation, unclear or illogical flow of ideas, or unpredictable switching from subject to subject?

Altered Level of Consciousness

4. Overall, how would you rate this patient's level of consciousness?

Alert (normal).

Vigilant (hyperalert, overly sensitive to environmental stimuli, startled very easily).

Lethargic (drowsy, easily aroused).

Stupor (difficult to arouse).

Coma (unarousable).

Uncertain.

Disorientation

5. Was the patient disoriented at any time during the interview, such as thinking that they were somewhere other than the hospital, using the wrong bed, or misjudging the time of day?

Memory Impairment

6. Did the patient demonstrate any memory problems during the interview, such as inability to remember events in the hospital or difficulty remembering instructions?

Perceptual Disturbances

7. Did the patient have any evidence of perceptual disturbances, for example, hallucinations, illusions, or misinterpretations (such as thinking something was moving when it was not)?

Psychomotor Agitation

8. Part 1.
   At any time during the interview, did the patient have an unusually increased level of motor activity, such as restlessness, picking at bedclothes, tapping fingers, or making frequent sudden changes of position?

Psychomotor Retardation

8. Part 2.
   At any time during the interview, did the patient have an unusually decreased level of motor activity, such as sluggishness, staring into space, staying in one position for a long time, or moving very slowly?

Altered Sleep–Wake Cycle

9. Did the patient have evidence of disturbance of the sleep–wake cycle, such as excessive daytime sleepiness with insomnia at night?

[a]The questions listed under this topic were repeated for each topic where applicable.

From Inouye, S. K., van Dyck, C. H., Alessi, C. A., et al. (1990). Clarifying confusion: The confusion assessment method. *Annals of Internal Medicine, 113*(12), 941–948. Used with permission.

Pathophysiology

The pathogenesis of AD is uncertain but the disease includes specific neuropathologic and biochemical changes that interfere with neurotransmission. These changes consist of neurofibrillary tangles (tangled masses of nonfunctioning neurons) and senile or neuritic plaques (deposits of amyloid protein, part of a larger protein called *amyloid precursor protein* in the brain). The neuronal damage occurs primarily in the cerebral cortex and results in decreased brain size. Similar changes are found in the normal brain tissue of nonsymptomatic older adults, although to a lesser extent. Cells that use the neurotransmitter acetylcholine are principally affected by AD. At the biochemical level, the enzyme active in producing acetylcholine, which is specifically involved in memory processing, is decreased.

Scientists have been studying complex neurodegenerative diseases such as AD and have focused on two key issues: whether a gene might influence a person's overall risk of developing the disease, and whether a gene might influence some particular aspect of a person's risk, such as the age at which the disease begins (age at onset). There are genetic differences in early- and late-onset forms of AD (NIH, 2017). Researchers are investigating what predisposes people to develop the plaques and neurofibrillary tangles that can be seen at autopsy in the brains of patients with AD. Understanding the complex ways in which aging as well as genetic and nongenetic factors affect brain cells over time, eventually leading to AD, continues to increase.

Clinical Manifestations

In the early stages of AD, forgetfulness and subtle memory loss occur. Patients may experience small difficulties in work or social activities but have adequate cognitive function to compensate for the loss and continue to function independently. With further progression of AD, the deficits can no longer be concealed. Forgetfulness is manifested in many daily actions; patients may lose their ability to recognize familiar faces, places, and objects and they may become lost in a familiar environment. They may repeat the same stories or ask the same question repeatedly. Trying to reason with people with AD and using reality **orientation** (a person's ability to recognize who and where they are in a time continuum) only increase their anxiety without increasing function. Conversation becomes difficult, and word-finding difficulties occur. The ability to formulate concepts and think abstractly disappears—for example, a patient can interpret a proverb only in concrete terms. Patients are often unable to recognize the consequences of their actions and, therefore, exhibit impulsive behavior—for example, on a hot day a patient may decide to wade in the city fountain fully clothed. Patients have difficulty with everyday activities, such as operating simple appliances and handling money.

Personality changes are also usually evident. Patients may become depressed, suspicious, paranoid, hostile, and even combative. Progression of the disease intensifies the symptoms: Speaking skills deteriorate to nonsense syllables, agitation and physical activity increase, and patients may wander at night. Eventually, assistance is needed for most ADLs, including eating and toileting, because dysphagia and incontinence develop. The terminal stage, in which patients are usually immobile and require total care, may last months or years. Occasionally, patients may recognize family members or caregivers. Death occurs as a result of complications such as pneumonia, malnutrition, or dehydration.

Assessment and Diagnostic Findings

A definitive diagnosis of AD can be made only at autopsy; however, an accurate clinical diagnosis can be made in the majority of cases. The most important goal is to rule out other causes of dementia that are reversible, such as depression, delirium, alcohol or drug abuse, or inappropriate drug dosage or drug toxicity. AD is a diagnosis of exclusion; a diagnosis of probable AD is made when the medical history, physical examination, and laboratory tests have excluded all known causes of other dementias.

The health history—including medical history, family history, social and cultural history, and medication history—and the physical examination, including functional and mental health status, are essential to the diagnosis of probable AD. Diagnostic tests, including complete blood count, chemistry profile, and vitamin B_{12} and thyroid hormone levels, as well as screening with electroencephalography, computed tomography (CT), magnetic resonance imaging (MRI), and examination of the cerebrospinal fluid (CSF), may all refute or support a diagnosis of probable AD.

Depression can closely mimic early-stage AD and coexists in many patients. Therefore, assessing the patient for underlying depression is important. The GDS is a useful tool to assess for depression (see Chart 8-6). Tools such as the MMSE (see Chart 8-3) are useful for assessing cognitive status and screening for AD. Both CT and MRI of the brain are useful for excluding hematoma, brain tumor, stroke, normal-pressure hydrocephalus, and atrophy but are not reliable in making a definitive diagnosis of AD. Infections and physiologic disturbances, such as hypothyroidism, Parkinson's disease, and vitamin B_{12} deficiency, can cause cognitive impairment that may be misdiagnosed as AD. Biochemical abnormalities can be excluded through examination of the blood and CSF.

Medical Management

In AD, the primary goal is to help maintain mental function as well as manage the cognitive and behavioral symptoms, and slow down the symptoms of the disease. Although there is no cure, several medications slow the progression of the disease. Cholinesterase inhibitors such as donepezil hydrochloride and rivastigmine tartrate, for example, enhance acetylcholine uptake in the brain, thus maintaining memory skills for a period of time. Cognitive ability may improve within 6 to 12 months of therapy. Rivastigmine is indicated for severe AD and it is recommended that treatment continue as long as possible (NIH, 2018b).

Behavioral problems such as agitation and psychosis can be managed by behavioral and other interventions such as music therapy (Weise, Jakob, Töpfer, et al., 2018). Associated depression and behavioral problems can also be treated pharmacologically if other interventions fail. Because symptoms change over time, all patients with AD should be reevaluated routinely, and the

nurse should document and report both positive and negative responses to medications.

Nursing Management

Nurses play an important role in the recognition of AD, particularly in hospitalized older adults, by assessing for signs (e.g., repeating or asking the same thing over and over). Nursing interventions for AD are aimed at promoting patient function and independence for as long as possible. Other important goals include promoting the patient's physical safety, promoting independence in self-care activities, reducing anxiety and agitation, improving communication, providing for socialization and intimacy, promoting adequate nutrition, promoting balanced activity and rest, and supporting and educating family caregivers. These nursing interventions apply to all patients with AD, regardless of cause.

Supporting Cognitive Function

Because dementia of any type is degenerative and progressive, patients display a decline in cognitive function over time. In the early phase of dementia, minimal cuing and guidance may be all that are needed for the patient to function fairly independently for a number of years. However, as the patient's cognitive ability declines, family members must provide more and more assistance and supervision. A calm, predictable environment helps people with dementia interpret their surroundings and activities. Environmental stimuli are limited, and a regular routine is established. A quiet, pleasant manner of speaking, clear and simple explanations, and the use of memory aids and cues help minimize confusion and disorientation and give patients a sense of security. Prominently displayed clocks and calendars may enhance orientation to time. Color-coding the doorway may help patients who have difficulty locating their room. Active participation may help patients maintain cognitive, functional, and social interaction abilities for a longer period. Physical activity and communication have also been demonstrated to slow some of the cognitive decline of AD.

Promoting Physical Safety

A safe home and hospital environment allow the patient to move about as freely as possible and relieves the family of constant worry about safety. For the patient residing at home, in order to prevent falls and other injuries, all obvious hazards are removed and hand rails are installed. A hazard-free environment allows the patient maximum independence and a sense of autonomy. Adequate lighting, especially in halls, stairs, and bathrooms, is necessary. Nightlights are helpful, particularly if the patient has increased

confusion at night, sometimes referred to as sundowning. Driving is prohibited, and smoking is allowed only with supervision. The patient may have a short attention span and be forgetful; therefore, the nurse and the family must be patient, repeat instructions as needed, and use reminders (i.e., post-it notes, electronic reminders) for daily activities. Doors leading from the house must be secured. Outside the home, all activities must be supervised to protect the patient, and the patient should wear some type of identification in case of separation from the caregiver.

If the patient is hospitalized, additional precautionary measures should be taken. Wandering behavior, which may be worse in the hospital due to unfamiliar surroundings, can often be reduced by gentle persuasion, distraction, or by placing the patient close to the nursing station. Restraints should be avoided because they can increase agitation and lead to injury.

Promoting Independence in Self-Care Activities

Pathophysiologic changes in the brain make it difficult for people with AD to maintain physical independence. Patients should be assisted to remain functionally independent for as long as possible. One way to do this is to simplify daily activities by organizing them into short, achievable steps so that the patient experiences a sense of accomplishment. Frequently, occupational therapists can suggest ways to simplify tasks or recommend adaptive equipment. Direct patient supervision is sometimes necessary; however, maintaining personal dignity and autonomy is important for people with AD, who should be encouraged to make choices when appropriate and to participate in self-care activities as much as possible.

Reducing Anxiety and Agitation

Despite profound cognitive losses, patients are sometimes aware of their diminishing abilities. Patients need constant emotional support that reinforces a positive self-image. When loss of skills occurs, goals are adjusted to fit the patient's declining ability.

The environment should be kept familiar and noise free. Excitement and confusion can be upsetting and may precipitate a combative, agitated state known as a catastrophic reaction (overreaction to excessive stimulation). The patient may respond by screaming, crying, or becoming abusive (physically or verbally); this may be the patient's only way of expressing an inability to cope with the environment. When this occurs, it is important to remain calm and unhurried. Forcing the patient to proceed with the activity only increases the agitation. It is better to postpone the activity until later, even to another day. Frequently, the patient quickly forgets what triggered the reaction. Measures such as moving to a familiar environment, listening to music, stroking, rocking, or distraction may quiet the patient. Research suggests that the use of

activities and music therapy, both individualized and in groups, help decrease agitation (Zhang, Cai, An, et al., 2017). Becoming familiar with a particular patient's usual responses to certain stressors helps caregivers avoid stressful situations.

Improving Communication

To promote the patient's interpretation of messages, the nurse should remain unhurried and reduce noises and distractions. Use of clear, easy-to-understand sentences to convey messages is essential because patients frequently forget the meaning of words or have difficulty organizing and expressing thoughts. In the earlier stages of dementia, lists and simple written instructions that serve as reminders may be helpful. In later stages, the patient may be able to point to an object or use nonverbal language to communicate. Tactile stimuli, such as hugs or hand pats, are usually interpreted as signs of affection, concern, and security.

Providing for Socialization and Intimacy Needs

Because socialization with friends can be comforting, visits, letters, and phone calls are encouraged. Recreation is important, and people with dementia are encouraged to participate in simple activities. Realistic goals for activities that provide satisfaction are appropriate. Hobbies and activities such as walking, exercising, and socializing can improve quality of life. The nonjudgmental friendliness of a pet may provide stimulation, comfort, and contentment. Care of plants or a pet can also be satisfying and an outlet for energy.

AD does not eliminate the need for intimacy. Patients and their spouses may continue to enjoy sexual activity. Spouses should be encouraged to talk about any sexual concerns, and sexual counseling may be necessary. Simple expressions of love, such as touching and holding, are often meaningful.

Promoting Adequate Nutrition

Mealtime can be a pleasant social occasion or a time of upset and distress, and it should be kept simple and calm, without confrontations. Patients prefer familiar foods that look appetizing and taste good. Cueing may be necessary to encourage adequate nutrition and hydration. Food is cut into small pieces to prevent choking. Liquids may be easier to swallow if they are thickened. Hot food and beverages are served warm, and the temperature of the foods should be checked to prevent burns.

When lack of coordination interferes with self-feeding, adaptive equipment is helpful (see Fig. 8-4). Some patients may do well eating with a spoon or with their fingers. If this is the case, an apron or a smock, rather than a bib, is used to protect clothing. As deficits progress, it may become necessary to feed the patient. Forgetfulness, disinterest, dental problems, lack of coordination,

overstimulation, and choking all serve as barriers to good nutrition and hydration.

Promoting Balanced Activity and Rest

Many patients with dementia exhibit sleep disturbances, wandering, and behaviors that may be considered inappropriate. These behaviors are most likely to occur when there are unmet underlying physical or psychological needs. Caregivers must identify the needs of patients who are exhibiting these behaviors because further health decline may occur if the source of the problem is not corrected. Adequate sleep and physical exercise are essential. If sleep is interrupted or the patient cannot fall asleep, music, warm milk, or a back rub may help the patient relax. During the day, patients should be encouraged to participate in exercise because a regular pattern of activity and rest enhances nighttime sleep. Long periods of daytime sleeping are discouraged.

Figure 8-4 • **A.** Assistive feeding devices make it easy for patients to grasp and get food on utensils. **B.** Assistive feeding devices may

be required for patients who are weak, fatigued, or paralyzed or have neuromuscular impairment.

Promoting Home, Community-Based, and Transitional Care

The emotional burden on the families of patients with all types of dementia is enormous. The physical health of the patient is often very stable and the decline gradual. Family members may cling to the hope that the diagnosis is incorrect and that their relative will improve with greater effort. Family members provide at least 83% of the home care that is required by patients with AD (Alzheimer's Association, 2019). They are faced with numerous difficult decisions (e.g., when the patient should stop driving, when to assume responsibility for the patient's financial affairs). Aggression and hostility exhibited by the patient are often misunderstood by caregivers, who may feel unappreciated, frustrated, and angry. Feelings of guilt, nervousness, and worry contribute to caregiver fatigue, depression, and family dysfunction. Researchers have identified that a Web-based intervention can be effective in helping with anxiety and stress, reducing depressive symptoms, and identifying care needs and planning interventions that promote balance and congruence in the lives of caregivers (Ploeg, Markle-Reid, Valaitis, et al., 2017).

Neglect or abuse of the patient can occur, and this has been documented in home situations as well as in institutions. If neglect or abuse of any kind—including physical, emotional, sexual, neglect, or financial abuse—is suspected, the local adult protective services agency must be notified. The responsibility of the nurse is to report the suspected abuse, not to prove it.

The Alzheimer's Association is a coalition of family members and professionals who share the goals of family support and service, education, research, and advocacy. Family support groups, respite (relief) care, and adult day care may be available through different community resources, such as the Area Agency on Aging, in which concerned volunteers are trained to provide structure to caregiver support groups (see Resources section at the end of chapter). Respite care is a commonly provided service in which caregivers can get away from the home for short periods while someone else tends to the needs of the patient.

Vascular Dementia

Vascular dementia is the second most common cause of dementia and is characterized by an uneven, stepwise downward decline in mental function (Norris, 2019). Multi-infarct dementia, the most common form of vascular dementia, has an unpredictable course and is characterized by variable impairment depending on the affected sites in the brain. The patient may present with a deficit in only one domain such as word retrieval whereas other

cognitive abilities may be intact. Diagnosis may be even more difficult if a patient has both vascular dementia and AD.

Because vascular dementia is associated with hypertension and cardiovascular disease, risk factors (e.g., hypercholesterolemia, smoking, heart disease, diabetes) are similar. Prevention and management are also similar (see Chapter 27). Measures to decrease blood pressure, control diabetes, and lower cholesterol levels may slow cognitive decline.

Additional Aspects of Health Care of the Older Adult

The nurse needs to consider other health issues of older adults. These include geriatric syndromes, elder neglect and abuse, as well as ethical and legal issues.

Geriatric Syndromes

Older adults tend to acquire multiple problems and illnesses as they age. The decline of physical function leads to a loss of independence and increasing frailty as well as to susceptibility to both acute and chronic health problems, which generally result from several factors rather than from a single cause. When combined with a decrease in host resistance, these factors can lead to illness or injury. Some problems commonly experienced by older adults are becoming recognized as **geriatric syndromes**. These conditions do not fit into discrete disease categories and require a multidisciplinary and comprehensive assessment to identify the underlying cause or causes. Examples include skin impairment (e.g., pressure injuries), poor nutrition, falls or functional decline, urinary incontinence, defecation incontinence, cognitive impairment (e.g., delirium), and sleep disturbances (Tang, Tang, Hu, et al., 2017). Although these conditions may develop slowly, the onset of symptoms is often acute. Furthermore, the presenting symptoms may appear in other body systems before becoming apparent in the affected system. For example, an older patient may present with confusion, and the underlying disease may be a UTI, dehydration, or a heart attack (van Seben, Reichardt, Aarden, et al., 2019).

The term *geriatric triad* includes changes in cognitive status, falls, and incontinence. This term is used to focus awareness on these three conditions, which need particular attention, and the implementation of prevention measures during the hospitalization of older patients.

Impaired Mobility

The causes of decreased mobility are many and varied. Common causes include strokes, Parkinson's disease, diabetic neuropathy, cardiovascular compromise, osteoarthritis, osteoporosis, and sensory deficits. To avoid

immobility, older people should be encouraged to stay as active as possible. During illness, bed rest should be kept to a minimum, even with hospitalized patients, because brief periods of bed rest quickly lead to deconditioning and, consequently, to a wide range of complications. When bed rest cannot be avoided, patients should perform active range-of-motion and strengthening exercises with the unaffected extremities, and nurses or family caregivers should perform passive range-of-motion exercises on the affected extremities. Frequent position changes help offset the hazards of immobility. Both the health care staff and the patient's family can assist in maintaining the current level of mobility.

Dizziness

Older adults frequently seek help for dizziness, which presents a particular challenge because there are numerous possible causes. For many, the problem is complicated by an inability to differentiate between true dizziness (a sensation of disorientation in relation to position) and vertigo (a spinning sensation). Other similar sensations include near-syncope and disequilibrium. The causes for these sensations range in severity from minor (e.g., buildup of ear wax) to severe (e.g., dysfunction of the cerebral cortex, cerebellum, brain stem, proprioceptive receptors, or vestibular system). Even a minor reversible cause, such as ear wax impaction, can result in a loss of balance and a subsequent fall and injury. Because dizziness has many predisposing factors, nurses should seek to identify any potentially treatable factors related to the condition.

Falls and Falling

Inadvertent injuries rank third as a cause of death for older people, and falls are the most common cause of nonfatal injuries and hospital admissions. The incidence of falls rises with increasing age.

Many older adults who fall do not sustain an injury; however, between 20% and 30% of older adults who fall sustain moderate to serious injury such as bruises, hip fractures, or head trauma. One out of five falls in older adults results in serious injury such as broken bones or a head injury (Heron, 2019). Overall, older women who fall sustain a greater degree of injury than do older men; however, men are more likely to die of a fall injury (World Health Organization [WHO], 2019). Hip fracture is a common type of fracture that can occur as a result of a fall. Fifty percent of adults who fall but cannot get up on their own and sustain a hip fracture are then unable to return to the same functional level after this type of injury. Causes of falls are multifactorial. Both extrinsic factors such as changes in the environment or poor lighting and intrinsic factors such as physical illness, neurologic changes, or sensory impairment play a role. Mobility difficulties, medication effects, foot problems

or unsafe footwear, orthostatic hypotension, visual problems, and tripping hazards are common and treatable causes. Polypharmacy, medication interactions, and the use of alcohol precipitate falls by causing drowsiness, decreased coordination, and orthostatic hypotension. Falls have physical dangers as well as serious psychological and social consequences. It is not uncommon for an older person who has experienced a fall to become fearful and lose self-confidence (Miller, 2019).

Nurses can encourage older adults and their families to make lifestyle and environmental changes to prevent falls. Adequate lighting with minimal glare and shadow can be achieved through the use of small area lamps, indirect lighting, sheer curtains to diffuse direct sunlight, dull rather than shiny surfaces, and nightlights. Sharply contrasting colors can be used to mark the edges of stairs. Grab bars by the bathtub, shower, and toilet are useful. Loose clothing, improperly fitting shoes, scatter rugs, small objects, and pets create hazards and increase the risk of falls. Older adults function best in familiar settings when the arrangement of furniture and objects remains unchanged.

Quality and Safety Nursing Alert

In hospitalized and institutionalized older adults, physical restraints (lap belts; geriatric chairs; side rails, vest, waist, and jacket restraints) and chemical restraints (medications) precipitate many of the injuries they were meant to prevent. Because of the acute negative consequences of restraint use, accrediting agencies of nursing homes and acute care facilities now maintain stringent guidelines for correct application and use.

Urinary Incontinence

Urinary incontinence may be acute, occurring during an illness, or may develop chronically over a period of years. Older patients often do not report this very common problem unless specifically asked. Transient causes may be attributed to *d*elirium and *d*ehydration; *r*estricted mobility; *i*nflammation, *i*nfection, and *i*mpaction; and *p*harmaceuticals and *p*olyuria (the acronym *drip* may be used to remember them). Once identified, the causative factor can be eliminated.

Older patients with incontinence should be urged to seek help from appropriate health care providers because incontinence can be both emotionally devastating and physically debilitating. Nurses who specialize in behavioral approaches to urinary incontinence management can help patients regain full continence or significantly improve the level of continence. Although medications such as anticholinergics may decrease some of the symptoms of urge incontinence (detrusor instability), the adverse effects of

these medications (dry mouth, slowed GI motility, and confusion) may make them inappropriate choices for older adults (Fick et al., 2019). Various surgical procedures are also used to manage urinary incontinence, particularly stress urinary incontinence.

Detrusor hyperactivity with impaired contractility is a type of urge incontinence that is seen predominantly in the older adult population. In this variation of urge incontinence, patients have no warning that they are about to urinate. They often void only a small volume of urine or none at all and then experience a large volume of incontinence after leaving the bathroom. Nurses should be familiar with this form of incontinence and not show disapproval when it occurs. Many patients with dementia suffer from this type of incontinence, because both incontinence and dementia are a result of dysfunction in similar areas of the brain. Prompted, timed voiding can be of assistance in these patients, although clean intermittent catheterization may be necessary because of postvoid residual urine. See Chapter 49 for information on management of urinary disorders.

Increased Susceptibility to Infection

Infectious diseases present a significant threat of morbidity and mortality to older adults, in part because of the blunted response of host defenses caused by a reduction in both cell-mediated and humoral immunity (see Chapters 31 and 32). Age-related loss of physiologic reserve and chronic illnesses also contribute to increased susceptibility. Pneumonia, UTIs, GI infections, and skin infections are some of the common infections in older adults.

Because of a weakened immune response, the effects of influenza and pneumococcal infections on older adults are significant. Vaccination can help prevent both infections. There is a national goal to increase vaccination rates among people 65 years of age and older. More than 71% of those 65 years of age and older reported receiving an influenza vaccination between January and June 2018 and 69% reported that they had received a pneumococcal vaccination (AoA, 2020).

Influenza and pneumococcal vaccinations lower the risks of hospitalization and death in older adults. The influenza vaccine, which is prepared yearly to adjust for the specific immunologic characteristics of the influenza viruses at that time, should be given annually in autumn. A systematic review and meta-analysis on the effectiveness of high-dose versus standard-dose influenza vaccine suggests that better protection is provided with the high-dose, trivalent, inactivated influenza vaccine versus the standard vaccine in older adults (Lee, Lam, Shin, et al., 2018). The pneumococcal vaccine should be administered as recommended (see Chapter 3, Table 3-3). Both of these injections can be received at the same time in separate injection sites. Nurses should urge older adults to be vaccinated. All health care providers working with older adults or high-risk chronically ill people should also be immunized.

AIDS occurs across the age spectrum. It is increasingly recognized that AIDS does not spare the older segment of society, and many who are living with HIV/AIDS are aging.

Atypical Responses

Many altered physical, emotional, and systemic reactions to disease are attributed to age-related changes in older adults. Physical indicators of illness that are useful and reliable in young and middle-aged people cannot be relied on for the diagnosis of potential life-threatening problems in older adults. The response to pain in older adults may be lessened because of reduced acuity of touch, alterations in neural pathways, and diminished processing of sensory data.

Older adults who are experiencing an MI may not have chest pain but present with confusion. Hiatal hernia or upper GI distress is often the cause of chest pain. Therefore, acute abdominal conditions may go unrecognized in older adults because of atypical signs and absence of pain.

The baseline body temperature for older adults is about 1°F lower than it is for younger people (Weber & Kelley, 2019). In the event of illness, the body temperature of an older person may not be high enough to qualify as a traditionally defined fever. A temperature of 37.8°C (100°F) in combination with systemic symptoms may signal infection. A temperature of 38.3°C (101°F) almost certainly indicates a serious infection that needs prompt attention. A blunted fever in the face of an infection often indicates a poor prognosis. Temperatures rarely exceed 39.5°C (103°F). Nurses must be alert to other subtle signs of infection, such as mental confusion, increased respirations, tachycardia, and a change in skin color.

Altered Emotional Impact

The emotional component of illness in older adults may differ from that in younger people. Many older adults equate good health with the ability to perform their daily activities and believe that "you are as old as you feel." An illness that requires hospitalization or a change in lifestyle is an imminent threat to well-being. Older adults admitted to the hospital are at high risk for disorientation, confusion, change in level of consciousness, and other symptoms of delirium, as well as anxiety and fear. In addition, economic concerns and fear of becoming a burden to families often lead to high anxiety in older adults. Nurses must recognize the implications of fear, anxiety, and dependency in older patients. They should encourage autonomy, independent decision making, and early mobilization. A positive and confident demeanor in nurses and family members promotes a positive mental outlook in older patients.

Altered Systemic Response

In an older person, illness has far-reaching repercussions. The decline in organ function that occurs in every system of the aging body eventually depletes the body's ability to respond at full capacity. Illness places new demands on body systems that have little or no reserve to meet the crisis. Homeostasis is jeopardized. Older adults may be unable to respond effectively to an acute illness or, if a chronic health condition is present, they may be unable to sustain appropriate responses over a long period. Furthermore, their ability to respond to definitive treatment is impaired. The altered responses of older adults reinforce the need for nurses to monitor all body system functions closely, being alert to signs of impending systemic complication.

Elder Neglect and Abuse

Older adults are at risk for abuse and neglect both in the community setting and in nursing homes (Burnes, Pillemer, & Lachs, 2017). Because of different definitions and terminology and the pattern of underreporting, a clear picture of the incidence and prevalence of abuse among older adults is lacking. Furthermore, one of the major barriers to fully understanding elder abuse is that most professionals in all professions, including law enforcement, are not equipped to recognize and report this type of abuse. Often victims are reluctant to report the abuse and clinicians are unaware of the frequency of the problems.

Neglect is the most common type of abuse. Other forms of abuse include physical, psychological or emotional, sexual, abandonment, and financial exploitation or abuse. Burnes and colleagues (2017) reported factors associated with physical and emotional abuse included being separated or divorced, living in a low-income household, functional impairment, and younger age for community-dwelling older adults. Neglect was associated with poor health, living below the poverty level, being separated or divorced, and younger age. Neglect was lowest in Hispanic households (Burnes et al., 2017).

Physical abuse associated with staff misconduct in long-term care facilities has received much attention in the past decade. Braaten and Malmedal (2017) did a qualitative study to understand the perspective of staff regarding prevention of physical abuse of nursing home residents. Staff were asked what measures they considered useful to implement in their daily work to prevent abusive behaviors. Staff shared that there was a need for increased competence among staff about the concept of abuse, known risk factors, good communication skills, and trusting relationships, as well as a work environment/culture that promotes openness where ethical dilemmas can be discussed (Braaten & Malmedal, 2017). Factors associated with resident on resident abuse in a nursing home setting were reported as previous staff physical or emotional abuse; younger age; limitations in ADLs and IADLs; and the emotional closeness of the resident to their family (Braaten &

Malmedal, 2017). Older adults with disability of all types are at increased risk for abuse from family members, paid caregivers, and staff, whether they live in the community or a long-term care facility.

Nurses should be alert to possible **elder abuse** and neglect. During the health history, the older adult should be asked about abuse during a private portion of the interview. Most states require that care providers, including nurses, report suspected abuse. Preventive action should be taken when caregiver strain is evident—before elder abuse occurs. Early detection and intervention may provide sufficient resources to the family or the person at risk to ensure patient safety. Interdisciplinary team members, including the psychologist, social worker, or chaplain, can be enlisted to help the caregiver develop self-awareness, increased insight, and an understanding of the disease or aging process. Community resources such as caregiver support groups, respite services, and local offices of Area Agencies on Aging (AAAs) are useful for both the older adult and the caregiver.

Social Services

Many social programs exist for older Americans, including Medicare, Medicaid, the Older Americans Act, Supplemental Security Income, Social Security amendments, Section 202 housing, and Title XX social services legislation. These federal programs have increased health care options and financial support for older Americans. The Older Americans Act mandated creation of a federal aging network, resulting in the establishment of the AAAs, a national system of social services and networks providing many community services for older adults. Each state has an advisory network that is charged with overseeing statewide planning and advocacy for older adults throughout the state. Among the services provided by the AAAs are assessment of need, information and referral, case management, transportation, outreach, homemaker services, day care, nutritional education and congregate meals, legal services, respite care, senior centers, and part-time community work. The agencies target low-income, ethnic minority, rural living, and frail older adults who are at risk for institutionalization; however, the assessment and information services are available to all older adults. Similar services such as homemaker, home health aide, and chore services can be obtained at an hourly rate through these agencies or through local community nursing services if the family does not meet the low-income criteria. Informal sources of help, such as family, friends, mail carriers, church members, and neighbors, all keep an informal watch on community-dwelling senior citizens. (See Resources section at the end of the chapter.)

Other community support services are available to help older adults outside the home. Senior centers have social and health promotion activities, and some provide a nutritious noontime meal. Adult day care facilities offer daily

supervision and social opportunities for older adults who cannot be left alone. Adult day care services, although expensive, provide respite and enable family members to carry on daily activities while the older person is at the day care center.

Health Care Costs of Aging

Health care is a major expenditure for older adults, especially for those with chronic illness and limited financial resources. Older adults, who make up about 15% of the population, accounted for 38% of health care costs, particularly in the last year of life (Centers for Medicaid & Medicare Services [CMS], 2018).

The two major programs that finance health care in the United States are Medicare and Medicaid, both of which are overseen by the CMS. Both programs cover acute care needs such as inpatient hospitalization, primary provider care, outpatient care, home health services, and skilled nursing care in a nursing facility. Medicare is federally funded, whereas Medicaid is given by states; therefore, eligibility and reimbursements for Medicaid services vary from state to state. For older adults with limited incomes, even with the support of Medicare or Medicaid, paying out-of-pocket expenses can be a hardship. Out-of-pocket health care expenses represent 28% of the income of poor and near-poor older adults. Despite changes to the Medicare prescription benefit plan, out-of-pocket expenditures and prescription costs can be burdensome (AoA, 2020).

Home Health Care

The use of home care services and skilled nursing home care increases with age. Because of the rapidly growing older adult population and the availability of Medicare funding for acute care, home health care in the United States has rapidly expanded. (See Chapter 2 for more information on home health care.)

Hospice Services

Hospice and palliative care have much in common. Both are for people with serious illnesses. Both follow treatment goals that aim to relieve pain, increase comfort, and improve quality of life for the patient and family. The goal of hospice is to improve the quality of life by focusing on symptom management, pain control, and emotional support. In most hospice cases, patients are not expected to live longer than 6 months. Hospice care focuses on quality of life, and by necessity, it usually includes realistic emotional, social, spiritual, and financial preparation for death. Palliative care is for people at any stage of a serious illness, and their condition does not have to be incurable. Palliative

care aims to relieve pain and other symptoms to maintain the highest quality of life for the longest period of time (Casey, 2019). Under Medicare and Medicaid, medical and nursing services are provided to keep patients as pain free and comfortable as possible. (For an in-depth discussion of palliative and end-of-life care, see Chapter 13.)

Aging With a Disability

As the life expectancy of people with all types of physical, cognitive, and mental disability has increased, individuals must deal with the normal changes associated with aging in addition to their preexisting disability. There are still large gaps in our understanding of the interaction between disability and aging, including how this interaction varies depending on the type and degree of disability and other factors such as socioeconomics and gender. For adults without disability, the changes associated with aging may be minor inconveniences. For adults with disorders such as spinal cord injuries, aging is associated with higher rates of secondary health conditions compared to those aging without a disability (Jorgensen, Iwarsson, & Lexell, 2019). Many people with disability are greatly concerned about what will happen to them as they age and whether assistance will be available when they need care.

It has been proposed that nurses view people with disability as capable, responsible individuals who are able to function effectively despite having a disability. Both the Interface and the Biopsychosocial models of disability can serve as a basis for the role of nurses as advocates for removal of barriers to health care. The use of such models would also encourage public policies that support full participation of all citizens through greater availability of personal assistants and affordable and accessible transportation. See Chapter 7, Chart 7-2 for discussion of other disability models.

Today, children born with intellectual and physical disability and those who acquire them early in life are also living into middle and older age. Often, their care has been provided by the family, primarily by the parents. As parents age and can no longer provide the needed care, they seek additional help with the care or long-term care alternatives for their children. However, few services are available at present to support a smooth transition between caregiving by parents and then by others. Research and public policy must focus on supports and interventions that allow people with disability who are aging to increase or maintain function within their personal environment as well as in the outside community. Important questions include who will provide the care and how will it be financed. The National Institute on Aging has identified aging with a disability as a focus and is striving to provide streamlined information and access to those with a disability and their family caregivers.

Ethical and Legal Issues Affecting the Older Adult

Nurses play an important role in supporting and informing patients and families when making treatment decisions. This nursing role becomes even more important in the care of aging patients who are facing life-altering and possibly end-of-life decisions. Loss of rights, victimization, and other serious problems might occur if a patient has not made plans for personal and property management in the event of disability or death. As advocates, nurses should encourage end-of-life discussions and educate older adults to prepare advance directives before incapacitation (Miller, 2019).

An advance directive is a formal, legally endorsed document that provides instructions for care (living will) or names a proxy decision maker (**durable power of attorney**). It is to be implemented if the signer becomes incapacitated. This written document must be signed by the person and by two witnesses, and a copy should be given to the primary provider and placed in the medical record. The advance directive is not meant to be used only when certain (or all) types of medical treatment are withheld; rather, it allows for a description of health care preferences, including requesting full use of all available medical interventions. The health care proxy may have the authority to interpret the patient's wishes on the basis of medical circumstances and should be guided by the decisions or situations stated in the living will (see Chart 8-8).

When such serious decisions are made, possibilities exist for significant conflict of values among patients, family members, health care providers, and the legal representative. Autonomy and self-determination are Western concepts, and people from different cultures may view advance directives as a method for denial of care. Older adults from some cultures may be unwilling to consider the future, or they may wish to protect relatives and not want them to be informed about a serious illness. Nurses can facilitate the decision making process by being sensitive to the complexity of patients' values and respecting their decisions. Directives must be focused on the wishes of the patient, not those of the family or the designated proxy.

Chart 8-8 **ETHICAL DILEMMA**

Does Stopping of Eating and Drinking Violate the Principle of Nonmaleficence?

Case Scenario

You work as a staff nurse in a skilled nursing facility in the Alzheimer care unit. C.R. is an 82-year-old woman with advanced Alzheimer's disease who has been a resident in the facility for over a year. Her status has deteriorated significantly over the past 2 months. C.R.'s daughter has been visiting her mother at dinnertime most evenings, bringing her favorite foods and drinks to feed her by hand. One evening, C.R.'s son visits during dinnertime and finds his sister feeding their mother. This was the first time C.R.'s son has visited her in over 2 months. He reacts angrily, noting that C.R. had noted in her advance directive that she did not wish to receive nutrition and fluids if she became incapacitated. He admonishes his sister "Mom does not even recognize either one of us—she would not want to keep going on this way!" C.R.'s daughter notes that although their mother does not recognize anyone or understand what is happening, she opens her mouth and seems to enjoy the food and fluids that she is receiving. C.R.'s son is his mother's sole designated proxy; he was authorized by her with her power-of-attorney to make health care decisions during a time when she had the mental capacity to make that decision. He reminds you and C.R.'s daughter of this, and tells you that he wants his sister to stop giving food and fluids to his mother.

Discussion

Whether or not a patient may autonomously decide to forego artificial nutrition and hydration therapy (ANH) is not subject to much debate at present. Most bioethicists tend to agree that a patient with mental capacity may decide to forego ANH, even if doing so may hasten the patient's death. Advance directives for health care that specify no ANH written by patients before such time as they lose capacity is considered binding. Proxy decision makers for patients who lose capacity may also make the decision to withhold ANH.

However, decisions to voluntarily stop eating and drinking (VSED), or taking nutrition and fluids by the "natural" oral route, can be more complicated. While ANH may only be delivered using medical interventions (e.g., intravenous fluids, feeding tubes), taking food and fluids orally might not be considered "medical care." In these instances, whether or not a designated proxy or person vested with power-of-attorney for health care agrees that this type of feeding can continue may be inconsequential. The ANA (2017) declares that "VSED, with the intention of hastening death can only be made by those patients with decision making capacity, not by surrogates." (p.1). In that same position statement, however, the ANA (2017) also states that "the patient's decision regarding VSED remains binding, even if the patient subsequently loses capacity." (p.1). It is important for a person who wishes to VSED to specify that in an advance directive.

Analysis

- Describe the ethical principles that are in conflict in this case (see Chapter 1, Chart 1-7). Which principle do you believe should have preeminence as you proceed to work with C.R. and her adult children? Does VSED in a patient who now lacks capacity violate the principle of nonmaleficence?
- Is C.R.'s son authorized to specify that his sister may not hand feed their mother? What if C.R.'s advance directive specifically states that, should she lose capacity, she would not wish to receive *oral* food and fluids? C.R. opens her mouth and willingly accepts the foods and fluids given to her by her daughter; does this imply that she now consents to be hand fed?
- What resources might be available to you and the health care team to help C.R.'s adult children determine what is in her best interests?

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Resources

See Chapter 1, Chart 1-10 for Steps of an Ethical Analysis and Ethics Resources.

If no advance arrangement has been made and the older person appears unable to make decisions, the court may be petitioned for a competency hearing. If the court rules that an older adult is incompetent, the judge appoints a guardian—a third party who is given powers by the court to assume responsibility for making financial or personal decisions for that person.

People with communication difficulties or mild dementia tend to be viewed as incapable of self-determination. However, people with mild dementia may have sufficient cognitive capability to make some, but perhaps not all, decisions. For example, a patient may be able to identify a proxy decision maker and yet be unable to select specific treatment options. People with mild dementia may be competent to understand the nature and significance of different options for care.

In 1990, the Patient Self-Determination Act (PSDA), a federal law, was enacted to require patient education about advance directives at the time of hospital admission, as well as documentation of this education. Nursing homes

are also mandated to enhance residents' autonomy by increasing their involvement in health care decision making. In both nursing homes and hospitals, the documentation and placement of advance directives in the medical record and the education of patients about advance directives vary considerably. Periodically, it is important to ensure that the directives reflect the current wishes of the patient and that all providers have a copy so that they are aware of the patient's wishes.

CRITICAL THINKING EXERCISES

1 ebp You notice an increase in the number of older patients who are confused on the medical-surgical unit where you work. What do you suspect may be the cause of this increase in patients who are confused? What screening tool(s) would you recommend for these patients? Would you recommend that these tools be used for every older patient? Why? What is the strength of the evidence base guiding your assessment, actions, and recommendations?

2 ipc A 90-year-old man has been admitted to your medical unit with urinary retention. What nursing and interprofessional assessments are indicated during your initial interactions with him? What other interprofessional services might you try to engage?

3 pq During a home visit, an 81-year-old woman with diabetes and a lower limb amputation admits to you that she has fallen three times in the past 6 months. Identify priorities and strategies that may help to prevent further falls for this patient.

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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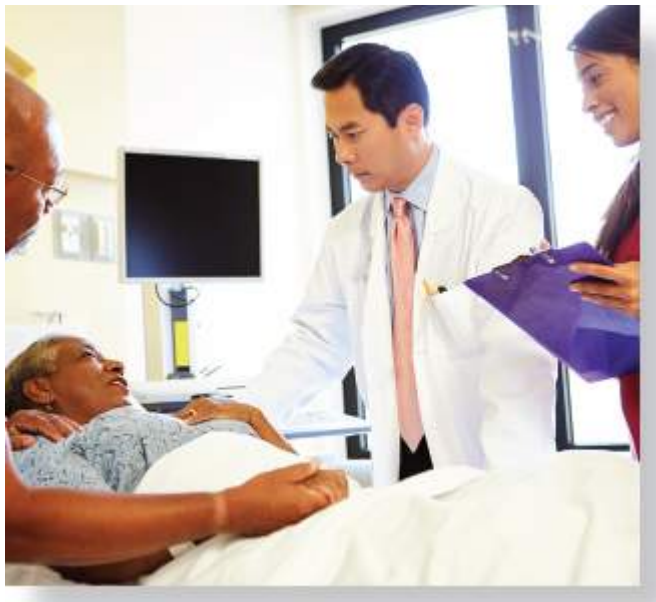
Resources

Administration on Aging (AoA), www.aoa.gov
Alzheimer's Association, www.alz.org
American Association for Geriatric Psychiatry (AAGP), www.aagponline.org
American Association of Retired Persons (AARP), www.aarp.org
American Federation for Aging Research (AFAR), www.afar.org
American Geriatrics Society (AGS), www.americangeriatrics.org
Association for Gerontology in Higher Education (AGHE), www.aghe.org
Children of Aging Parents (CAPS), www.caps4caregivers.org
Family Caregiver Alliance (FCA), www.caregiver.org
Gerontological Society of America (GSA), www.geron.org
Hartford Institute for Geriatric Nursing, www.hign.org
Hospital Elder Life Program (HELP), www.hospitalelderlifeprogram.org
LeadingAge (formerly American Association of Homes and Services for the Aging), www.leadingage.org
MedicAlert + Alzheimer's Association Safe Return (program for locating lost patients), www.alz.org/care/dementia-medic-alert-safe-return.asp
National Caucus and Center on Black Aging (NCBA), www.ncba-aged.org
National Council on Aging (NCOA), www.ncoa.org
National Gerontological Nursing Association (NGNA), www.ngna.org
National Institute on Aging (NIA), Alzheimer's Disease Education and Referral (ADEAR) Center, www.nia.nih.gov/Alzheimers

UNIT 2 Concepts and Principles of Patient Management

Case Study

PROMOTING TEAMWORK AND COLLABORATION IN PALLIATIVE CARE



A 56-year-old woman diagnosed with advanced adenocarcinoma of the lung arrives at her outpatient palliative care appointment with delirium, lethargy, and confusion. Her blood work is drawn, and she is transferred to the inpatient oncology unit where you work for further evaluation. The admission profile reports that she is prescribed gabapentin 300 mg three times daily and fentanyl 50 mcg transdermal patch to be replaced every 72 hours. Upon assessment you find the patient confused and unable to rate her pain. The family is concerned about the confusion and worried that she is unable to tolerate the medications ordered for pain. Because this patient has many underlying components to her care, you request a case conference with the family, palliative care team, pharmacist, and the oncologist to determine the best plan of care at this time.

QSEN Competency Focus: Teamwork and Collaboration

The complexities inherent in today's health care system challenge nurses to demonstrate integration of specific interdisciplinary core competencies. These competencies are aimed at ensuring the delivery of safe, quality patient care (Institute of Medicine, 2003). The Quality and Safety Education for Nurses project (Cronenwett, Sherwood, Barnsteiner, et al., 2007; QSEN, 2020) provides a framework for the knowledge, skills, and attitudes (KSAs) required for nurses to demonstrate competency in these key areas, which include ***patient-centered care, interdisciplinary teamwork and collaboration, evidence-based practice, quality improvement, safety,*** and ***informatics.***

Teamwork and Collaboration Definition: Function effectively within nursing and interprofessional teams, fostering open communication, mutual respect, and shared decision-making to achieve quality patient care.

SELECT PRE-LICENSURE KSAs	APPLICATION AND REFLECTION
Knowledge	
Recognize contributions of other individuals and groups in helping patient/family achieve health goals	Describe the nursing role in participating in a case conference. How do the various health care team members work with the patient and family and as a team to develop the best plan to manage care for this patient's pain while managing and minimizing the deleterious effects of delirium?
Skills	
Function competently within own scope of practice as a member of the health care team	Even though the patient is unable to rate her pain, what other methods of assessment can you use and rely on to assess pain in this patient? What interventions for pain can a nurse implement as part of a nursing care plan?
Attitudes	
Contribute to resolution of conflict and disagreement	After the case conference, the palliative care team recommends that the pain medication be administered to the patient as prescribed. The family is in conflict with the decision because the patient is confused and is not rating her pain. How can you best resolve the conflict? Are there other members of the team that may be instrumental in communicating with the family?

Cronenwett, L., Sherwood, G., Barnsteiner, J., et al. (2007). Quality and safety education for nurses. *Nursing Outlook*, *55*(3), 122–131; Institute of Medicine. (2003). *Health professions education: A bridge to quality*. Washington, DC: National Academies Press; QSEN Institute. (2020). *QSEN competencies: Definitions and pre-licensure KSAs; Teamwork and collaboration.* Retrieved on 8/15/2020 at: qsen.org/competencies/pre-licensure-ksas/#teamwork_collaboration

9 Pain Management

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the fundamental concepts of pain including the types of pain, the four processes of nociception, and neuropathic pain.
2. Explain and demonstrate methods to perform a pain assessment.
3. List the first-line agents from the three groups of analgesic agents.
4. Identify the unique effects of select analgesic agents on older adults.
5. Describe practical nonpharmacologic methods that can be used in the clinical setting in patients with pain.
6. Use the nursing process as a framework for care of the patient with pain.

NURSING CONCEPTS

Addiction
Comfort

GLOSSARY

acute pain: pain that results from tissue damage that generally abates as healing occurs; serves as a warning signal that something is wrong or needs attention

adjuvant analgesic agent: a substance or medication added to an analgesic medication regimen to improve analgesia (*synonym:* co-analgesic agent)

agonist: a medication that binds to an opioid receptor mimicking the way endogenous substances provide analgesia

agonist–antagonist: a type of opioid (e.g., nalbuphine and butorphanol) that binds to the kappa opioid receptor site acting as an agonist (capable of producing analgesia) and simultaneously to the mu opioid receptor site acting as an antagonist (reversing mu agonist effects)

allodynia: pain due to a stimulus that does not normally provoke pain, such as touch; typically experienced in the skin around areas affected by nerve injury and commonly seen with many neuropathic pain syndromes

antagonist: a medication that competes with agonists for opioid receptor binding sites; can displace agonists, thereby inhibiting their action

breakthrough pain: a transitory increase in pain that occurs in the context of otherwise controlled persistent pain

ceiling effect: an analgesic dose above which further dose increments produce no change in effect

central sensitization: a key central mechanism of neuropathic pain; the abnormal hyperexcitability of central neurons in the spinal cord, which results from complex changes induced by the incoming afferent barrages of nociceptors and results in an increased nociceptive neuron response

chronic or persistent pain: pain that may or may not be time limited but that persists beyond the usual course/time of tissue healing

co-analgesic agent: one of many medications that can either improve the effectiveness of another analgesic agent or independently have analgesic action (*synonym:* adjuvant analgesic agent)

comfort–function goal: the pain rating identified by the individual patient above which the patient experiences interference with function and quality of life (e.g., activities the patient needs or wishes to perform)

efficacy: the extent to which a medication or another treatment "works" and can produce the intended effect—analgesia in this context

half-life: the time it takes for the plasma concentration (amount of medication in the body) to be reduced by 50% (after starting a medication, or increasing its dose; four to five half-lives are required to

approach a steady-state level in the blood, irrespective of the dose, dosing interval, or route of administration; after four to five half-lives, a medication that has been discontinued generally is considered to be mostly eliminated from the body)

hydrophilic: a substance or medication that is readily absorbed in aqueous solution

hyperalgesia: an increasingly intense experience of pain resulting from a noxious stimulus

intraspinal: "within the spine"; refers to the spaces or potential spaces surrounding the spinal cord into which medications can be given

lipophilic: a substance or medication that is readily absorbed in fatty tissues

metabolite: the product of biochemical reactions during medication metabolism

mu agonist: any opioid that binds to the mu opioid receptor subtype and produces analgesic effects (e.g., morphine); used interchangeably with the terms *full agonist, pure agonist,* and *morphinelike medication*

multimodal analgesia or multimodal pain management: the intentional, concurrent use of more than one pharmacologic or nonpharmacologic intervention with different methods of action with the goal to achieve better analgesia while using lower doses of medications with fewer adverse effects

neuraxial: of the central nervous system

neuropathic (pathophysiologic) pain: pain caused by injury or dysfunction (lesion or disease) of one or more nerves of the peripheral or central nervous systems with resultant impaired processing of sensory input

neuroplasticity: the ability of the peripheral and central nervous systems to change both structure and function as a result of noxious stimuli

nociceptive (physiologic) pain: pain that is sustained by ongoing activation of the sensory system that conducts the perception of noxious stimuli; implies the existence of damage to somatic or visceral tissues sufficient to activate the nociceptive system

nociceptor: a type of primary afferent neuron that has the ability to respond to a noxious stimulus or to a stimulus that would be noxious if prolonged

nonopioid: refers to analgesic medications that include acetaminophen and nonsteroidal anti-inflammatory drugs (NSAIDs)

NSAID: an acronym for nonsteroidal anti-inflammatory drug (pronounced "en said")

opioid: refers to morphine and other natural, semisynthetic, and synthetic medications that relieve pain by binding to multiple types of opioid receptors; term is preferred to “narcotic”

opioid dose–sparing effect: occurs when a nonopioid or co-analgesic medication is prescribed in addition to an opioid, enabling the opioid dose to be lower without diminishing analgesic effects

opioid-induced hyperalgesia: a phenomenon in which exposure to an opioid induces increased sensitivity, or a lowered threshold, to the neural activity conducting pain perception; it is the “flip side” of tolerance

opioid naïve: denotes a person who has not recently taken enough opioid on a regular enough basis to become tolerant to the opioid’s effects

opioid tolerant: denotes a person who has taken opioids long enough at doses high enough to develop tolerance to many of the opioid’s effects, including analgesia and sedation

pain: an unpleasant experience that is either emotional or sensory resulting from actual or possible damage to tissues and is uniquely experienced and described by each person

peripheral sensitization: a key peripheral mechanism of neuropathic pain that occurs when there are changes in the number and location of ion channels; in particular, sodium channels abnormally accumulate in injured nociceptors, producing a lower nerve depolarization threshold, ectopic discharges, and an increase in the response to stimuli

physical dependence: the body’s normal response to administration of an opioid for 2 or more weeks; withdrawal symptoms may occur if an opioid is abruptly stopped or an antagonist is given

placebo: any medication or procedure, including surgery, that produces an effect in a patient because of its implicit or explicit intent and not because of its specific physical or chemical properties

preemptive analgesic agents: pre-injury pain treatments (e.g., preoperative epidural analgesia and preincision local anesthetic infiltration) to prevent the development of peripheral and central sensitization of pain

refractory: nonresponsive or resistant to therapeutic interventions such as analgesic agents

substance use disorder (SUD): problematic use of substances such as opioids, benzodiazepines, or alcohol based on identification of at least two of the diagnostic criteria listed by the American Psychiatric Association. It is characterized by craving the substance; continuing use despite harm; inability to stop using; and experiencing withdrawal

symptoms when abruptly not using the substance; formerly known as addiction

titration: upward or downward adjustment of the amount (dose) of an analgesic agent

tolerance: a normal physiologic process characterized by decreasing effects of a medication at its previous dose, or the need for a higher dose of medication to maintain an effect

withdrawal: result of abrupt cessation or rapid decrease in dose of a substance upon which one is physically dependent. It is not necessarily indicative of substance use disorder

Pain serves as a survival tactic that guides individuals not only to avoid damage in the moment, but also to learn to avoid danger in the future (Martin, Power, Boyle, et al., 2017). Nurses in all settings play a key role in the management of pain as experts in assessment, medication administration, and patient education. They are uniquely positioned to assume this role as members of the health care team most consistently at the patient's bedside. These characteristics have led to nurses' distinction as the primary managers of patients who are experiencing pain (Curtis & Wrona, 2018).

Fundamental Concepts

Understanding the definition, effects, and types of pain lays the foundation for proper pain assessment and management.

Definition of Pain

The American Pain Society (APS, 2016) defines **pain** as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage" (p. 2). This definition describes pain as a complex phenomenon that can impact a person's psychosocial, emotional, and physical functioning. The clinical definition of pain reinforces that pain is a highly personal and subjective experience: "Pain is whatever the experiencing person says it is, existing whenever he says it does" (McCaffery, 1968, p. 8). The self-report by the patient is the standard; it is considered to be the most reliable indicator of pain and the most essential component of pain assessment (DiMaggio, Clark, Czarenecki, et al., 2018).

Effects of Pain

Pain affects individuals of every age, gender, race, and socioeconomic class (APS, 2016). It is the primary reason people seek health care and one of the

most common conditions that nurses treat (U.S. Department of Health & Human Services [HHS], 2019). Unrelieved pain has the potential to affect every system in the body and cause numerous harmful effects, some of which may last a lifetime (Table 9-1). Despite many advances in the understanding of the underlying mechanisms of pain and the availability of improved analgesic agents and technology, as well as nonpharmacologic pain management methods, all types of pain continue to be undertreated (Jungquist, Vallerand, Sicoutris, et al., 2017).

Types and Categories of Pain

Pain can be categorized in many ways, and clear distinctions are not always possible. Pain often is described from the perspective of duration, as being acute or chronic (persistent) (APS, 2016). **Acute pain** involves tissue damage as a result of surgery, trauma, burn, or venipuncture, and is expected to have a relatively short duration and resolve with normal healing. **Chronic or persistent pain** is subcategorized as being of cancer or noncancer origin and can persist throughout the course of a person's life. Examples of noncancer chronic pain include peripheral neuropathy from diabetes, back or neck pain after injury, and osteoarthritis pain from joint degeneration. Chronic pain may be intermittent, occurring with flares, or it may be continuous. Some conditions can produce both acute and chronic pain. For example, some patients with cancer have continuous chronic pain and also experience more intense acute exacerbations of pain periodically, which is called **breakthrough pain** (BTP). Patients may also endure acute pain from repetitive painful procedures during cancer treatment (APS, 2016).

Pain is also classified by its inferred pathology as being either nociceptive pain or neuropathic pain (Table 9-2). **Nociceptive (physiologic) pain** refers to the normal functioning of physiologic systems that leads to the perception of noxious stimuli (tissue injury) as being painful (International Association for the Study of Pain [IASP], 2017). This is the reason why nociception is described as "normal" pain transmission. **Neuropathic (pathophysiologic) pain** is pathologic and results from abnormal processing of sensory input by the nervous system as a result of damage to the peripheral or central nervous system (CNS) or both (IASP, 2017).

TABLE 9-1 Harmful Effects of Unrelieved Pain

Domains Affected	Specific Responses to Pain
Endocrine	↑ Adrenocorticotrophic hormone (ACTH), ↑ cortisol, ↑ antidiuretic hormone (ADH), ↑ epinephrine, ↑ norepinephrine, ↑ growth hormone (GH), ↑ catecholamines, ↑ renin, ↑ angiotensin II, ↑ aldosterone, ↑ glucagon, ↑ interleukin-1; ↓ insulin, ↓ testosterone
Metabolic	Gluconeogenesis, hepatic glycogenolysis, hyperglycemia, glucose intolerance, insulin resistance, muscle protein catabolism, ↑ lipolysis
Cardiovascular	↑ Heart rate, ↑ cardiac workload, ↑ peripheral vascular resistance, ↑ systemic vascular resistance, hypertension, ↑ coronary vascular resistance, ↑ myocardial oxygen consumption, hypercoagulation, deep vein thrombosis
Respiratory	↓ Flows and volumes, atelectasis, shunting, hypoxemia, ↓ cough, sputum retention, infection
Genitourinary	↓ Urinary output, urinary retention, fluid overload, hypokalemia
Gastrointestinal	↓ Gastric and bowel motility
Musculoskeletal	Muscle spasm, impaired muscle function, fatigue, immobility
Cognitive	Reduction in cognitive function, mental confusion
Immune	Depression of immune response
Developmental	↑ Behavioral and physiologic responses to pain, altered temperaments, higher somatization; possible altered development of the pain system, ↑ vulnerability to stress disorders, addictive behavior, and anxiety states
Future pain	Debilitating chronic pain syndromes: postmastectomy pain, post thoracotomy pain, phantom pain, postherpetic neuralgia
Quality of life	Sleeplessness, anxiety, fear, hopelessness, ↑ thoughts of suicide

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Patients may have a combination of nociceptive and neuropathic pain. For example, a patient may have nociceptive pain as a result of tumor growth, and also report radiating sharp and shooting neuropathic pain if the tumor is pressing against a nerve plexus. Sickle cell disease pain is usually a combination of nociceptive pain from the various hematologic changes of sickled cells as well as neuropathic pain from nerve ischemia (Belvis, Henderson, & Benzon, 2018).

Nociceptive Pain

Nociception includes four specific processes: transduction, transmission, perception, and modulation (Ellison, 2017). Figure 9-1 illustrates these processes and following is an overview of each.

TABLE 9-2 Classification of Pain by Inferred Pathology

	Nociceptive Pain	Neuropathic Pain	Mixed Pain
Physiologic Processes	Normal processing of stimuli that damages tissues or has the potential to do so if prolonged; can be somatic or visceral	Abnormal processing of sensory input by the peripheral or central nervous system or both	Components of both nociceptive and neuropathic pain; poorly defined
Categories and Examples	***Somatic Pain:*** Arises from bone joint, muscle, skin, or connective tissue. It is usually described as aching or throbbing in quality and is well localized *Examples:* Surgical, trauma; wound and burn pain; cancer pain (tumor growth) and pain associated with bony metastases; labor pain (cervical changes and uterine contractions); osteoarthritis and rheumatoid arthritis pain; osteoporosis pain; pain of Ehlers–Danlos syndrome; ankylosing spondylitis ***Visceral Pain:*** Arises from visceral organs, such as the GI tract and pancreas. This may be subdivided: • Tumor involvement of the organ capsule that causes aching and fairly well-localized pain • Obstruction of hollow viscus, which causes intermittent cramping and poorly localized pain *Examples:* Organ-involved cancer pain; ulcerative colitis; irritable bowel syndrome; Crohn's disease; pancreatitis	***Centrally Generated Pain*** *Deafferentation pain:* Injury to either the peripheral or central nervous system; burning pain below the level of a spinal cord lesion reflects injury to the central nervous system *Examples:* Phantom pain as a result of peripheral nerve damage; poststroke pain; pain following spinal cord injury *Sympathetically maintained pain:* Associated with dysregulation of the autonomic nervous system *Example:* Complex regional pain syndrome ***Peripherally Generated Pain*** *Painful polyneuropathies:* Pain is felt along the distribution of many peripheral nerves. *Examples:* Diabetic neuropathy; postherpetic neuralgia; alcohol–nutritional	No identified categories *Examples:* Fibromyalgia; some types of neck, shoulder, and back pain; some headaches; pain associated with HIV; some myofascial pain; pain associated with Lyme disease

		neuropathy; some types of neck, shoulder, and back pain; pain of Guillain–Barré syndrome *Painful mononeuropathies:* Usually associated with a known peripheral nerve injury; pain is felt at least partly along the distribution of the damaged nerve *Examples:* Nerve root compression, nerve entrapment; trigeminal neuralgia; some types of neck, shoulder, and back pain	
Pharmacologic Treatment	Most responsive to nonopioids, opioids, and local anesthetics	Co-analgesic agents, such as antidepressants, anticonvulsants, and local anesthetics, but there is wide variability in terms of efficacy and adverse-effect profiles	Co-analgesic agents, such as antidepressants, anticonvulsants, and local anesthetics, but there is wide variability in terms of efficacy and adverse-effect profiles

GI, gastrointestinal; HIV, human immune deficiency virus.

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Transduction

Transduction refers to the processes by which noxious stimuli, such as a surgical incision or burn, activate primary afferent neurons called **nociceptors,** located throughout the body in the skin, subcutaneous tissue, and visceral (organ), and somatic (musculoskeletal) structures (Montgomery, Mallick-Searle, Peltier, et al., 2018). These neurons have the ability to respond selectively to noxious stimuli generated as a result of tissue damage from

mechanical (e.g., incision, tumor growth), thermal (e.g., burn, frostbite), chemical (e.g., toxins, chemotherapy), and infectious sources. Noxious stimuli cause the release of a number of excitatory compounds (e.g., serotonin, bradykinin, histamine, substance P, and prostaglandins), which move pain along the pain pathway (Ringkamp, Dougherty, & Raja, 2018) (see Fig. 9-1A). In addition, sodium, calcium, and potassium ion channels are stimulated to open, resulting in electrical impulses that are transmitted through the large, rapid conducting A-delta and smaller, peripheral C-fiber nociceptors (Ellison, 2017).

Prostaglandins are lipid compounds that initiate inflammatory responses that increase tissue swelling and pain at the site of injury (Baral, Udit, & Chiu, 2019). They form when the enzyme phospholipase breaks down phospholipids into arachidonic acid. In turn, the enzyme cyclo-oxygenase (COX) acts on arachidonic acid to produce prostaglandins (Fig. 9-2). COX-1 and COX-2 are isoenzymes of COX and play an important role in producing the effects of the **nonopioid** analgesic agents, which include the nonsteroidal anti-inflammatory drugs (**NSAIDs**) and acetaminophen. NSAIDs produce pain relief by mediating inflammation at the site of trauma, primarily by blocking the formation of prostaglandins (Leppert, Malec-Milewska, Zajaczkowska, et al., 2018). The nonselective NSAIDs, such as ibuprofen, naproxen, diclofenac, and ketorolac, inhibit both COX-1 and COX-2, and the COX-2 selective NSAIDs, such as celecoxib, inhibit only COX-2. As Figure 9-2 illustrates, both types of NSAIDs produce anti-inflammation and pain relief through the inhibition of COX-2. Acetaminophen is known to be a COX inhibitor that has minimal peripheral effect, is not anti-inflammatory, and can both relieve pain and reduce fever by preventing the formation of prostaglandins in the CNS (Slattery & Klegeris, 2018).

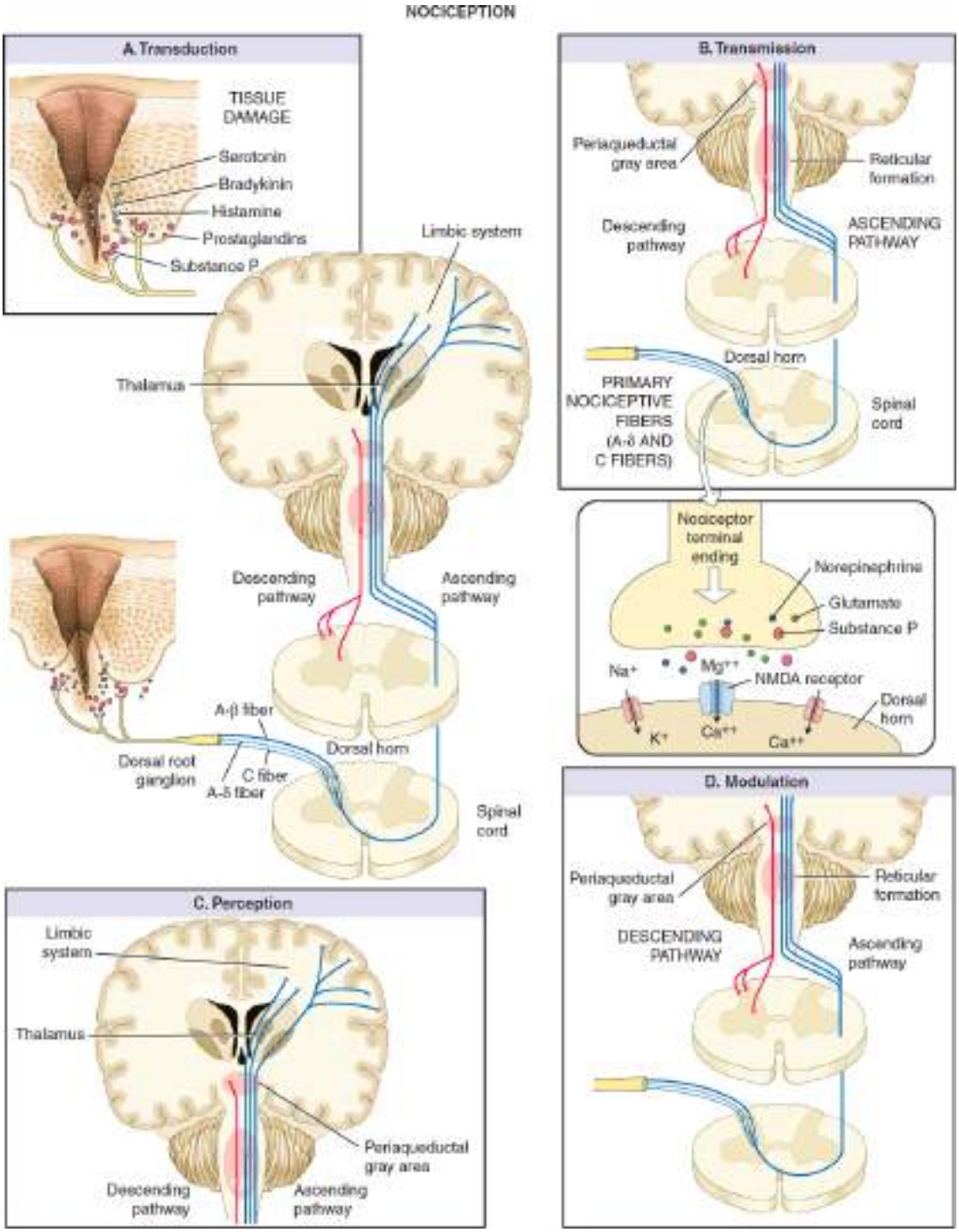

Figure 9-1 • Nociception. **A.** Transduction. **B.** Transmission. **C.** Perception. **D.** Modulation. Redrawn from Pasero, C., & McCaffery, M. (2011). *Pain assessment and pharmacologic management* (p. 5). St. Louis, MO: Mosby-Elsevier. Copyright 2011, Pasero, C., & McCaffery, M. Used with permission.

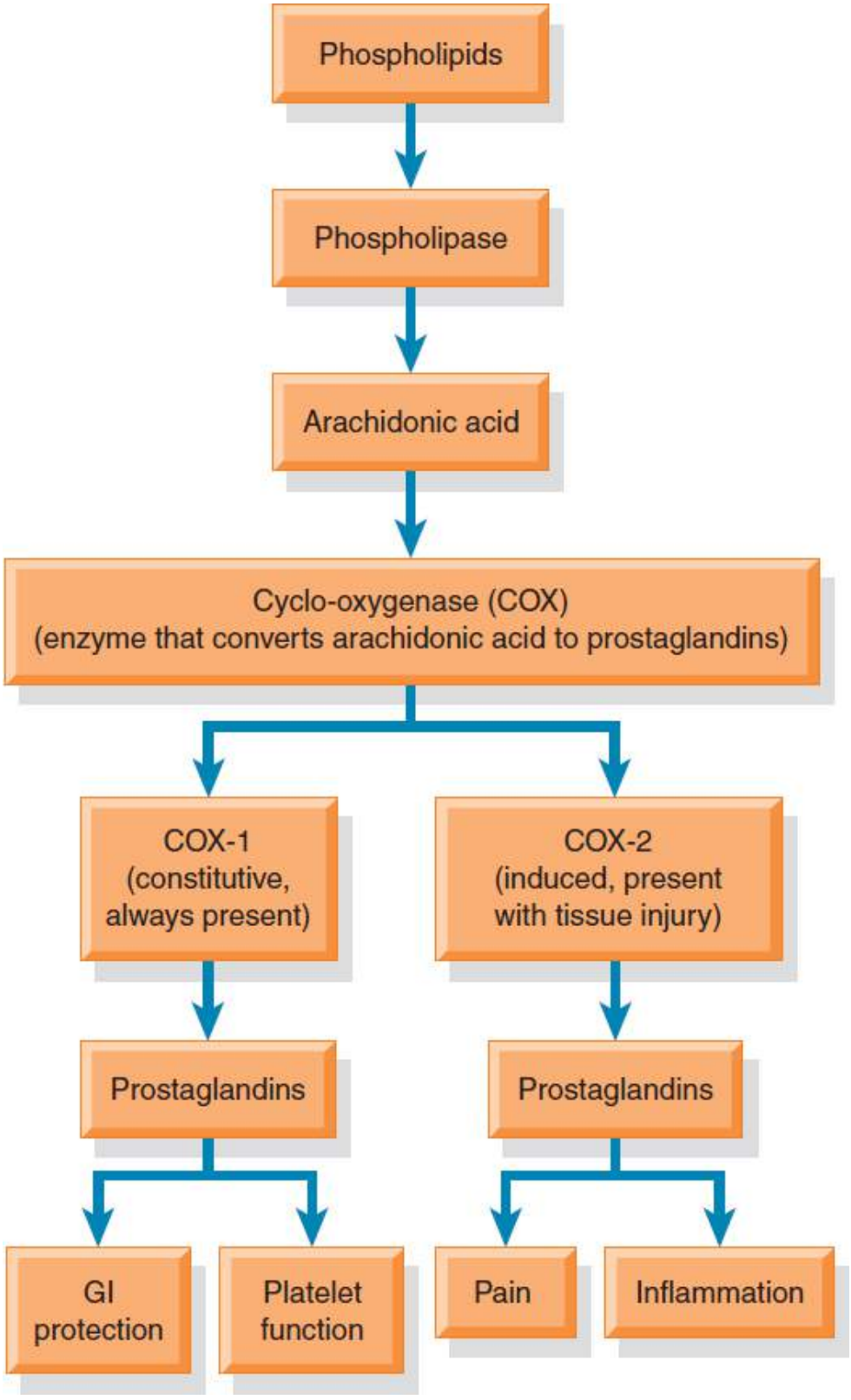

Figure 9-2 • Enzyme pathway: COX-1 and COX-2. Redrawn from Pasero, C., & McCaffery, M. (2011). *Pain assessment and pharmacologic management* (p. 6). St. Louis, MO: Mosby-Elsevier. Copyright 2004, Pasero, C., & McCaffery, M. Used with permission.

Other analgesic agents work at the site of transduction by affecting the flux of ions. For example, sodium channels are closed and inactive at rest but undergo changes in response to nerve membrane depolarization. Transient channel opening leads to an influx of sodium that results in nerve conduction (Nouri, Osuagwu, Boyette-Davis, et al., 2018). Local anesthetics reduce nerve conduction by blocking sodium channels. The calcium channel blocking anticonvulsants that are used to treat neuropathic pain facilitate analgesia by reducing the flux of calcium ions and limiting glutamate, norepinephrine, and substance P release (Peterson, Benson, & Hurley, 2018).

Transmission

Transmission is another process involved in nociception. Effective transduction generates an action potential that is transmitted along the lightly myelinated rapid conducting A-delta fibers and the unmyelinated slower impulse conducting C fibers (Ellison, 2017) (see Fig. 9-1B). The endings of A-delta fibers detect thermal and mechanical injury, allow relatively quick localization of pain, and are responsible for a rapid reflex withdrawal from the painful stimulus. Unmyelinated C fibers respond to mechanical, thermal, and chemical stimuli. They produce poorly localized and often aching or burning pain. A-beta (β) fibers are the largest of the fibers and respond to touch, movement, and vibration but do not normally transmit pain (Ellison, 2017; Vardeh & Naranjo, 2017).

The action potential impulse with the noxious information passes through the dorsal root ganglia, then synapses in the dorsal horn of the spinal cord, and then ascends up to the spinal cord and transmits the information to the brain, where pain is perceived (Ellison, 2017; Ringkamp et al., 2018) (see Fig. 9-1B). Extensive modulation occurs in the dorsal horn via complex neurochemical mechanisms (see Fig. 9-1B inset). The primary A-delta fibers release glutamate and C fibers release substance P and other neuropeptides (Schliessbach & Maurer, 2017). Glutamate is a key neurotransmitter because it binds to the *N*-methyl-*D*-aspartate (NMDA) receptor and promotes pain transmission (Zhou, 2017).

Perception

An additional process involved in nociception is perception, which is the result of the neural activity associated with transmission of noxious stimuli (Ringkamp et al., 2018). It requires activation of higher brain structures for the occurrence of awareness, emotions, and impulses associated with pain (see Fig. 9-1C). Although the physiology of pain perception continues to be studied, it can be targeted by nonpharmacologic therapies, such as distraction, which are based on the belief that innate brain processes can strongly influence pain perception (Chayadi & McConnell, 2019).

Modulation

Modulation is another process involved in nociception. Modulation of the information generated in response to noxious stimuli occurs at every level from the periphery to the cortex and involves many different neurochemicals (Damien, Colloca, Bellei-Rodriguez, et al., 2018) (see Fig. 9-1D). For example, serotonin and norepinephrine are inhibitory neurotransmitters that are released in the spinal cord and the brain stem by the descending (efferent) fibers of the modulatory system (Nouri et al., 2018). Some antidepressants provide pain relief by blocking the body's reuptake (resorption) of serotonin and norepinephrine, extending their availability to fight pain (Martin et al., 2017). Endogenous opioids are located throughout the peripheral and central nervous systems, and like exogenous opioids, they bind to opioid receptors in the descending system and inhibit pain transmission (Nouri et al., 2018).

Neuropathic Pain

Neuropathic pain is caused by either a lesion or a disease involving the somatosensory nervous system (Bouhassira, 2019). Injuries to peripheral nerves can either be traumatic or nontraumatic, such as diabetic or compression neuropathies (Osborne, Anastakis, & Davis, 2018). Although specific causes may vary based on the underlying pathology, it is theorized that there are changes in the ion channels; imbalance of the stimuli processing between excitatory and inhibitory somatosensory signals; activity of glial cells; or potential differences in modulation of pain that occur with neuropathic pain (Colloca, Ludman, Bouhassira, et al., 2017; Liu, Zhu, Ju, et al., 2019) (Fig. 9-3). Recent research findings suggest that dysfunction in autophagy (i.e., cellular degradation of unnecessary materials) is involved with neuropathic pain (Liu et al., 2019). Research is ongoing to better define the peripheral and central mechanisms that initiate and maintain neuropathic pain (García, Gutiérrez-Lara, Centurión, et al., 2019; Kwiatkowski & Mika, 2018; Liu et al., 2019; Nishimura, Kawasaki, Suzuki, et al., 2019).

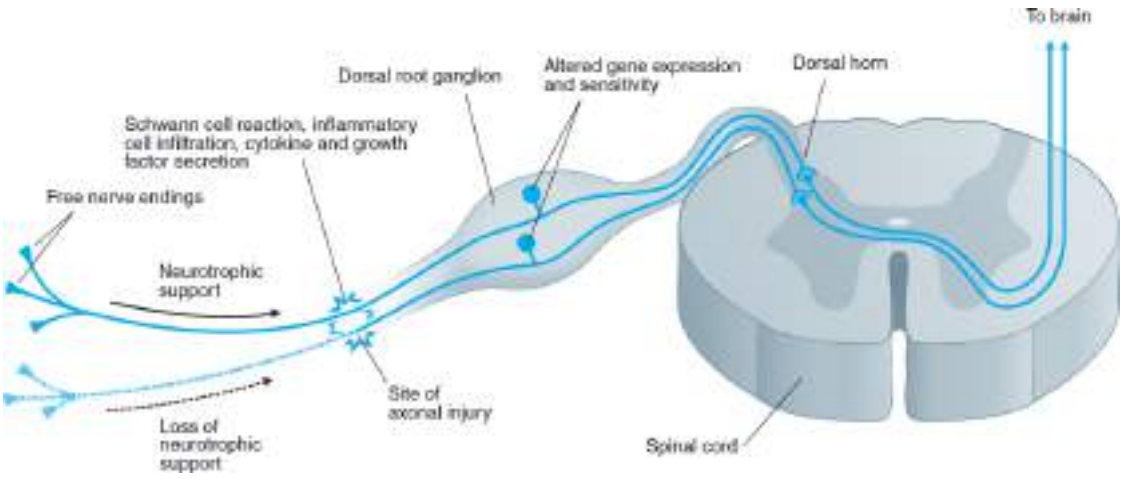

Figure 9-3 • Neuropathic pain. Nociceptive injury or inflammation may result in an altered physiologic response within the nociceptive system. These changes cause release of inflammatory cytokines that may alter gene expression and sensitivity in nociceptive fibers. In turn, these alter nociceptive activity, causing neuropathic pain. Used with permission from Golan, D. E., Tashjian, A. H., & Armstrong, E. J. (2017). *Principles of pharmacology: The pathophysiologic basis of drug therapy* (4th ed.). Baltimore, MD: Wolters Kluwer Health | Lippincott Williams & Wilkins.

Peripheral Mechanisms

At any point from the periphery to the CNS, the potential exists for the development of neuropathic pain. Nerve endings in the periphery can become damaged, leading to abnormal reorganization in the nervous system called maladaptive **neuroplasticity,** an underlying mechanism of some neuropathic pain states (Osborne et al., 2018). Changes in ion channels can occur, such as increased sodium channel activity in sensory nerves resulting in heightened excitability, increased transduction, and release of neurotransmitters (Colloca et al., 2017). These and many other processes lead to a phenomenon called **peripheral sensitization,** which is thought to contribute to the maintenance of neuropathic pain and is thought to be reflected in allodynia and hyperalgesia (Osborne et al., 2018). **Allodynia,** or pain from a normally non-noxious stimulus (e.g., touch), is one such type of abnormal sensation and a common feature of neuropathic pain (Chekka & Benzon, 2018; Osborne et al., 2018). In patients with allodynia, the mere weight of clothing or bedsheets on the skin can be excruciatingly painful. **Hyperalgesia** is an increased response of pain sensation from a stimulus which at a usual pain threshold produces a less intense pain response.

Central Mechanisms

Central mechanisms also play a role in the establishment of neuropathic pain. **Central sensitization** is defined as abnormal hyperexcitability of central

neurons in the spinal cord, which results from complex changes induced by incoming afferent barrages of nociceptors, which also can result in allodynia and hyperalgesia (Osborne et al., 2018). Extensive release and binding of excitatory neurotransmitters, such as glutamate, activate the NMDA receptor and cause an increase in intracellular calcium levels into the neuron, resulting in pain (Yan, Li, Zhou, et al., 2017). Similar to what happens in the peripheral nervous system, an increase in the influx of sodium is thought to lower the threshold for nerve activation, increase response to stimuli, and enlarge the receptive field served by the affected neuron (Osborne et al., 2018; Yan et al., 2017).

As in the peripheral nervous system, anatomic changes can occur in the CNS. For example, when the NMDA receptor cells are continuously activated, reorganization in the dorsal horn of the spinal cord can occur (Nouri et al., 2018). Nerve fibers can invade other locations and create abnormal sensations, such as allodynia, in the area of the body served by the injured nerve.

Pain Assessment

The highly subjective nature of pain causes challenges in assessment and management; however, the patient's self-report is the undisputed standard for assessing the existence and intensity of pain (APS, 2016; Herr, Coyne, McCaffery, et al., 2011; McCaffery, Herr, & Pasero, 2011). Self-report is considered the most reliable measure of the existence and intensity of the patient's pain and is recommended by The Joint Commission (Baker, 2017). Accepting and acting on the patient's report of pain are sometimes difficult. Because pain cannot be proven, clinicians may feel vulnerable to inaccurate or untruthful reports of pain. Although clinicians are entitled to their personal opinions, those thoughts cannot interfere with appropriate patient care. Chart 9-1 provides strategies to use when the patient's report of pain is not accepted.

Chart 9-1

Strategies to Use When the Patient's Report of Pain Is Not Accepted

- Acknowledge that everyone is entitled to a personal opinion, but personal opinion does not form the basis for professional practice.
- Clarify that the sensation of pain is subjective and cannot be proved or disproved.
- Quote recommendations from clinical practice guidelines, especially those published by the American Pain Society.
- Ask, "Why is it so difficult to believe that this person hurts?"

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Quality and Safety Nursing Alert

Although accepting and responding to the report of pain may result in administering analgesic agents to an occasional patient who does not have pain, doing so helps to ensure that everyone who does have pain receives appropriate care. Health care professionals do not have the right to deprive any patient of appropriate assessment and treatment simply because they believe a patient is not being truthful. Pain is an extremely personal experience manifested uniquely by each person. It is important to carefully assess and reassess pain when administering analgesic medications.

Performing the Comprehensive Pain Assessment: Patient Interview

A comprehensive pain assessment should be conducted during the admission assessment or initial interview with the patient, with each new report of pain, and whenever indicated by changes in the patient's condition or treatment plan. It serves as the foundation for developing and evaluating the effectiveness of the pain treatment plan. The following are components of a comprehensive pain assessment and tips on how to elicit the information from the patient:

- *Location(s) of pain:* Ask the patient to state or point to the area(s) of pain on the body. Sometimes allowing patients to make marks on a body diagram is helpful in gaining this information.
- *Intensity:* Ask the patient to rate the severity of the pain using a reliable and valid pain assessment tool. Chart 9-2 provides guidance for educating patients and their families on how to use a pain rating scale. Various scales translated in several languages have been

evaluated and made available for use in clinical practice and for educational practice. The most common include the following:

Chart 9-2 **PATIENT EDUCATION**

Educating Patients and Their Families How to Use a Pain Rating Scale[a]

Step 1. Show the pain rating scale to the patient and the family and explain its primary purpose.

Example: "This is a pain rating scale that many of our patients use to help us understand their pain and to set goals for pain relief. We will ask you regularly about pain, but any time you have pain you must let us know. We do not always know when you hurt."

Step 2. Explain the parts of the pain rating scale. If the patient does not like it or understand it, switch to another scale (e.g., vertical presentation, VDS, or faces).

Example: "On this pain rating scale, 0 means no pain and 10 means the worst possible pain. The middle of the scale, around 5, means moderate pain. A 2 or 3 would be mild pain, but 7 or higher means severe pain."

Step 3. Discuss pain as a broad concept that is not restricted to a severe and intolerable sensation.

Example: "Pain refers to any kind of discomfort anywhere in your body. Pain also means aching and hurting. Pain can include pulling, tightness, burning, knifelike feelings, and other unpleasant sensations."

Step 4. Verify that the patient understands the broad concept of pain. Ask the patient to mention two examples of pain they have experienced. If the patient is already in pain that requires treatment, use the present situation as the example.

Example: "I want to be sure that I have explained this clearly, so would you give me two examples of pain you have had recently?" If the patient's examples include various parts of the body and various pain characteristics, that indicates that they understand pain as a fairly broad concept. An example of what a patient might say is "I have a mild, sort of throbbing headache now, and yesterday my back was aching."

Step 5. Ask the patient to practice using the pain rating scale with the present pain or select one of the examples mentioned.

Example: "Using the scale, what is your pain right now? What is it at its worst?" OR "Using the pain rating scale and one of your examples of pain, what is that pain usually? What is it at its worst?"

Step 6. Set goals for comfort and function/recovery/quality of life. Ask patients what pain rating would be acceptable or satisfactory, considering the activities required for recovery or for maintaining a satisfactory quality of life.

Example for a surgical patient: "I have explained the importance of coughing and deep breathing to prevent pneumonia and other complications. Now we need to determine the pain rating that will not interfere with this so that you may recover quickly."

Example for patient with chronic pain or terminal illness: "What do you want to do that pain keeps you from doing? What pain rating would allow you to do this?"

[a]When a patient is obviously in pain or not focused enough to learn to use a pain rating scale, pain treatment should proceed without pain ratings. Education can be undertaken when pain is reduced to a level that facilitates understanding how to use a pain scale.

VDS, verbal descriptor scale.

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- *Numeric Rating Scale (NRS):* The NRS is most often presented as a horizontal 0- to 10-point scale, with word anchors of "no pain" at one end of the scale, "moderate pain" in the middle of the scale, and "worst possible pain" at the end of the scale. It may also be put on a vertical axis, which may be helpful for patients who read from right to left.
- *Wong–Baker FACES Pain Rating Scale:* The FACES scale consists of six cartoon faces with word descriptors, ranging from a smiling face on the left for "no pain (or hurt)" to a frowning, tearful face on the right for "worst pain (or hurt)." Patients are asked to choose the face that best reflects their pain. The faces are most commonly numbered using a 0, 2, 4, 6, 8, 10 metric, although 0 to 5 can also be used. Patients are asked to choose the face that best describes their pain. The FACES scale is used in adults and children as young as 3 years (McCaffery et al., 2011). It is important to appreciate that FACES scales are self-report tools; clinicians should not attempt to match a face shown on a scale to the patient's facial expression to determine pain intensity. Patients may be able to understand the tool better if it is displayed vertically with no pain as the anchor at the bottom.
- *Faces Pain Scale—Revised (FPS-R):* The FPS-R has six faces to make it consistent with other scales using the 0 to 10 metric. The faces range from a neutral facial expression to one of intense pain and are numbered 0, 2, 4, 6, 8, and 10. As with the Wong–Baker FACES scale, patients are asked to choose the face that best reflects their pain. Faces scales have been shown to be reliable and valid measures in children as young as 3 years of age; however, the ability to optimally quantify pain (identify a number) is not acquired until approximately 8 years of age (Spagrud, Piira, & Von Baeyer, 2003). Ongoing research suggests that the FPS-R is preferred by both patients who are cognitively intact and older adults who are cognitively impaired, and by minority populations (Kang & Demiris, 2018).

- *Verbal descriptor scale (VDS):* A VDS uses different words or phrases to describe the intensity of pain, such as "no pain, mild pain, moderate pain, severe pain, very severe pain, and worst possible pain." The patient is asked to select the phrase that best describes pain intensity.
- *Visual Analogue Scale (VAS):* The VAS is a horizontal (sometimes vertical) 10-cm line with word anchors at the extremes, such as "no pain" on one end and "pain as bad as it could be" or "worst possible pain" on the other end. Patients are asked to make a mark on the line to indicate intensity of pain, and the length of the mark from "no pain" is measured and recorded in centimeters or millimeters. Although often used in research, the VAS is impractical for use in daily clinical practice and rarely used in that setting.
- *Quality:* Ask the patient to describe how the pain feels. Descriptors such as "sharp," "shooting," or "burning" may help identify the presence of neuropathic pain.
- *Onset and duration:* Ask the patient when the pain started and whether it is constant or intermittent.
- *Aggravating and relieving factors:* Ask the patient what makes the pain worse and what makes it better.
- *Effect of pain on function and quality of life:* The effect of pain on the ability to perform recovery activities should be regularly evaluated in the patient with acute pain. It is particularly important to ask patients with persistent pain about how pain has affected their lives, what they could do before the pain began that they can no longer do, or what they would like to do but cannot do because of the pain.
- ***Comfort–function goal*** (pain intensity): For patients with acute pain, identify short-term functional goals and reinforce to the patient that good pain control will more likely lead to successful achievement of the goals. For example, surgical patients are told that they will be expected to ambulate or participate in physical therapy postoperatively. Patients with chronic pain can be asked to identify their unique functional or quality-of-life goals, such as being able to work or walk the dog. Success is measured by progress toward meeting those functional goals (Topham & Drew, 2017).
- *Other information:* The patient's culture, past pain experiences, and pertinent medical history such as comorbidities, laboratory tests, and diagnostic studies are considered when establishing a treatment plan.

Patients who are unable to report their pain are at higher risk for undertreated pain than those who can report (Horgas, 2017; McCaffery et al., 2011). In the adult population, this includes patients who are cognitively impaired, critically ill (intubated, unresponsive), comatose, or imminently dying. Patients who are receiving neuromuscular blocking agents or are sedated from anesthesia and other medications given during surgery are also among this at-risk population.

The Hierarchy of Pain Measures is recommended as a framework for assessing pain in patients who are nonverbal (Herr et al., 2011; McCaffery et al., 2011). The key components of the hierarchy require the nurse to (1) attempt to obtain self-report, (2) consider underlying pathology or conditions and procedures that might be painful (e.g., surgery), (3) observe behaviors, (4) evaluate physiologic indicators, and (5) conduct an analgesic trial. Chart 9-3 provides detailed information on each component of the Hierarchy of Pain Measures.

When patients cannot self-report their pain, some observational tools may be used to help with clinical decision making. Some of these assign a score by observing behaviors that tend to be associated with pain. These observational scores are not considered equivalent to a patient's self-reported pain intensity score, however.

It is imperative to remember that behaviors can indicate the presence of pain, but the absence of behavior does not indicate the absence of pain. Patients who are not moving or making any sounds may still be experiencing intense pain. For instance, older adults with moderate and severe dementia frequently have comorbid disorders that may cause pain (Mueller, Schumacher, Holzer, et al., 2017). Accurately assessing and treating their pain can be difficult to achieve (see Chart 9-4 Nursing Research Profile: Evaluation of a Tool to Assess Pain in Older Adults with Dementia). The following tools are examples of validated measures that are appropriate for different populations of patients unable to self-report their pain (Fry & Elliott, 2018; Kochman, Howell, Sheridan, et al., 2017; Rijkenberg, Stilma, Bosman, et al., 2017; Schofield & Abdulla, 2018).

Chart 9-3

Hierarchy of Pain Measures

1. Attempt to obtain the patient's self-report, the single most reliable indicator of pain. Do not assume that a patient cannot provide a report of pain; many patients who are cognitively impaired are able to use a self-report tool if simple actions are taken.
   - Try using standard pain assessment tools (see text).
   - Increase the size of the font and other features of the scale.
   - Present the tool in vertical format (rather than the frequently used horizontal).
   - Try using alternative words, such as "ache," "hurt," and "sore," when discussing pain.
   - Ensure eyeglasses and hearing aids are functioning.
   - Ask about pain in the present.
   - Repeat instructions and questions more than once.
   - Allow ample time to respond.
   - Remember that head nodding and eye blinking or squeezing the eyes tightly can also be used to signal presence of pain and sometimes used to rate intensity.
   - Ask patients who are intubated and who are awake and oriented to point to a number on the numerical scale if they are able.
   - Repeat instructions and show the scale each time pain is assessed.
2. Consider the patient's condition or exposure to a procedure that is thought to be painful. If appropriate, assume pain is present and document as such when approved by institution policy and procedure. As an example, pain should be assumed to be present in a patient who is unresponsive, mechanically ventilated, and critically ill due to trauma.
3. Observe behavioral signs, for example, facial expressions, crying, restlessness, and changes in activity. A pain behavior in one patient may not be in another. Try to identify pain behaviors that are unique to the patient ("pain signature"). Many behavioral pain assessment tools are available that will yield a pain behavior score and may help determine whether pain is present. However, it is important to remember that a behavioral score is not the same as a pain intensity score. Behavioral tools are used to help identify the presence of pain, but the pain intensity is unknown if the patient is unable to provide it.
   - A surrogate who knows the patient well (e.g., parent, spouse, or caregiver) may be able to provide information about underlying painful pathology or behaviors that may indicate pain.
4. Evaluate physiologic indicators with the understanding that they are the *least* sensitive indicators of pain and may signal the existence of conditions other than pain or a lack of it (e.g., hypovolemia, blood loss). Patients quickly adapt physiologically despite pain and may have normal or below normal vital signs in the presence of severe pain. The overriding principle

is that the absence of an elevated blood pressure or heart rate does not mean the absence of pain.

5. Conduct an analgesic trial to confirm the presence of pain and to establish a basis for developing a treatment plan if pain is thought to be present. An analgesic trial involves the administration of a low dose of nonopioid or opioid and observing patient response. The initial low dose may not be enough to elicit a change in behavior and should be increased if the previous dose was tolerated, or another analgesic agent may be added. If behaviors continue despite optimal analgesic doses, other possible causes should be investigated. In patients who are completely unresponsive, no change in behavior will be evident and the optimized dose of the analgesic agent should be continued.

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Adapted from Pasero, C. (2009). Challenges in pain assessment. *Journal of PeriAnesthesia Nursing, 24*(1), 50–54; Pasero, C., & McCaffery, M. (2011). *Pain assessment and pharmacologic management*. St. Louis, MO: Mosby-Elsevier.

Chart 9-4 NURSING RESEARCH PROFILE

Evaluation of a Tool to Assess Pain in Older Adults with Dementia

Mueller, G., Schumacher, P., Holzer, E., et al. (2017). The inter-rater reliability of the observation instrument for assessing pain in elderly with dementia: An investigation in the long-term care setting. *Journal of Nursing Measurement, 25*(3), E173–E184.

Purpose

The aim of this study was to examine the interrater reliability of the German version of the observation instrument for assessing pain in older adults with dementia called the BISAD for the German (Beobachtungsinstrument für das Schmerzassessment bei alten Menschen mit Demenz). This is a tool that is commonly used to assess pain among older adults with moderate and severe dementia who reside in long-term care facilities in both Germany and Austria; however, interrater reliability was not previously done to ensure its validity.

Design

This study used a quantitative multicenter-descriptive cross-sectional design with a convenience sample of 71 participants who resided in one of three nursing homes in Austria. The nursing participants consisted of 46 registered nurses who had been working at one of the same three nursing homes for at least 2 y. Nurse participants were paired to independently evaluate a resident participant within the same hour using the eight-item BISAD observational pain assessment tool.

Findings

Although modest agreement between raters was noted, the absolute concordance of the total was only 25.32%. The analysis of interrater reliability was low and did not support reliability of the items in the BISAD. There was agreement that pain was greater with movement than when the participant residents were at rest.

Nursing Implications

Findings of this study are important since they indicate the items used in the BISAD tool are not reliable for assessing pain in older adult residents with moderate and severe dementia in nursing homes in Austria, although it is commonly used. This is an important finding since use of this tool with that population could yield inaccurate data upon which nurses could base pain management care. One interesting aspect of this study was that behaviors did demonstrate greater pain with activity than when at rest. Finally, the authors note that there may be cultural and language issues that affected the results and encourage a translated version of the tool be assessed in long-term care facilities where English is the primary language.

- FLACC: indicated for use in young children. Scores are assigned after assessing *F*acial expression, *L*eg movement, *A*ctivity, *C*rying, and *C*onsolability, with each of these five categories assigned scores from 0 to 2, yielding a total composite score of 0 to 10. Scores of "0" are interpreted as reflecting that the patient is relaxed and comfortable, scores of "1" to "3" are interpreted as consistent with mild discomfort, scores from "4" to "6" are considered consistent with moderate pain, and scores from "7" to "10" are considered consistent with severe discomfort or pain.
- PAINAD (*P*ain *A*ssessment *IN A*dvanced *D*ementia): indicated for use in adults with advanced dementia who are not able to verbalize their needs. Patterned after the FLACC, this tool was developed by the U.S. Department of Veterans Affairs for patients who have dementia.
- CPOT (*C*ritical Care *P*ain *O*bservation *T*ool): indicated for use in patients in critical-care units who cannot self-report pain, whether or not they may be intubated. It is also patterned after the FLACC.

Reassessing Pain

Following initiation of the pain management plan, pain is reassessed and documented on a regular basis to evaluate the effectiveness of treatment. At a minimum, pain should be reassessed with each new report of pain and before and after the administration of analgesic agents (McCaffery et al., 2011). The frequency of reassessment depends on the stability of the patient and the timing of peak effect of the medication administered, which is generally between 15 and 30 minutes following parenteral administration and between 1 and 2 hours following oral administration (Chou, Gordon, de Leon-Casasola, et al., 2016). For example, in the postanesthesia care unit (PACU), reassessment may be necessary as often as every 10 minutes when pain is unstable during intravenous (IV) opioid **titration** but may be done an hour following administration of oral medication in patients with satisfactory and stable pain control the day following surgery.

Veterans Considerations

Nurses should be aware that research has demonstrated a high prevalence of pain associated disorders, including arthritis, fibromyalgia, headaches and generalized abdominal, back, and joint pain in veteran populations (Nahin, 2017). In addition, reports of severe pain are more common in military veterans compared to nonveterans, especially in those who served, more recently, in conflicts in Iraq and Afghanistan (Nahin, 2017). In particular, younger veterans (18 to 39 years of age) and male veterans report significantly

higher levels of pain compared to matched age groups and men in the general public (Nahin, 2017). As a result, it is important for the nurse to determine during assessment if a patient has served in the U.S. military, to recognize that this group may have unique needs related to their service, and to advocate for multimodal and multidisciplinary approaches to help veterans better cope with pain. For example, Groessi, Liu, Change, and colleagues (2017) found that yoga was a safe and beneficial intervention in helping veterans to reduce pain and disability, while taking fewer opioid medications.

Pain Management

Achieving optimal pain relief is best viewed on a continuum, with the primary objective being to provide both effective and safe analgesia (Pozek, De Ruyter, & Khan, 2018). The quality of pain control should be addressed whenever patient care is passed on from one clinician to another, such as at change of shift and transfer from one clinical area to another. Optimal pain relief is the responsibility of *every* member of the health care team and begins with titration of the analgesic agent, followed by continued prompt assessment, analgesic agent administration, and nonpharmacologic interventions during the course of care to safely achieve pain intensities that allow patients to meet their functional goals with relative ease.

Although it may not always be possible to achieve a patient's pain intensity goal within the short time the patient is in an area like the PACU or emergency department, this goal provides direction for ongoing analgesic care. Important information to provide during transfer report is the patient's comfort–function goal, how close the patient is to achieving it, what has been done thus far to achieve it (analgesic agents and doses and/or nonpharmacologic interventions), and how well the patient has tolerated administration of the analgesic agent (adverse effects). There is growing interest among both clinicians and researchers in linking pain management to functional goals. One effort in this work is the Clinically Aligned Pain Assessment (CAPA) Tool, which is used to assess various degrees of comfort, pain control, function, and sleep (Topham & Drew, 2017). Pain management interventions should improve and not inhibit progress toward healing and rehabilitation.

Pharmacologic Management of Pain: Multimodal Analgesia

Pain is a complex phenomenon involving multiple underlying mechanisms that requires more than one analgesic agent to manage it safely and effectively. The recommended approach for the treatment of all types of pain in all age groups is called **multimodal analgesia or multimodal pain management.** A

multimodal regimen intentionally and simultaneously combines medications with different underlying mechanisms, along with nonpharmacologic interventions, which allows for lower doses of each of the medications in the treatment plan, reducing the potential for adverse effects. Furthermore, multimodal analgesia can result in comparable or greater pain relief with fewer adverse effects than can be achieved with any single analgesic agent (Beverly, Kaye, Ljungqvist, et al., 2017; Blackburn, 2018).

Routes of Administration

Oral is the preferred route of analgesic administration and should be used whenever feasible (Chou et al., 2016). Medications administered via the oral route are generally best tolerated, easiest to administer, and most cost-effective. When the oral route is not possible, such as when patients cannot swallow, are NPO (nothing by mouth), or nauseated, other routes of administration are used. For example, patients with cancer pain who are unable to swallow may take analgesic agents by the transdermal, rectal, or subcutaneous route of administration (Burchum & Rosenthal, 2019).

In the immediate postoperative period, the IV route is most often the first-line route of administration for analgesic delivery, and patients are transitioned to the oral route as tolerated (see Chapter 16 for the management of postoperative pain).

The rectal route of analgesic administration is an alternative route when oral or IV analgesic agents are not an option (e.g., for palliative purposes during end-of-life care). The rectum allows passive diffusion of medications and absorption into the systemic circulation. This route can be less expensive and does not involve the skill and expertise required of the parenteral route of administration. Limitations are that medication absorption can be unreliable and depends on many factors including rectal tissue health and administrator technique. Some patients may be resistant to or fearful of rectal administration. The rectal route is contraindicated in patients who are neutropenic or thrombocytopenic because of potential rectal bleeding. Diarrhea, perianal abscess or fistula, and abdominoperineal resection are also relative contraindications (Burchum & Rosenthal, 2019).

The topical route of administration is used for both acute and chronic pain. For example, the nonopioid diclofenac is available in patch and gel formulations for application directly over painful areas. Local anesthetic creams, such as eutectic mixture or emulsion of local anesthetics and lidocaine cream 4%, can be applied directly over the injection site prior to painful needle stick procedures; the lidocaine patch 5% is often used for well-localized types of neuropathic pain, such as postherpetic neuralgia. It is important to distinguish between topical and transdermal medication delivery. Although both routes require the medication to cross the stratum corneum to produce analgesia, transdermal delivery requires absorption into the systemic

circulation to achieve effects, whereas topical agents produce effects in the tissues immediately under the site of application (referred to as targeted peripheral analgesia). Compounding pharmacies may be consulted to custom blend antispasmodic agents, such as topical morphine or gabapentin, for topical application at the painful site.

A more invasive method used to manage pain is accomplished using **neuraxial** analgesia, which involves administering medication in the epidural or subarachnoid space (American Society of Regional Anesthesia and Pain Medicine, 2016). Delivery of analgesic agents by the neuraxial route is accomplished by inserting a needle into the subarachnoid space (for intrathecal [spinal] analgesia) or the epidural space, and either injecting the analgesic medication directly, or threading a catheter through the needle to enable bolus dosing or continuous administration (Conlin, Grant, & Wu, 2018; Hernandez, Grant, & Wu, 2018). Intrathecal catheters for acute pain management are used most often for providing anesthesia or a single bolus dose of an analgesic agent. Implanted intrathecal pumps deliver very small amounts of medication in a constant infusion for treatment of end-of-life pain or persistent pain (Jamison, Cohen, & Rosenow, 2018). Temporary epidural catheters for acute pain management are removed after 2 to 4 days. Epidural analgesia is administered by clinician-given bolus, continuous infusion (basal rate), and patient-controlled epidural analgesia (PCEA). The most common opioids given intraspinally are morphine, fentanyl, and hydromorphone. These are often combined with a local anesthetic, most often ropivacaine or bupivacaine (Jamison et al., 2018). The multimodal use of local anesthetics with opioids improves analgesia and produces an **opioid dose–sparing effect.**

A pain management technique that involves the use of an indwelling catheter is the continuous peripheral nerve block (also called *perineural anesthesia*), whereby an initial local anesthetic block is established and followed by the placement of a catheter or catheters through which an infusion of local anesthetic, usually ropivacaine or bupivacaine, is infused continuously to the targeted site of innervation. The effect of local anesthetic is dose dependent: at lower doses, the smaller sensory nerve fibers are affected before the larger motor fibers. Patients thus medicated are able to walk but have well controlled pain (Burchum & Rosenthal, 2019; Ilfeld & Mariano, 2018).

Dosing Regimen

Achieving, then maintaining, optimal pain management that is safe, effective, and progresses toward realistic functional goals requires patient education with continuing reassessment of analgesic effect and development of any untoward effects (Chou et al., 2016). Accomplishing these goals may require the mainstay analgesic agent to be given on a scheduled around-the-clock (ATC) basis, rather than PRN (as needed) to maintain stable analgesic blood levels when pain is continuous (Eksterowicz & DiMaggio, 2018). ATC dosing

regimens are designed to control pain for patients who report pain being present 12 hours or more during a 24-hour period. PRN dosing of analgesic agents is appropriate for intermittent pain, such as prior to painful procedures and for BTP (pain that "breaks through" the pain being managed by the mainstay analgesic agent), for which supplemental doses of analgesia are provided (Palat, 2018).

Patient-Controlled Analgesia

Patient-controlled analgesia (PCA) is an interactive method of pain management that allows patients to treat their pain by self-administering doses of analgesic agents (Burchum & Rosenthal, 2019). It is used to manage all types of pain by multiple routes of administration, including oral, IV, subcutaneous, epidural, and perineural (Fernandes, Hernandes, de Almeida, et al., 2017). Current guidelines from the APS, the American Society of Regional Anesthesia and Pain Medicine, and the American Society of Anesthesiologists strongly recommended IV PCA for postoperative pain management when it is necessary to use the parenteral route to deliver analgesic medications (Chou et al., 2016). A PCA infusion device is programmed so that the patient can press a button (pendant) to self-administer a dose of an analgesic agent (PCA dose) at a set time interval (demand or lockout) as needed. Patients who use PCAs must be able to understand the relationships among pain, pushing the PCA button or taking the analgesic agent, and pain relief, and must be cognitively and physically able to use any equipment that is necessary to administer the therapy (ECRI Institute Patient Safety Organization, 2017).

A basal rate (continuous infusion) may be used for patients who are opioid tolerant, and when PCEA is used. It is discouraged for patients who are opioid naïve and receiving IV PCA due to the risk of oversedation with subsequent respiratory depression (Chou et al., 2016; ECRI Institute Patient Safety Organization, 2017). Essential to the safe use of a basal rate with PCA is close monitoring by nurses of sedation and respiratory status and prompt decreases in opioid dose (e.g., discontinue basal rate) if increased sedation is detected (Pasero, Quinn, Portenoy, et al., 2011).

The primary benefit of PCA is that it recognizes that only the patient can feel the pain and only the patient knows how much analgesic will relieve it. This reinforces that PCA is for patient use only and that unauthorized activation of the PCA device by anyone other than the patient (PCA by proxy) should be discouraged (Burchum & Rosenthal, 2019).

Quality and Safety Nursing Alert

Staff, family, and other visitors should be instructed to contact the nurse if they have concerns about pain control rather than activating the PCA device for the patient.

However, for some patients who are candidates for PCA but unable to use the PCA equipment, the nurse or a capable family member may be authorized to manage the patient's pain using PCA equipment. This is referred to as Authorized Agent Controlled Analgesia; guidelines are available for the safe administration of this therapy (Cooney, Czarnecki, Dunwoody, et al., 2013).

Analgesic Medications

Analgesic medications are categorized into three main groups: (1) nonopioid antispasmodic agents, which include acetaminophen and NSAIDs; (2) opioid antispasmodic agents, which include, among others, morphine, hydromorphone, fentanyl, and oxycodone; and (3) co-analgesic agents (also referred to as **adjuvant analgesic agents).** The co-analgesic agents comprise the largest group and include various agents with unique and widely differing mechanisms of action. Examples are local anesthetics, some anticonvulsants, and some antidepressants (APS, 2016).

Nonopioid Analgesic Agents

Acetaminophen and NSAIDs comprise the group of nonopioid analgesic agents (refer to earlier discussion of the two categories of NSAIDs; see Fig. 9-2).

Indications and Administration

Nonopioid medications are analgesic agents used for a wide variety of painful conditions. They are appropriate alone for mild to some moderate nociceptive pain (e.g., from surgery, trauma, or osteoarthritis) and are added to opioids, local anesthetics, and/or anticonvulsants as part of a multimodal analgesic regimen for more severe nociceptive pain (APS, 2016; Chou et al., 2016; Comerford & Durkin, 2020). Since acetaminophen and NSAIDs have different mechanisms of action, they may be administered concomitantly (Chou et al., 2016). Although there is no research supporting staggering the two medications, it may be helpful for some patients. Unless contraindicated, surgical patients should routinely be given acetaminophen and an NSAID in scheduled doses throughout the postoperative course, which can be initiated preoperatively (Chou et al., 2016).

Nonopioids are often combined in a single tablet with opioids, such as oxycodone or hydrocodone, and are very popular for the treatment of mild to moderate acute pain. They are traditionally a common choice after invasive pain management therapies are discontinued and for pain treatment after

hospital discharge and dental surgery when an opioid is prescribed. Many people with persistent pain also take a combination nonopioid–opioid analgesic agent; however, it is important to remember that these combination medications are not appropriate for severe pain of any type because the maximum daily dose of the nonopioid limits the escalation of the opioid dose (Burchum & Rosenthal, 2019; Comerford & Durkin, 2020).

Acetaminophen is versatile in that it can be given by multiple routes of administration, including oral, rectal, and IV. Oral acetaminophen has a long history of safety in recommended doses in all age groups. It is a useful addition to multimodal treatment plans for postoperative pain (Wick, Grant, & Wu, 2017). Findings from one research study suggest that patients who receive scheduled acetaminophen with PRN opioids will use less opioids than if they receive PRN acetaminophen plus opioids (Valentine, Carvalho, Lazo, et al., 2015). These results were supported in a more recent study evaluating opioid use among women who underwent Cesarean deliveries (Holland, Bateman, Cole, et al., 2019).

IV acetaminophen is approved for the treatment of pain and fever and is given by a 15-minute infusion in single or repeated doses. It may be given alone for mild to moderate pain or in combination with opioid analgesic agents for more severe pain. The results of several research studies have been inconsistent regarding the opioid sparing effects of IV acetaminophen (Nelson & Wu, 2018). Recommended dosing is 1000 mg every 6 hours for a maximum of 4000 mg in adult patients (Comerford & Durkin, 2020).

A benefit of the NSAID group is the availability of a wide variety of agents for administration via noninvasive routes. Ibuprofen, naproxen, and celecoxib are the most widely used oral NSAIDs in the United States. When rectal formulations are unavailable, an intact oral tablet or a crushed tablet in a gelatin capsule may be inserted into the rectum. The rectal route may require higher doses than the oral route to achieve similar analgesic effects (Pasero et al., 2011). Diclofenac can be prescribed in patch and gel form for topical administration, and an intranasal patient-controlled formulation of ketorolac has been approved for the treatment of postoperative pain.

IV formulations of ketorolac and ibuprofen are available for acute pain treatment. Both have been shown to produce excellent analgesia alone for moderate nociceptive pain, and significant opioid dose–sparing effects when given as part of a multimodal analgesia plan for more severe nociceptive pain (Comerford & Durkin, 2020; Williams, 2018).

Adverse Effects of Nonopioid Analgesic Agents

Acetaminophen is widely considered one of the safest, best tolerated, and most cost effective of the analgesic agents (APS, 2016; Williams, 2018). Its most serious complication is hepatotoxicity (liver damage) as a result of overdose. In the healthy adult, a maximum daily dose below 4000 mg is rarely associated

with liver toxicity. Nevertheless, one manufacturer of oral acetaminophen voluntarily changed its dosing recommendations in 2011, calling for a maximum daily dose of 3000 mg (Shiffman, Battista, Kelly, et al., 2018). In 2014, the U.S. Food and Drug Administration (FDA) recommended that health care professionals stop prescribing and pharmacists stop dispensing prescription combination medication products that contain more than 325 mg of acetaminophen per tablet, capsule, or other dosage unit in order to reduce the risk of hepatotoxicity (FDA, 2014). Acetaminophen does not increase bleeding time and has a low incidence of gastrointestinal (GI) adverse effects, making it the analgesic agent of choice in many individuals with comorbidities. There are two potential interactions with acetaminophen that warrant caution. Acetaminophen should be avoided when consuming alcohol because the combination can result in serious liver damage; acetaminophen also should be avoided when warfarin is prescribed because it can inhibit metabolism of warfarin resulting in toxicity with bleeding risk (Burchum & Rosenthal, 2019).

NSAIDs have considerably more adverse effects than acetaminophen, with gastric toxicity and ulceration being the most common (Comerford & Durkin, 2020). The primary underlying mechanism of NSAID-induced gastric ulceration is the inhibition of COX-1, which leads to a reduction in GI-protective prostaglandins (see Fig. 9-2). This is a systemic (rather than local) effect and can occur regardless of the route of administration of the NSAID. Risk factors include advanced age (older than 60 years), presence of prior ulcer disease, and cardiovascular (CV) disease and other comorbidities (Williams, 2018). In patients with elevated risks, the use of a COX-2 selective NSAID (e.g., celecoxib) or the least ulcerogenic nonselective NSAID (e.g., ibuprofen) plus a proton pump inhibitor is recommended; however, there are risks with proton pump inhibitors as well (Gwee, Goh, Lima, et al., 2018). Proton pump inhibitors may decrease the absorption of some other medications such as itraconazole and rilpivirine (Burchum & Rosenthal, 2019). As with all medications, it is important to frequently reassess the need for continued use and to discontinue when appropriate. GI adverse effects are also related to the dose and duration of NSAID therapy; the higher the NSAID dose and the longer the duration of NSAID use, the higher the risk of GI toxicity (Williams, 2018). A principle of nonopioid analgesic use is to administer the lowest dose for the shortest time necessary (Pasero, Portenoy, & McCaffery, 2011).

All NSAIDs carry a risk of CV adverse effects through prostaglandin inhibition, and the risk is increased with COX-2 inhibition, whether it is produced by a COX-2 selective NSAID (e.g., celecoxib) or by NSAIDs that are nonselective inhibitors of both COX-1 and COX-2 (e.g., ibuprofen, naproxen, and ketorolac). Findings from a recent meta-analysis suggest that the risk of acute myocardial infarction is greatest during the first month of treatment with NSAIDs, with this risk developing during the first week of

treatment (Bally, Dendukuri, Rich, et al., 2017). All patients prescribed NSAIDs should receive the lowest effective dose for the shortest time period to decrease risks.

NSAIDs can negatively impact renal function, and are associated with diminished renal prostaglandin formation, interstitial nephritis, reduced secretion of renin, and greater reabsorption of water and sodium (APS, 2016). NSAID-induced renal toxicity can occur, but is relatively rare in otherwise healthy adults who are given NSAIDs for short-term pain management (e.g., in the perioperative period); however, individuals with acute or chronic volume depletion or hypotension rely on prostaglandin synthesis to maintain adequate renal blood flow, and NSAID inhibition of prostaglandin synthesis in such patients can cause acute kidney injury (Burchum & Rosenthal, 2019). Attention to adequate hydration is essential when administering NSAIDs to prevent this complication (Pasero et al., 2011).

Most nonselective NSAIDs increase bleeding time through inhibition of COX-1. This is both medication and dose related, so the lowest dose of nonopioids with minimal or no effect on bleeding time should be used in patients having procedures with high risk for bleeding. Options include acetaminophen, celecoxib, choline magnesium trisalicylate, salsalate, and nabumetone (APS, 2016; Burchum & Rosenthal, 2019).

Opioid Analgesic Agents

Although it is often used, the term *narcotic* is inaccurate and considered obsolete when discussing the use of **opioids** for pain management, in part because it is a term used loosely by law enforcement and the media to refer to various substances of potential abuse, which include opioids as well as cocaine and other illicit substances. Legally, controlled substances classified as narcotics include opioids, cocaine, and others. The accurate term, when discussing these agents in the context of pain management, is *opioid analgesics* (Burchum & Rosenthal, 2019).

Opioid analgesic agents are divided into two major groups: (1) **mu agonist** opioids (also called *morphinelike medications*) and (2) **agonist–antagonist** opioids. The mu agonist opioids comprise the larger of the two groups and include morphine, hydromorphone, hydrocodone, fentanyl, oxycodone, and methadone, among others. The agonist–antagonist opioids include buprenorphine, nalbuphine, and butorphanol (APS, 2016).

Opioid analgesic agents exert their effects by interacting with opioid receptor sites located throughout the body, including in the peripheral tissues, GI system, and CNS; they are abundant in the dorsal horn of the spinal cord. There are three major classes of opioid receptor sites involved in analgesia: the mu, delta, and kappa. The pharmacologic differences in the various opioids are the result of their interaction with these opioid receptor types (Burchum & Rosenthal, 2019; Sheth, Holtsman, & Mahajan, 2018). When an opioid binds

to the opioid receptor sites, it produces analgesia as well as unwanted effects, such as constipation, nausea, sedation, and respiratory depression (Arthur & Hui, 2018).

The opioid analgesic agents that are designated as first line (e.g., morphine, hydromorphone, fentanyl, and oxycodone) belong to the mu opioid agonist class because they bind primarily to the mu-type opioid receptors. The agonist–antagonist opioids are designated as "mixed" because they bind to more than one opioid receptor site. They bind as **agonists**, producing analgesia, at the kappa opioid receptor sites, and as weak antagonists at the mu opioid receptor sites. Their propensity to antagonize the effects of mu opioid analgesic agents limits their usefulness in pain management (Burchum & Rosenthal, 2019). They should be avoided in patients receiving long-term mu opioid therapy because their use may trigger severe pain and opioid **withdrawal** syndrome characterized by rhinitis, abdominal cramping, nausea, agitation, and restlessness.

Antagonists (e.g., naloxone, naltrexone, naloxegol) are medications that also bind to opioid receptors but produce no analgesia. If an antagonist is present, it competes with opioid molecules for binding sites on the opioid receptors and has the potential to block analgesia and other effects. Antagonists are used most often to reverse adverse effects, such as respiratory depression (Burchum & Rosenthal, 2019). Antagonists have been incorporated in the manufacture of some opioids in an effort to deter abuse of the opioid (Li, 2019)

Administration

Safe and effective use of opioid analgesic agents requires the development of an individualized treatment plan based on a comprehensive pain assessment, which includes clarifying the goals of treatment and discussing options with the patient and the family when appropriate (Chou et al., 2016; Sheth et al., 2018). Goals are periodically reevaluated, and changes made depending on patient response and in some cases disease progression.

Many factors are considered when determining the appropriate opioid analgesic agent for the patient with pain. These include the unique characteristics of the various opioids and patient factors, such as pain intensity, age, coexisting disease, current medication regimen and potential medication interactions, prior treatment outcomes, and patient preference (APS, 2016; Sheth et al., 2018). In all cases, a multimodal approach that may rely on the selection of appropriate analgesic agents from the nonopioid, opioid, and co-analgesic agent groups is recommended to manage all types of pain (APS, 2016; Li, 2019). Chart 9-5 lists the key considerations when developing an opioid pain treatment plan.

Titration of the opioid dose is usually required at the start and throughout the course of treatment when opioids are given. Whereas patients with cancer

pain most often are titrated upward over time for progressive pain, patients with acute pain, particularly postoperative pain, are eventually titrated downward and discontinued as pain resolves (Chou et al., 2016; FDA, 2017; Sheth et al., 2018). The dose and analgesic effect of mu agonist opioids have no **ceiling effect,** although the dose may be limited by adverse effects. The absolute dose given is based on a balance between pain relief and tolerability of adverse effects. The goal of titration is to use the smallest dose that provides satisfactory pain relief with the fewest adverse effects (Sheth et al., 2018). The time at which the dose can be increased is determined by the onset and peak effects of the opioid and its formulation.

Chart 9-5

Use of Opioids

- Perform a comprehensive assessment that addresses pain, comorbidities, and functional status.
- Develop an individualized treatment plan that includes specific goals related to pain intensity, activities (function/quality of life), and adverse effects (e.g., pain intensity rating of 3 on a 0–10 numerical rating scale to ambulate accompanied by minimal or no sedation).
- Use multimodal analgesia (e.g., add acetaminophen and NSAID; anticonvulsant in patients at risk for persistent postsurgical pain).
- Assess for presence preoperatively of underlying persistent pain in surgical patients and optimize its treatment.
- Consider **preemptive analgesic agents** before surgery, particularly for those at risk for severe postoperative pain or a persistent postsurgical pain syndrome.
- Provide analgesic agents prior to all painful procedures.
- Medication selection
  - Consider diagnosis, condition, or surgical procedure, current or expected pain intensity, age, presence of major organ dysfunction or failure, and presence of coexisting disease.
  - Consider pharmacologic issues (e.g., accumulation of metabolites and effects of concurrent medications).
  - Consider prior treatment outcomes and patient preference.
  - Be aware of available routes of administration (oral, transdermal, rectal, intranasal, IV subcutaneous, perineural, intraspinal) and formulations (e.g., short acting, modified release).
  - Be aware of cost differences.
- Route of administration selection
  - Use least invasive route possible.
  - Consider convenience and patient's ability to adhere to the regimen.
  - Consider staff's (or patient's or caregiver's) ability to monitor and provide care required.
- Dosing and titration
  - Consider previous dosing requirement and relative analgesic potencies when initiating therapy.
  - Use equianalgesic dose chart (Table 9-3) to determine starting dose with consideration of patient's current status (e.g., sedation and respiratory status) and comorbidities (e.g., medical frailty), and then titrate until adequate analgesia is achieved or dose-limiting adverse effects are encountered.
  - Use appropriate dosing schedule (e.g., around-the-clock for continuous pain; PRN for intermittent pain).
  - When dose is safe but additional analgesia is desired, titrate upward as prescribed by 25% for slight increase, 50% for moderate

increase, and 100% for considerable increase in analgesia.
    - Provide supplemental doses for breakthrough pain; consider PCA if appropriate.
- Treatment of adverse effects
    - Be aware of the prevalence and impact of opioid adverse effects.
    - Remember that most opioid adverse effects are dose dependent; always consider decreasing the opioid dose as a method of treating or eliminating an adverse effect; adding nonopioid analgesic agents for additive analgesia facilitates this approach.
    - Use a preventive approach in the management of constipation, including for patients receiving short-term opioid treatment.
    - Prevent respiratory depression by monitoring sedation levels and respiratory status frequently and decreasing the opioid dose as soon as increased sedation is detected.
- Monitoring
    - Continually and consistently evaluate the plan on the basis of the specific goals identified at the outset and assess pain intensity, adverse effects, and activity levels.
    - Make necessary modifications to treatment plan to maintain efficacy and safety.
- Tapering and cessation of treatment
    - If a decrease in dose or cessation of treatment is appropriate, do so in accordance with decreased pain intensity and after evaluation of functional outcomes.
    - Be aware of the potential for withdrawal syndrome (rhinitis, abdominal cramping, diarrhea, restlessness, agitation) and need for tapering schedule in patients who have been receiving opioid therapy for more than a few days.

IV, intravenous; NSAID, nonsteroidal anti-inflammatory drug; PCA, patient-controlled analgesia; PRN, as needed.

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Equianalgesia. The term *equianalgesia* means approximately "equal analgesia." An equianalgesic chart provides a list of doses of analgesic agents, both oral and parenteral (IV, subcutaneous, and intramuscular), that are approximately equal to each other in ability to provide pain relief. Equianalgesic conversion of doses is developed from the ratio representing the difference in the potency of the two medications (Treillet, Laurent, & Hadjiat, 2018). The information is used to help ensure that patients are not overdosed or underdosed when they are switched from one opioid or route of administration to another. It requires a series of calculations based on the daily dose of the current opioid to determine the equianalgesic dose of the opioid to

which the patient is to be switched. Several excellent guidelines are available to assist in calculating equianalgesic doses (Burchum & Rosenthal, 2019) (see Table 9-3). Equianalgesic tools available in electronic health records enable all clinicians at any facility to easily convert analgesic dosages (APS, 2016).

TABLE 9-3 Equianalgesic Dose Chart for Common mu Opioid Analgesic Agents

- *Equianalgesic* means approximately the same pain relief.
- The equianalgesic chart is a guideline for selecting doses for patients who are opioid-naïve. Doses and intervals between doses are titrated according to individuals' responses.
- The equianalgesic chart is helpful when switching from one medication or route of administration to another.

Opioid	Oral	Parenteral	Comments
Morphine	30 mg	10 mg	Standard for comparison; first-line opioid via multiple routes of administration; once- and twice-daily oral formulations; clinically significant metabolites
Fentanyl	No formulation	100 mcg IV 100 mcg/h of transdermal fentanyl is approximately equal to 4 mg/h of IV morphine; 1 mcg/h of transdermal fentanyl is approximately equal to 2 mg/24 h of oral morphine	First-line opioid via IV, transdermal, and intraspinal routes; available in oral transmucosal and buccal formulations for breakthrough pain in patients who are opioid-tolerant; no clinically relevant metabolites
Hydrocodone	30 mg (not recommended)	No formulation	Available only in combination with acetaminophen and as such is appropriate only for mild to some moderate pain
Hydromorphone	7.5 mg	1.5 mg	First-line opioid via multiple routes of administration; once-daily oral formulation; clinically significant metabolites noted with long-term and high-dose infusion
Oxycodone	20 mg	No formulation in the United States	Short-acting and twice-daily oral formulations
Oxymorphone	10 mg	1 mg	Parenteral and short-acting and twice-daily oral formulations

IV, intravenous.

Adapted from Comerford, K. C., & Durkin, M. T. (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer; Pasero, C., & McCaffery, M. (2011). *Pain assessment and pharmacologic management*. St. Louis, MO: Mosby-Elsevier.

Formulation terminology. The terms *short acting, immediate release,* and *normal release* have been used interchangeably to describe oral opioids that have an onset of action of approximately 30 minutes and a relatively short duration of 3 to 4 hours. The term *immediate release* is misleading because none of the oral analgesic agents have an immediate onset of analgesia; *short acting* is preferred. The terms *modified release, extended release, sustained release, controlled release,* and *long acting* are used to describe opioids that are formulated to release over a prolonged period of time. For the purposes of this chapter, the term *modified release* will be used when discussing these opioid formulations.

Substance Use Disorder, Physical Dependence, and Tolerance

In 2013 the American Psychological Association (APA) renamed *addiction* as *substance use disorder* (SUD) (Lo Coco, Melchiori, Oiendi, et al., 2019). SUD includes a number of subcategories, including *opioid use disorder.* The terms *physical dependence* and *tolerance* often are confused with *substance use disorder*, previously understood as *addiction*; thus, clarification of definitions is important (Burchum & Rosenthal, 2019).

- **Physical dependence** is a normal response that occurs with repeated administration of the opioid, with intensity and duration dependent upon the half-life of the medication and how long it has been used. It is manifested by the occurrence of withdrawal symptoms when the opioid is suddenly stopped or rapidly reduced, or an antagonist such as naloxone is given. Withdrawal symptoms may be suppressed by the natural, gradual reduction of the opioid as pain decreases or by gradual, systematic reduction, referred to as tapering (Burchum & Rosenthal, 2019). Withdrawal occurs with prolonged use of opioids, regardless of whether the use of opioids is prescribed for pain management or because of SUD (Sheth et al., 2018).
- **Tolerance** is also a normal physiologic response that can occur with regular administration of an opioid and consists of a decrease in one or more effects of the opioid (e.g., decreased analgesia, sedation, or respiratory depression). Although it may occur in conjunction with SUD, it cannot be equated with SUD. It may be treated with increases in dose to attain the previous effect. With the exception of constipation, tolerance to the opioid adverse effects develops with regular daily dosing of opioids over several days (Burchum & Rosenthal, 2019; Sheth et al., 2018).

- **Substance Use Disorder (SUD)** was historically known as addiction or addictive disease, and defined as a chronic, relapsing, treatable neurologic disease. The APA has since described SUD as the impaired use of a substance, such as opioids, even while experiencing major problems, characterized by impaired control over use, compulsive use, continued use despite harm, and craving for the substance. With SUD, use of the opioid is for nontherapeutic reasons and is thus independent of pain relief. The development and characteristics of SUD are influenced by genetic, psychosocial, and environmental factors (Auriacombe, Serre, Denis, et al., 2019; Lo Coco et al., 2019; Sheth et al., 2018).
- **Withdrawal** occurs when a medication or substance to which the body has become dependent is abruptly reduced or discontinued. This is true of prescribed medications as well as illicitly obtained substances. Withdrawal is exhibited by a cascade of unpleasant symptoms including anxiety, nausea, vomiting, rhinitis, sneezing, chills, hot flashes, abdominal cramping, tremors, diaphoresis, hyperreflexia, diarrhea, piloerection, and/or insomnia (APS, 2016; Burchum & Rosenthal, 2019; Sheth et al., 2018).
- *Pseudoaddiction* is a mistaken diagnosis of substance use disorder that occurs when a patient's pain is not well controlled; the patient may begin to manifest symptoms suggestive of SUD. In an effort to obtain adequate pain relief, the patient may respond with demanding behavior, escalating demands for more or different medications, and repeated requests for opioids on time or before the prescribed interval between doses has elapsed. Pain relief typically eliminates these behaviors and is often accomplished by increasing opioid doses or decreasing intervals between doses (Sheth et al., 2018; Weissman & Haddox, 1989).

Pain management specialists have increasingly come to realize that the progression from prescribed opioid use to the disease of opioid SUD is poorly understood and complex. The National Institute on Drug Abuse (2014) estimated that the rates of SUD among patients with chronic pain vary widely, from 3% to 40%. A government effort to address the issue of SUD is the *Comprehensive Addiction and Recovery Act of 2016* which provides prevention, treatment, and rehabilitative support (Burchum & Rosenthal, 2019). There is real concern for adequately treating the 2 million Americans who are living with opioid SUD and the 50 million people who are living with chronic pain (National Institutes of Health [NIH], 2019). The patients in both groups need and deserve to receive informed, evidence-based, compassionate nursing care.

Opioid naïve versus opioid tolerant. Patients are often characterized as being either *opioid naïve* or *opioid tolerant.* Whereas an **opioid naïve** person

has not recently taken enough opioid on a regular basis to become tolerant to the effects of an opioid, an **opioid tolerant** person has taken an opioid long enough at doses high enough to develop tolerance to many of the effects, including analgesia and sedation. There is no set time for the development of tolerance, and there is great individual variation, with some not developing tolerance at all. By convention, most clinicians consider a patient who has taken opioids regularly for approximately 7 or more days to be opioid tolerant (Pasero et al., 2011).

Opioid-Induced Hyperalgesia

Opioid-induced hyperalgesia (OIH) is a paradoxical situation in which increasing doses of an opioid result in increasing sensitivity to pain. The incidence of clinically significant OIH has not been determined; however, it is a serious consequence of opioid administration. At this time, it is not possible to predict who will develop OIH as a result of opioid exposure, and the mechanisms underlying OIH are largely unknown. In general, OIH is thought to be the result of changes in the central and peripheral nervous systems that produce increased transmission of nociceptive signals (APS, 2016; Higgins, Smith, & Matthews, 2018; Ringkamp et al., 2018; Spofford & Hurley, 2018).

Some experts characterize OIH and analgesic tolerance as "opposite sides of the coin" (Pasero et al., 2011). In tolerance, increasing doses of opioid are needed to provide the same level of pain relief because opioid exposure induces neurophysiologic changes that reverse analgesia; in OIH, opioid exposure induces neurophysiologic changes that produce pain or increase sensitivity to noxious input (APS, 2016). In other words, tolerance may be inferred clinically when opioid treatment leads to decreased sensitivity to opioid analgesia over time (in the absence of another process that would explain this), whereas OIH may be inferred clinically when opioid treatment leads to increased pain or sensitivity to pain. Patients with OIH may report an increase in pain that increases with increased dosing of opioids (APS, 2016). Recent research findings have reported the onset of postoperative OIH following intraoperative administration of opioids (Spofford & Hurley, 2018). OIH is an area in which additional research is much needed.

Select Opioid Analgesic Agents

Morphine is the standard against which all other opioid medications are compared. It is used worldwide, particularly for cancer pain, and its use is established by extensive research and clinical experience. It is available in a wide variety of short-acting and modified-release oral formulations and is given by multiple routes of administration. It was the first medication to be given intraspinally and remains a first-line choice for long-term **intraspinal** analgesia. It is the only opioid uniquely formulated to produce analgesia for up to 48 hours following epidural administration for acute pain management (extended-release epidural morphine). Morphine is a **hydrophilic** medication

(readily absorbed in aqueous solution), which accounts for its slow onset and long duration of action when compared with other opioid analgesic agents (Tables 9-3 and 9-4). It has two principal, clinically significant **metabolites:** morphine-3-glucuronide (M3G) and morphine-6-glucuronide (M6G). M6G may be responsible for some of the analgesic effect of morphine; accumulation of M3G can produce neurotoxicity, which necessitates switching the patient to a different opioid (Burchum & Rosenthal, 2019; Conlin et al., 2018; Howard & Brant, 2019; Sheth et al., 2018).

TABLE 9-4 Characteristics of Select First-Line Opioid Analgesic Agents[a]

Opioid	Onset (Minutes)	Peak (Minutes)	Duration (Hours)
Morphine	30 (PO) 5 (IV)	60–120 (PO) 20 (IV)	4–12 (PO) 4–5 (IV)
Fentanyl	5–15 (OT) 1–2 (IV)	20–30 (OT) 3–5 (IV)	2–5 (OT) 1/2–1 (IV)
Hydromorphone	15–30 (PO) 10–15 (IV)	30–60 (PO) 15–30 (IV)	4–5 (PO) 2–3 (IV)

[a]Characteristics do not apply to modified-release formulations.

IV, intravenous; OT, oral transmucosal; PO, oral.

Adapted from Comerford, K. C., & Durkin, M. T. (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer; Pasero, C., & McCaffery, M. (2011). *Pain assessment and pharmacologic management*. St. Louis, MO: Mosby-Elsevier.

Fentanyl, in contrast to morphine, is a **lipophilic** (readily absorbed in fatty tissues) opioid and as such has a fast onset and short duration of action (see Tables 9-3 and 9-4). These characteristics make it the most commonly used IV opioid when rapid analgesia is desired, such as for the treatment of severe, escalating acute pain, and for procedural pain when a short duration of action is desirable. This medication is a good choice for patients with end-organ failure because it has no clinically relevant metabolites. It also produces minimal hemodynamic adverse effects; thus, fentanyl is often preferred in patients who are hemodynamically unstable, such as the critically ill (Chou et al., 2016; Conlin et al., 2018; Howard & Brant, 2019).

Its lipophilicity makes fentanyl ideal for medication delivery by transdermal patch for long-term opioid administration and by the oral transmucosal and buccal routes for BTP treatment in patients who are opioid tolerant. Following application of the transdermal patch, a subcutaneous depot of fentanyl is established in the skin near the patch. After absorption from the depot into the systemic circulation, the medication distributes to fat and muscle. When the first patch is applied, 12 to 18 hours are required for clinically significant analgesia to be obtained; attention must be paid to providing adequate supplemental analgesia during that time. Conversely, when the patch is removed, the serum levels of fentanyl remain for a minimum of 16 hours, so it

is important to not administer additional long-acting opioids during that time. Another important caution is that heat (e.g., heating pads, hot water blankets, hot tubs, fever) may increase the rate of absorption leading to serious adverse events. The patch is changed every 48 to 72 hours depending on patient response. It is important to note that the patch is not appropriate for treating acute pain or rapidly changing pain (Burchum & Rosenthal, 2019; Howard & Brant, 2019; Sheth et al., 2018).

Hydromorphone is less hydrophilic than morphine but less lipophilic than fentanyl, which contributes to an onset and duration of action that is intermediate between morphine and fentanyl (see Tables 9-3 and 9-4). This medication is often used as an alternative to morphine, especially for acute pain because the two medications produce similar analgesia and have comparable adverse effect profiles. It is a first- or second-choice opioid (after morphine) for postoperative pain management via IV PCA and is available in a once-daily modified-release oral formulation for chronic pain management. Accumulation of its neuroexcitatory metabolite hydromorphone-3-glucuronide (H3G) may occur with high-dose, long-term infusion therapy, which would necessitate a switch to another opioid (Burchum & Rosenthal, 2019; Sheth et al., 2018).

Oxycodone is available in the United States for administration by the oral route only and is used to treat all types of pain. Single-entity short-acting and modified-release oxycodone formulations are used most often for moderate to severe cancer pain and in some patients with moderate to severe noncancer pain (see Table 9-3). When it is combined with acetaminophen, the dose of oxycodone is limited by the acetaminophen dose to avoid exceeding the maximum daily dose of that agent. Oxycodone has been used successfully as part of a multimodal treatment plan for postoperative pain as well (Burchum & Rosenthal, 2019; Sheth et al., 2018).

Oxymorphone has been available for many years in parenteral formulation and more recently in short-acting and modified-release oral tablets for the treatment of moderate to severe chronic pain (see Table 9-3). It must be taken on an empty stomach (1 hour before or 2 hours after a meal), and coingestion of alcohol at the time of dosing must be avoided because food and alcohol can increase the serum concentration of the medication up to 300% (Burchum & Rosenthal, 2019; Comerford & Durkin, 2020; Sheth et al., 2018).

Hydrocodone is commercially available only in combination with nonopioids (e.g., with acetaminophen or ibuprofen), which limits its use to the treatment of mild to some moderate pain (see Table 9-3). It is one of the more commonly prescribed analgesic agents in the United States; however, its prescription for the treatment of persistent pain (except for breakthrough dosing) should be carefully evaluated because of its ceiling on **efficacy** and safety concerns inherent in the nonopioid constituent. In the rare situation when a patient can only tolerate hydrocodone and needs a dose higher than is

possible with the acetaminophen or ibuprofen combination, hydrocodone alone can be obtained from a compounding pharmacy with a prescription. In 2014, the U.S. Drug Enforcement Agency changed hydrocodone from a schedule III to the more restrictive schedule II classification to reduce abuse of this pain medication (Federal Register, 2014). It is now also available as two extended-release products (Burchum & Rosenthal, 2019; Comerford & Durkin, 2020).

Methadone is a unique synthetic opioid analgesic medication that may have advantages over other opioids in carefully selected patients. In addition to being a mu opioid, it is an antagonist at the NMDA receptor site and thus has the potential to produce analgesic effects as a second- or third-line option for some neuropathic pain states. It may be used as an alternative when it is necessary to switch a patient to a new opioid because of inadequate analgesia or unacceptable adverse effects. The use of conventional equianalgesic dose conversion is not recommended when switching patients to and from methadone. Extensive guidelines on how to safely accomplish this are available elsewhere. In 2014, the APS, in conjunction with the Heart Rhythm Society and the College on Problems of Drug Dependence, issued clinical practice guidelines to encourage safe use of methadone (APS, 2016).

Methadone is usually given orally but has also been given by virtually every other route of administration. Although it has no active metabolites, methadone has a very long and highly variable **half-life** (5 to 100-plus hours; average is 20 hours), which makes it a good choice for the treatment of SUD; patients must be watched closely for excessive sedation, a sign of medication accumulation during this time period. (The medication is described as "long acting" because of its exceptionally long half-life.) When methadone is used to treat opioid use disorder, it is dosed once daily and is not intended to manage pain; acute pain management with other analgesic medications is needed in addition to daily methadone dosing. Other limitations are its propensity to interact with a large number of medications and prolong the QTc interval on the electrocardiogram (ECG). Some medications (e.g., clarithromycin and some antifungal medications) that inhibit CYP3A4, the enzyme that metabolizes methadone, should be avoided as they can inadvertently increase methadone levels in the blood. Despite these characteristics, methadone can be an effective and safe medication when prescribed by providers who have an appreciation of the unique characteristics of the medication and who are experienced in prescribing it (APS, 2016; Burchum & Rosenthal, 2019; Comerford & Durkin, 2020; Sheth et al., 2018).

Dual-Mechanism Analgesic Agents

The dual-mechanism analgesic agents tramadol and tapentadol bind weakly to the mu opioid receptor site and block the reuptake (resorption) of the inhibitory neurotransmitters serotonin and norepinephrine at central synapses in the spinal cord and brain stem of the modulatory descending pain pathway

(APS, 2016; Holtsman & Hale, 2018). This makes these neurotransmitters more available to counteract pain. Dual-mechanism analgesic agents have been described as providing automatic "built-in" multimodal analgesia because a single tablet produces an effect on more than one analgesic action site (Varrassi, Hanna, Macheras, et al., 2017). The underlying mechanisms of tapentadol and tramadol differ in that tramadol blocks the reuptake of both serotonin and norepinephrine, but tapentadol blocks the reuptake of only norepinephrine. This is pertinent because norepinephrine may play a more significant role than serotonin in the endogenous analgesia pathways. Serotonin may be the more powerful mediator of depression; low serotonin levels are associated with depression. This helps explain why selective serotonin reuptake inhibitors (SSRIs), such as fluoxetine and paroxetine, which block only serotonin, are effective for the treatment of depression but not pain (APS, 2016; Burchum & Rosenthal, 2019; Comerford & Durkin, 2020; Holtsman & Hale, 2018).

Tramadol is used for both acute and chronic pain and is available in oral short-acting and modified-release formulations, including a short-acting tablet in combination with acetaminophen. It has demonstrated good efficacy for the treatment of neuropathic pain (Comerford & Durkin, 2020). The medication can lower seizure threshold and interact with other medications that block the reuptake of serotonin, such as the SSRIs, putting the patient at risk for serotonin syndrome, characterized by agitation, diarrhea, heart and blood pressure changes, and loss of coordination (Holtsman & Hale, 2018).

Tapentadol is available in short-acting and modified-release oral formulations. This medication has been shown to produce dose-dependent analgesia comparable to oxycodone. Major benefits are that it has no active metabolites and a significantly more favorable adverse effect profile (particularly GI) compared with opioid analgesic agents. These characteristics make tapentadol an attractive alternative to traditional oral opioid analgesic agents for many patients with pain (Comerford & Durkin, 2020; Holtsman & Hale, 2018).

Opioids to Avoid

Codeine is a prodrug, which means it is pharmacologically inactive when given. It must be metabolized to morphine for the patient to experience pain relief. It is estimated that 5% to 10% of patients lack the enzymatic ability to convert codeine to morphine via the CYP2D6 metabolic pathway, meaning that in this population of patients, codeine is an ineffective analgesic agent. In contrast, codeine has been associated with overdoses in some children due to rapid metabolism of the medication to morphine.

Meperidine has either been removed from or severely restricted on hospital formularies for the treatment of pain in an effort to improve patient safety. However, it is an accepted practice to use it in low doses (12.5 to 25 mg IV) to

treat *rigors* (shivering) associated with general anesthesia. A major limitation to the use of meperidine is its active metabolite, normeperidine, which is a CNS stimulant and can cause delirium, irritability, tremors, myoclonus, and generalized seizures. Concern for meperidine's neurotoxicity risks has dramatically reduced its use (APS, 2016; Burchum & Rosenthal, 2019; Comerford & Durkin, 2020; Sheth et al., 2018).

Adverse Effects of Opioid Analgesic Agents

The most common adverse effects of opioids are constipation, nausea, vomiting, pruritus, hypotension, and sedation. Respiratory depression, while less common, is the most serious and feared of the opioid adverse effects (Pasero, 2009). The risk of respiratory depression is increased when other medications that have depressive effects on the CNS, such as benzodiazepines (e.g., diazepam), alcohol, and barbiturates, are used concurrently with opioids. In surgical patients, postoperative ileus can become a major complication as well (Burchum & Rosenthal, 2019; Comerford & Durkin, 2020; Sheth et al., 2018). Morphine lowers blood pressure by dilating peripheral arterioles and veins. In the presence of dehydration or with concomitant use of hypotensive medications, orthostatic hypotension may result (Burchum & Rosenthal, 2019). Long-term use of opioids may result in opioid-induced androgen deficiency and sleep disordered breathing (Chowdhuri & Javaheri, 2017; Hsieh, DiGiorgio, Fakunle, et al., 2018; Nagappa, Weingarten, Montandon, et al., 2017).

Opioids can result in delayed gastric emptying, slowed bowel motility, and decreased peristalsis, all of which result in slow-moving, hard stool that is difficult to pass. Risk is elevated with advanced age, and immobility; however, it is an almost universal opioid adverse effect (i.e., tolerance rarely develops). Constipation is a primary reason people stop taking their pain medication, which underscores the importance of taking a preventive approach and aggressive management if symptoms are detected. Prevention includes reminding patients to take a daily stool softener plus mild peristaltic stimulant for as long as they are taking opioids (APS, 2016; Burchum & Rosenthal, 2019).

Postoperative nausea and vomiting (PONV) occur following opioid administration due to medulla chemoreceptor trigger zone stimulation. PONV are among the most unpleasant of the adverse effects associated with surgery, and can have a negative impact on patient outcomes, and increase the need for nursing intervention. Guidelines from the American Society of PeriAnesthesia Nurses (ASPAN) recommend that all patients be evaluated for PONV risk, risk factors be reduced if possible, multimodal analgesia be provided (so that no opioid or the lowest effective opioid dose can be given), and prophylactic treatment (e.g., dexamethasone and a serotonin receptor antagonist, such as ondansetron, at the end of surgery) be given to patients with moderate risk

(APS, 2016; ASPAN, 2006; Gan, Diemunsch, Habib, et al., 2014). More aggressive interventions should be utilized in patients with high risk (Pasero et al., 2011). (See Chapter 16 for further discussion of PONV.)

Pruritus is an adverse effect of opioids, not an allergic reaction to them. Although antihistamines such as diphenhydramine are commonly used, and patients may report being less bothered by itching after taking an antihistamine, this may be the result of sedating effects. Any additional coadministered sedating medication can be problematic in people already at risk for excessive sedation, such as postoperative patients, because this can lead to life-threatening respiratory depression (APS, 2016). Loratadine and cetirizine are considered nonsedating histamines and might be selected. Often the most effective, safest, and least expensive treatment of pruritus is opioid dose reduction. In fact, simply decreasing the opioid dose is sufficient to eliminate or make most of the adverse effects tolerable for many patients. Opioid rotation is another possible treatment. Nonsedating analgesic agents can be added to facilitate this approach. Parenteral low dose nalbuphine, an agonist–antagonist opioid, has been reported to be superior to placebo, control, antihistamines, and naloxone in the treatment of pruritus caused by neuraxial opioids (APS, 2016).

In addition to dose reduction strategies, most opioid pain treatment plans include prescriptions for medications that can be used to treat adverse effects should they occur. Recent research with animals demonstrated successful prevention of opioid induced pruritis through administration of capsaicin (Melo, Basso, Iftinca, et al., 2018). Nonpharmacologic interventions may also be effective, such as the application of a cool damp cloth over affected areas to help relieve the discomfort of pruritus.

With the exception of constipation, as patients become opioid tolerant, an accompanying tolerance to the opioid adverse effects develops. It is reassuring for patients receiving long-term opioid therapy to know that most of the adverse effects will subside with regular daily doses of opioids over several days.

Sedation and respiratory depression. Most patients experience sedation at the beginning of opioid therapy and whenever the opioid dose is increased significantly. If left untreated, excessive sedation can progress to clinically significant respiratory depression. Like other opioid adverse effects, sedation and respiratory depression are dose related. In most cases (exceptions may apply at the end of life), nurses should promptly reduce opioid doses or stop titration whenever advancing sedation is detected to prevent respiratory depression (Pasero, 2009; Pasero et al., 2011). In some patients (e.g., those with obstructive sleep apnea, pulmonary dysfunction), monitoring with capnography is warranted (Jarzyna, Junquist, Pasero, et al., 2011). When supplemental oxygen is needed to maintain the patient's oxygen saturation, pulse oximetry may not detect hypoventilation. Patients receiving opioid

therapy and supplemental oxygen can benefit from capnography, which reflects the adequacy of ventilation and airflow, in conjunction with monitoring of sedation and respiratory function (Gupta & Edwards, 2018).

Quality and Safety Nursing Alert

Opioid-induced respiratory depression is dose related and preceded by increasing sedation. Prevention of clinically significant opioid-induced respiratory depression begins with the administration of the lowest effective opioid dose, careful titration, close monitoring of sedation and respiratory function and status (i.e., rate, depth, regularity, excursion) throughout therapy, and prompt dose reduction when advancing sedation is detected (Nagappa et al., 2017).

The knowledge that excessive sedation precedes opioid-induced respiratory depression reinforces that systematic sedation assessment is an essential aspect of the care of patients receiving opioid therapy (Gupta & Edwards, 2018; Pasero, 2009). Nursing assessment of sedation is convenient, inexpensive, and takes minimal time to perform. A simple, easy-to-understand sedation scale, developed for the assessment of *unintended* sedation, which includes what should be done at each level of sedation, is recommended to enhance accuracy and consistency of assessment, better monitor trends, and improve communication among members of the health care team (Garcia & McMullan, 2019; Jarzyna et al., 2011; Pasero, 2009; Pasero et al., 2011; Quinlan-Colwell, Thear, Miller-Baldwin, et al., 2017). Chart 9-6 presents a widely used sedation scale.

Chart 9-6

Pasero Opioid-Induced Sedation Scale with Interventions

Each level of sedation is followed by the appropriate action in italics.

S = Sleep, easy to arouse
Acceptable; no action necessary; may increase opioid dose if needed

1 = Awake and alert
Acceptable; no action necessary; may increase opioid dose if needed

2 = Slightly drowsy, easily aroused
Acceptable; no action necessary; may increase opioid dose if needed

3 = Frequently drowsy, arousable, drifts off to sleep during conversation
Unacceptable; monitor respiratory status and sedation level closely until sedation level is stable at less than 3 and respiratory status is satisfactory; decrease opioid dose 25–50%[1] or notify primary[2] or anesthesia provider for orders; consider administering a nonsedating, opioid-sparing nonopioid, such as acetaminophen or an NSAID, if not contraindicated; ask patient to take deep breaths every 15–30 min.

4 = Somnolent, minimal, or no response to verbal and physical stimulation
Unacceptable; stop opioid; consider administering naloxone[3,4]; call Rapid Response Team (Code Blue); stay with patient, stimulate, and support respiration as indicated by patient status; notify primary[2] or anesthesia provider; monitor respiratory status and sedation level closely until sedation level is stable at less than 3 and respiratory status is satisfactory.

[1]Opioid analgesic agent prescriptions or a hospital protocol should include the expectation that a nurse will decrease the opioid dose if a patient is excessively sedated.

[2]For example, the primary provider, nurse practitioner, advanced practice nurse, or physician assistant responsible for the pain management prescription.

[3]For adults experiencing respiratory depression, mix 0.4 mg of naloxone and 10 mL of normal saline in syringe and administer this dilute solution very slowly (0.5 mL over 2 min) while observing the patient's response (titrate to effect).

[4]Hospital protocols should include the expectation that a nurse will administer naloxone to any patient suspected of having life-threatening opioid-induced sedation and respiratory depression.

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Respiratory depression is assessed on the basis of what is normal for a particular person and is usually described as clinically significant when there is a decrease in the rate, depth, and regularity of respirations from baseline, rather than just by a specific number of respirations per minute (Pasero et al., 2011). There are many risk factors for opioid-induced respiratory depression, including older age (65 years of age or older), obesity, obstructive sleep apnea, and preexisting pulmonary dysfunction, or other comorbidities (APS, 2016;

Jarzyna et al., 2011). Risk is elevated during the first 24 hours following surgery and in patients who require a high dose of opioid in a short period of time (e.g., more than 10 mg of IV morphine or equivalent in the PACU). Patients who receive regularly scheduled opioids often develop tolerance to this effect in approximately 1 week (APS, 2016; Nagappa et al., 2017).

A comprehensive respiratory assessment constitutes more than counting a patient's respiratory rate (Pasero, 2009). A proper assessment requires watching the rise and fall of the patient's chest to determine rate, depth, and regularity of respirations. Listening to the sound of the patient's respirations is critical as well—snoring indicates airway obstruction and must be attended to promptly with repositioning and, depending on severity, a request for respiratory therapy consultation and further evaluation (Pasero, 2009; Pasero et al., 2011).

In most cases (exceptions may apply at the end of life), the opioid antagonist naloxone is promptly given IV to reverse clinically significant opioid-induced respiratory depression (Burchum & Rosenthal, 2019). The goal is to reverse only the sedation and respiratory depressant effects of the opioid. To this end, it should be diluted and titrated very slowly to prevent severe pain and other adverse effects, which can include hypertension, tachycardia, ventricular arrhythmias, pulmonary edema, and cardiac arrest (APS, 2016) (see Chart 9-6, footnote 3, for correct technique). Sometimes more than one dose of naloxone is necessary, because naloxone has a shorter duration of action (1 hour in most patients) than most opioids. In particular, this is true with transdermal fentanyl for which reversal requires repeated doses or an infusion of naloxone to insure appropriate reversal (Burchum & Rosenthal, 2019).

Co-Analgesic Medications

The **co-analgesic agents** comprise the largest group of analgesic agents, which offers many options. Medication selection and dosing is based on both experience and evidence-based guideline recommendations. There is considerable variability among individuals in their response to co-analgesic agents, including to agents within the same class; often a "trial and error" strategy is used in the outpatient setting. Treatment in the outpatient setting often is primarily for patients who have a neuropathic component of pain and involves the use of low initial doses and gradual dose escalation to allow tolerance to the adverse effects. Patients must be forewarned in this setting that the onset of analgesia is likely to require time to achieve analgesic benefit (Pasero, Polomano, Portenoy, et al., 2011). Following is a brief overview of the most commonly used co-analgesic agents.

Local Anesthetics

Local anesthetics have a long history of safe and effective use for all types of pain management. Local anesthetics are sodium channel blockers that affect

the formation and propagation of action potentials. They are given by various routes of administration and are generally well tolerated by most individuals (Pasero et al., 2011). Injectable and topical local anesthetics are commonly used for procedural pain treatment. Local anesthetics are added to opioid analgesic agents and other agents to be given intraspinally for the treatment of both acute and chronic pain. They are also infused for continuous peripheral nerve blocks, primarily after surgery (Chou et al., 2016).

The lidocaine patch 5% is placed directly over or adjacent to the painful area for absorption into the tissues directly below. This medication produces minimal systemic absorption and adverse effects. The patch is left in place for 12 hours and then removed for as long as 12 hours (12 hours on, 12 hours off regimen). This application process is repeated as needed for continuous analgesia (Burchum & Rosenthal, 2019). The medication is FDA approved for the neuropathic pain syndrome and postherpetic neuralgia; however, research suggests that it is effective and safe for a variety of other painful neuropathic conditions (APS, 2016). Lidocaine is also available in topical preparations as cream, gel, solution, ointment, and aerosol (APS, 2016; Burchum & Rosenthal, 2019). More recent liposomal formulations of local anesthetics such as bupivacaine, which can be instilled in a surgical wound, are reported to have longer duration of action, supporting improved analgesia (Shah, Votta-Velis, & Borgeat, 2018).

Allergy to local anesthetics is rare. Cardiac and CNS adverse effects are dose related (Burchum & Rosenthal, 2019). CNS signs of systemic toxicity include ringing in the ears, metallic taste, irritability, and seizures. Signs of cardiotoxicity include circumoral tingling and numbness, bradycardia, cardiac arrhythmias, and CV collapse (Pasero et al., 2011).

Membrane Stabilizer Anticonvulsant Medications

The anticonvulsant calcium channel blockers gabapentin and pregabalin are first-line analgesic agents for neuropathic pain (Peterson et al., 2018). They are increasingly being added to postoperative pain treatment plans to address the neuropathic component of surgical pain and can be considered as part of a multimodal approach for postoperative analgesia (Chou et al., 2016). Although further research is needed, their addition has been shown to improve analgesia, allow lower doses of other analgesic agents, and help prevent persistent neuropathic postsurgical pain syndromes, such as phantom limb, post thoracotomy, posthernia, and postmastectomy pain. They may be effective in improving the acute pain associated with burn injuries and as treatment for the neuropathic pain and pruritis following major burn injuries (Griggs, Goverman, Bittner, et al., 2017; Kaul, Amin, Rosenberg, et al., 2018; Wang, Beekman, Hew, et al., 2018). Analgesic anticonvulsant therapy is initiated with low doses and titrated according to patient response. Initial doses of gabapentin may not provide analgesia; titration to effective dosing may take up

to 2 months. Pregabalin has a more rapid onset of action with expected maximum effect typically reached in 2 weeks. Primary adverse effects of anticonvulsants are sedation and dizziness, which are usually transient and most notable during the titration phase of treatment (Peterson et al., 2018).

Antidepressant Medications

From an analgesic perspective, antidepressant co-analgesic medications are divided into two major groups: the tricyclic antidepressants (TCAs) and the serotonin and norepinephrine reuptake inhibitors (SNRIs). Evidence-based guidelines recommend the TCAs desipramine and nortriptyline and the SNRIs duloxetine and venlafaxine as first-line options for neuropathic pain treatment (Cruccu & Truini, 2017). Their delayed onset of action makes them inappropriate for acute pain treatment. Analgesic antidepressant therapy is initiated with low doses and titrated according to patient response (Comerford & Durkin, 2020; Issa, Marshall, & Wasan, 2018).

Primary adverse effects of TCAs are dry mouth, sedation, dizziness, mental clouding, weight gain, and constipation. Orthostatic hypotension is a potentially serious TCA adverse effect. The most serious adverse effect is cardiotoxicity, and patients with significant heart disease are at high risk. SNRIs are thought to have a more favorable adverse effect profile and to be better tolerated than the TCAs. Due to the side effects, including delirium and confusion, amitriptyline is not indicated for use in older adults (Aguiar, Costa, da Costa, et al., 2019; Burchum & Rosenthal, 2019). The 2015 Beers Criteria® identified amitriptyline as potentially inappropriate for prescription among older adults (Fick, Semla, Steinman, et al., 2019) (see Chapter 8 for further information on the Beers Criteria). The most common SNRI adverse effects are nausea, headache, sedation, insomnia, weight gain, impaired memory, sweating, and tremors (Comerford & Durkin, 2020).

Ketamine

Ketamine is a dissociative anesthetic with dose-dependent analgesic, sedative, and amnestic properties (Burchum & Rosenthal, 2019). As an NMDA antagonist, it blocks the binding of glutamate at the NMDA receptors and thus prevents the transmission of pain to the brain via the ascending pathway (see Fig. 9-1B, inset). At high doses, this medication can produce psychomimetic effects (e.g., hallucinations, dreamlike feelings); however, these are minimized when low doses are given. A benefit of the medication is that it does not produce respiratory depression. Ketamine is given most often by the IV route but can also be given by the oral, rectal, intranasal, and subcutaneous routes. In addition to intraoperative and procedural use, ketamine has been used for the treatment of persistent neuropathic pain, but its adverse effect profile makes it less favorable than other analgesic agents for long-term therapy. It is, however, increasingly used as a third-line analgesic agent for **refractory** acute pain among patients who are very opioid-tolerant or for patients who are not able to

be treated with opioids. It does have a potential for abuse (APS, 2016; Burchum & Rosenthal, 2019).

Gerontologic Considerations

Older adults often live with chronic pain, yet physiologic changes and comorbidities make management more complicated among them (HHS, 2019). Older adults are often sensitive to the effects of co-analgesic agents that produce sedation and other CNS effects, such as antidepressants and anticonvulsants. Since they are also at risk for undertreatment of pain, therapy should be initiated with low doses, and titration should proceed slowly with systematic assessment of patient response (Burchum & Rosenthal, 2019).

Older adults are also at increased risk for NSAID-induced GI toxicity. Acetaminophen should be used for mild pain and is recommended as first line for musculoskeletal pain (e.g., osteoarthritis). If an NSAID is needed for inflammatory pain, it is recommended that a COX-2 selective NSAID (if not contraindicated by an increased CV risk) or the nonselective NSAID least likely to cause a peptic ulcer should be used. The addition of a proton pump inhibitor to NSAID therapy, or opioid analgesic agents rather than an NSAID, is recommended for high-risk patients. The American Geriatric Society (AGS) recommends using extreme caution when prescribing NSAIDs among older adults (Jones, Ehrhardt, Ripoll, et al., 2016). NSAIDs are safest when used for short-term pain flares that may occur during transient worsening in severity of chronic diseases or conditions (e.g., osteoarthritis, fibromyalgia, low back pain). A number of NSAIDs are available in topical formulations which may be preferred for older adults (Burchum & Rosenthal, 2019; Horgas, 2017; HSS, 2019; Sowa, Weiner, & Camacho-Soto, 2018).

Age is considered an important factor to consider when selecting an opioid dose. The starting opioid dose should be reduced by 25% to 50% in adults older than 70 years because they are more sensitive to opioid adverse effects than younger adults; the number of subsequent doses is based on patient response (American Geriatrics Society [AGS], 2009; Burchum & Rosenthal, 2019).

Use of Placebos

A **placebo** is "any sham medication or procedure designed to be void of any known therapeutic value" (Lang, Christopher, Emmott, et al., 2018, p. 55). A saline injection is one example of a placebo. Administration of a medication at a known subtherapeutic dose (e.g., 0.10 mg of morphine in an adult) is also considered a placebo.

Placebos only are appropriately used as controls in research evaluating the effects of a new medication. The new substance or treatment is compared with the effects of a placebo and must show more favorable effects than placebos to

warrant further investigation or marketing of the substance or treatment (Enck, Klosterhalfen, & Weimer, 2017). When a person responds to a placebo in accordance with its intent, it is called a *positive placebo response* (Arnstein, Broglio, Wuhrman, et al., 2011). Individuals who participate in placebo-controlled research must be able to give informed consent or have a guardian who can provide informed consent.

TABLE 9-5 Nonpharmacologic Methods of Pain Management

Type	Examples	Nursing Considerations
Physical modalities	Proper body alignment; application of heat and/or cold; massage; transcutaneous electrical nerve stimulation (TENS); acupuncture; physical therapy; and aqua therapy	Be aware that some of these methods require a prescription in the inpatient setting, as inappropriate use can cause harm (e.g., burns or frostbite from extreme temperatures and prolonged thermal application).
Cognitive and behavioral methods	Relaxation breathing; distraction; listening, singing, or rhythmic tapping to music; imagery; humor; pet therapy; prayer; meditation; hypnosis	Prior to use, evaluate patient's cognitive ability to learn and perform necessary activities.
Movement therapy	Yoga, T'ai chi	Prior to use, evaluate patient's physical ability to perform necessary activities.
Biologically based therapies	Taking herbs, vitamins, and proteins; aromatherapy; diet modifications	Evaluate use to identify potential adverse effects.
Energy therapies	Therapeutic touch, Reiki, and healing touch	Obtain patient's permission before using intervention.

Adapted from National Center for Complementary and Integrative Health (NCCIH). (2015). *Complementary, alternative, or integrative health: What's in a name?* Retrieved on 11/9/2019 at: www.nccih.nih.gov/health/integrative-health#types; O'Conner-Von, S., Heck, C. R., & Peltier, C. H. (2018). *Complementary and integrative therapies for pain management*. In M. L. Czarnecki, & H. N. Turner (Eds.). *Core curriculum for pain management nursing* (3rd ed.). St. Louis, MO: Elsevier.

Chart 9-7

Considerations in Selecting and Using Nonpharmacologic Methods

- Do the patient, family, and health care team understand the relationship between nonpharmacologic pain management and antispasmodic agents? Patients who have been taking analgesic agents may mistakenly assume that when clinicians suggest a nonpharmacologic method, the purpose is to reduce the use or dose of analgesic agents. All involved must understand that nonpharmacologic methods are used to complement—not replace—pharmacologic methods.
- Does the patient understand the limitations of nonpharmacologic methods? Nonpharmacologic methods are valuable as comfort measures; however, not all such measures relieve pain and should not be promoted as such.
- Is the patient interested in using a nonmedication method, and have any been tried previously? If so, what happened? Is the patient using nonmedication methods because of unfounded fears about analgesic agents? Willingness and interest are important for successful use of nonpharmacologic methods; however, patients may fear taking analgesic agents that clearly are indicated for their pain, such as nonsteroidal anti-inflammatory drugs (NSAIDs) for an inflammatory painful condition. Such fears should be explored, and accurate information and appropriate treatment provided. Alternately, the reasons a patient refuses to use a nonpharmacologic method also should be explored, but the patient's right to refuse must be respected.
- What are the patient's preferences and coping styles? Encouraging patients to choose from a variety of techniques allows them to match the technique to their individual and cultural preferences. If none of the choices appeal to the patient, the patient's right to refuse use should be respected.
- Does the patient have the physical and cognitive abilities necessary for using the nonpharmacologic method? Does the patient have sufficient energy to learn and perform any tasks involved? For example, physical and mental fatigue can interfere with the use of distraction and relaxation imagery techniques. Does the patient want to dedicate the necessary time required for the nonpharmacologic method? For example, those who do not find a 20-min self-sustained relaxation technique appealing may be more suited for passive application of cold or heat.
- Do others (e.g., family, friends) want to be involved in helping the patient? Is the method a potential vehicle for improving relationships between the patient and others? For example, a method that patients cannot do for themselves, such as massage, may be a burden to some caregivers in the home, whereas others may welcome that opportunity to be physically close to a loved one.

- Are support materials and patient education resources available? Whenever possible, verbal, written, and in some cases, online or video education should be provided.

Adapted from McCaffery, M. (2002). What is the role of nondrug methods in the nursing care of patients with acute pain? *Pain Management Nursing, 3*(3), 77–80; McCaffery, M., & Pasero, C. (1999). *Pain: Clinical manual*. St. Louis, MO: Mosby.

Placebos should never be used clinically in a deceitful manner and without informed consent. It is disrespectful and harmful to use them. Pain relief resulting from a placebo is mistakenly believed to invalidate a patient's report of pain. This typically results in the patient being deprived of pain-relief measures, despite research showing that many patients who have obvious physical stimuli for pain (e.g., abdominal surgery) report pain relief after placebo administration. The reason for this is a mystery, but it is one of the many reasons that pain guidelines, position papers, nurse practice acts, and hospital policies nationwide agree that there are no individuals for whom and no condition for which placebos are the recommended treatment. The deceptive use of placebos has both ethical and legal implications, violates the nurse–patient relationship, and inevitably deprives patients of appropriate assessment and treatment (Arnstein et al., 2011; Enck et al., 2017; Lang et al., 2018).

Nonpharmacologic Methods of Pain Management

Most individuals use self-management strategies to deal with their health issues and promote well-being. According to national health information, it is estimated that American adults spent $30.2 billion on complementary health practices to treat painful conditions (O'Conner-Von, Heck, & Peltier, 2018). Nonpharmacologic complementary and alternative interventions include using natural products (e.g., herbs or botanicals, vitamins, probiotics) or using mind and body practices (e.g., acupuncture, behavior-based therapies, chiropractic manipulation, massage therapy, spirituality, yoga, T'ai chi) (HHS, 2019). Table 9-5 lists examples of select complementary and alternative therapies.

Nonpharmacologic therapies are usually effective alone for mild to some moderate-intensity pain. They should not be a replacement or alternative but complement pharmacologic therapies as part of a multimodal approach for more severe pain. The effectiveness of nonpharmacologic methods can be unpredictable, and although not all will relieve pain, they offer many benefits to patients with pain. For example, research suggests that nonpharmacologic methods can facilitate relaxation and reduce anxiety and stress. Many patients find that the use of nonpharmacologic methods helps them cope better with

their pain and feel greater control over the pain experience (HHS, 2019; O'Conner-Von et al., 2018).

Several nonpharmacologic methods can be used in the clinical setting to provide comfort and pain relief for all types of pain; however, time is often limited in this setting for implementation of these methods. Nurses play an important role in providing them and educating patients about their use. Many of the methods are relatively easy for nurses to incorporate into daily clinical practice and may be used individually or in combination with other nonpharmacologic therapies to facilitate patient-centered care utilizing a multimodal approach (HHS, 2019; O'Conner-Von et al., 2018). Chart 9-7 provides points for nurses to consider before using nonpharmacologic methods.

Unfolding Patient Stories: Stan Checketts • Part 1

Stan Checketts, a 52-year-old man, is in the emergency department with severe abdominal pain. The provider has prescribed buprenorphine 0.3-mg IV push for pain. Explain the assessments performed by the nurse prior to, during, and following the administration of the medication. Also consider nonpharmacologic interventions the nurse can incorporate to assist with his pain relief. (Stan Checketts' story continues in Chapter 41.)

Care for Stan and other patients in a realistic virtual environment: *vSim* (**thepoint.lww.com/vSimMedicalSurgical**). Practice documenting these patients' care in DocuCare (**thepoint.lww.com/DocuCareEHR**).

Nursing Implications of Pain Management

The provision of optimal pain management requires a collaborative approach between patients with pain, their families, and members of the health care team. Everyone involved must share common goals, a common knowledge base, and a common language with regard to the antispasmodic agents and nonpharmacologic methods used to manage pain. Whether nurses provide care in the home, hospital, or any other setting, they are in a unique position to coordinate a comprehensive, evidence-based approach to meet the needs of people with pain. Chart 9-8 provides a plan of nursing care for the patient with pain.

Chart 9-8 PLAN OF NURSING CARE

Care of the Patient with Acute Pain

NURSING DIAGNOSIS: Acute Pain
GOAL: Achievement and maintenance of patient's comfort–function goal

Nursing Intervention	Rationale	Expected Outcomes
1. Perform and document a comprehensive pain assessment. a. Use a reliable and valid tool to determine pain intensity. b. Accept the patient's report of pain. c. Assist the patient in establishing a comfort–function goal. d. Apply the Hierarchy of Pain Measures in patients who are unable to report their pain. 2. Administer analgesic agents as prescribed. 3. Offer and educate patient how to use appropriate nonpharmacologic interventions. 4. Reassess for degree of pain relief and presence of adverse effects at peak effect time of intervention. 5. Obtain additional prescriptions as needed. 6. Prevent and treat adverse effects.	1. The comprehensive pain assessment is the foundation of the pain treatment plan; documentation ensures communication between team members. a. The use of valid and reliable tools helps ensure accuracy and consistency in assessment. b. Accepting the patient's report of pain is the undisputed standard of pain assessment. c. The comfort–function goal links function to pain control and provides direction for necessary adjustments in the treatment plan to maximize function. d. The use of the Hierarchy of Pain Measures provides a process to ensure pain	• If able, provides information about the pain • Expresses understanding of the link between function and pain control and establishes a realistic comfort–function goal • Reports a pain intensity that allows participation in important functional activities • If not able to report pain, demonstrates behaviors that indicate pain relief and participation in important functional activities • Expresses satisfaction with the use of nonpharmacologic methods • Tolerates pharmacologic and nonpharmacologic interventions without adverse effects

7. Educate patient and family about the effects of analgesic agents and the goals of care; explain how adverse effects will be prevented and treated; address fears of substance use disorder.	treatment in the patient who cannot report pain. 2. Pharmacologic interventions are the cornerstone of pain management. 3. Nonpharmacologic methods are used to supplement pharmacologic interventions. 4. Reassessment permits evaluation of both the effectiveness and safety of interventions. 5. Prescriptions for additional analgesic agents or adjustment in dose are often needed to maximize pain control. 6. Adverse effects are prevented whenever possible and promptly treated to reduce patient discomfort and prevent harm. 7. An understanding of the treatment plan and goals of care educates patients and their families how to partner with the health care team to optimize pain control.	• Demonstrates an understanding of the treatment plan and goals of care

CRITICAL THINKING EXERCISES

1 ebp An 88-year-old woman arrives in the emergency department following a motor vehicle crash in which she was the restrained front seat passenger. She repeatedly says "owie" and her daughter reports that this is her mom's way of expressing pain. Her daughter also reports that her mother was recently diagnosed with dementia after family members began noticing increasing forgetfulness and confusion at home. When asked to rate the intensity of her pain, the patient replies "owie, yes" but she is not able to easily assign a number to her pain. What pain assessment tool would be most helpful in assessing this patient's pain and in evaluating the effectiveness of interventions? What is the strength of the evidence supporting the assessment tool you selected?

2 pq A 62-year-old woman who has chronic abdominal pain following multiple surgeries resulting from an abusive domestic situation is admitted to the medical floor for reports of worsening pain at home. She reports pain and nausea but denies diarrhea or vomiting. In addition to the 50-mcg fentanyl transdermal patch she has used to control pain at home for the last 2 years, the primary provider has prescribed: 1 mg intravenous hydromorphone every 2 hours PRN pain; promethazine 25 mg IV every 4 hours PRN nausea; lorazepam 0.5 mg IV every 6 hours PRN anxiety; and zolpidem 1.75 mg sublingual nightly prior to sleep. The patient asks you to give her all her medications at the same time so that she can sleep. She asserts that "the nurses always give me the medication that way when I am in the hospital." You are concerned that all these medications are central nervous system depressants and that given together, they could lead to oversedation and possibly result in respiratory depression. How would you prioritize administering the medications that she is requesting and your ongoing assessments to ensure adequate symptom relief while maintaining patient safety and minimizing the risks of adverse outcomes?

3 ipc A 28-year-old man is hospitalized with a diagnosis of an epidural abscess. He reports a 5-year history of daily intravenous self-administration of heroin. He tells you that the oxycodone his primary provider prescribed is "not doing anything" and his pain "is 100/10." How will you collaborate with other members of the interprofessional health care team to manage his pain? Using a multimodal approach for analgesia, what other interventions, both pharmacologic and nonpharmacologic, can the team incorporate into his plan of care to better manage his severe pain?

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

American Academy of Pain Medicine (AAPM), www.painmed.org
American Chronic Pain Association, www.theacpa.org
American Pain Foundation (APF), www.painfoundation.org
American Society for Pain Management Nursing (ASPMN), www.aspmn.org
City of Hope Pain & Palliative Care Resource Center, www.cityofhope.org/
National Center for Complementary and Integrative Health (NCCIH), www.nccih.nih.gov
Pain Treatment Topics, www.pain-topics.org

10 Fluid and Electrolytes

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Differentiate between osmosis, diffusion, filtration, and active transport.
2. Describe the role of the kidneys, lungs, and endocrine glands in regulating the body's fluid composition and volume.
3. Plan effective care of patients with the following imbalances: fluid volume deficit and fluid volume excess, sodium deficit (hyponatremia) and sodium excess (hypernatremia), and potassium deficit (hypokalemia) and potassium excess (hyperkalemia).
4. Describe the cause, clinical manifestations, management, and nursing interventions for the following imbalances: calcium deficit (hypocalcemia) and calcium excess (hypercalcemia), magnesium deficit (hypomagnesemia) and magnesium excess (hypermagnesemia), phosphorus deficit (hypophosphatemia) and phosphorus excess (hyperphosphatemia), and chloride deficit (hypochloremia) and chloride excess (hyperchloremia).
5. Explain the roles of the lungs, kidneys, and chemical buffers in maintaining acid–base balance; and compare metabolic as well as respiratory acidosis and alkalosis with regard to causes, clinical manifestations, diagnosis, and management.
6. Interpret arterial blood gas measurements.

NURSING CONCEPTS

Acid–Base
Cellullar Regulation
Fluids and Electrolytes
Metabolism

GLOSSARY

acidosis: an acid–base imbalance characterized by an increase in H^+ concentration (decreased blood pH) (A low arterial pH due to increased H^+ concentration or reduced bicarbonate concentration is called *metabolic acidosis;* a low arterial pH due to increased PCO_2 is called *respiratory acidosis.*)

active transport: physiologic pump that uses energy to move fluid or electrolytes from one region to another

alkalosis: an acid–base imbalance characterized by a reduction in H^+ concentration or increase in bicarbonate concentration (increased blood pH) (A high arterial pH with either decreased H^+ ion concentration or increased bicarbonate concentration is called *metabolic alkalosis;* a high arterial pH due to reduced PCO_2 is called *respiratory alkalosis.*)

colloid: a fluid containing particles that are nonsoluble and evenly distributed throughout the solution

colloid oncotic pressure: osmotic pressure created by the protein (mainly albumin) in the bloodstream (*synonym:* colloidal osmotic pressure)

crystalloid: a fluid containing soluble mineral ions and water in solution

diffusion: the process by which solutes move from an area of higher concentration to one of lower concentration; does not require expenditure of energy

homeostasis: maintenance of a constant internal equilibrium in a biologic system

hydrostatic pressure: the pressure created by the weight of fluid against the wall that contains it. In the body, hydrostatic pressure in blood vessels results from the weight of fluid itself and the force resulting from cardiac contraction (*synonym:* hydraulic pressure)

hypertonic solution: a solution with an osmolality higher than that of serum

hypotonic solution: a solution with an osmolality lower than that of serum

isotonic solution: a solution with the same osmolality as blood

osmolality: the number of milliosmoles (the standard unit of osmotic pressure) per kilogram of solvent; expressed as milliosmoles per kilogram (mOsm/kg). (The term *osmolality* is used more often than *osmolarity* to evaluate serum and urine.)

osmolarity: the number of milliosmoles (the standard unit of osmotic pressure) per liter of solution; expressed as milliosmoles per liter (mOsm/L); describes the concentration of solutes or dissolved particles

osmosis: the process by which fluid moves across a semipermeable membrane from an area of low solute concentration to an area of high solute concentration; the process continues until the solute concentrations are equal on both sides of the membrane

tonicity: fluid tension or the effect that osmotic pressure of a solution with impermeable solutes exerts on cell size because of water movement across the cell membrane

Fluid and electrolyte balance are dependent on dynamic processes that are crucial for life and **homeostasis** (the maintenance of a constant internal equilibrium in a biologic system). Potential and actual disorders of fluid and electrolyte balance occur in every setting, with every disorder, and with a variety of changes that affect healthy people as well as those who are ill.

Nurses need to understand the physiology of fluid and electrolyte balance and acid–base balance to anticipate, identify, and respond to imbalances. Maintaining the balance of fluid and electrolytes is crucial to the care of patients of every age and in every clinical setting.

Fundamental Concepts

Basic concepts of chemistry are involved in fluid and electrolyte balance and imbalance. A solution is a mixture of solvent, which is a fluid medium, and solutes, which are particles. Blood is composed of blood cells that are suspended in plasma. The blood cells include erythrocytes, leukocytes, and platelets. Plasma is composed of 92% water, which is a solvent that contains solutes including proteins (mainly albumin), glucose, lipoproteins, and mineral ions, termed electrolytes.

Amount and Composition of Body Fluids

Approximately 60% of a typical adult's weight consists of fluid (water and electrolytes) (Fig. 10-1). Factors that influence the amount of body fluid are age, gender, and body fat. In general, younger people have a higher percentage of body fluid than older adults, and men have proportionately more body fluid than women. The skeleton has low water content. Muscle, skin, and blood contain the highest amounts of water (Norris, 2019).

Body fluid is located in two fluid compartments: the intracellular space (fluid in the cells) and the extracellular space (fluid outside the cells). Approximately two thirds of body fluid is in the intracellular fluid (ICF) compartment. Approximately one third is in the extracellular fluid (ECF) compartment (Norris, 2019).

The ECF compartment is further divided into the intravascular (blood), interstitial, and transcellular fluid spaces:

- The intravascular space (the fluid within the blood vessels) contains plasma, the effective circulating volume. Approximately 3 L of the average 6 L of blood volume in adults is made up of plasma. The remaining 3 L is made up of the blood cells: erythrocytes, leukocytes, and thrombocytes (platelets).
- The interstitial space contains the fluid that surrounds the cell and totals about 11 to 12 L in an adult. Lymph is an interstitial fluid.
- The transcellular space is the smallest division of the ECF compartment and contains approximately 1 L. Examples of transcellular fluids include cerebrospinal, pericardial, synovial, intraocular, and pleural fluids, sweat, and digestive secretions.

As the next section describes, the ECF transports electrolytes; it also carries other substances, such as enzymes and hormones.

Body fluid normally moves between the two major compartments (i.e., ICF and ECF) in an effort to maintain equilibrium between the spaces. A semipermeable membrane surrounding each of the cells allows certain fluids and electrolytes to move between the ICF and ECF. Loss of fluid from the ICF or ECF can disrupt equilibrium. The body constantly works to keep fluid and electrolytes in a homeostatic balance. If too much fluid moves from ICF to ECF, cellular dehydration can occur. If too much fluid moves from ECF to ICF, cell swelling can occur (Papadakis, McPhee, & Rabow, 2019).

Sometimes fluid is not lost from the body but is unavailable for use by either the ICF or ECF. Loss of ECF into a space that does not contribute to equilibrium between the ICF and the ECF is referred to as a third-space fluid shift, or third spacing. Third-space fluid accumulates within membrane-bound spaces in the body such as the peritoneal cavity and pleural space. Examples of third-spaced fluid include ascites, pleural effusion, pericardial effusion, and angioedema (Papadakis et al., 2019).

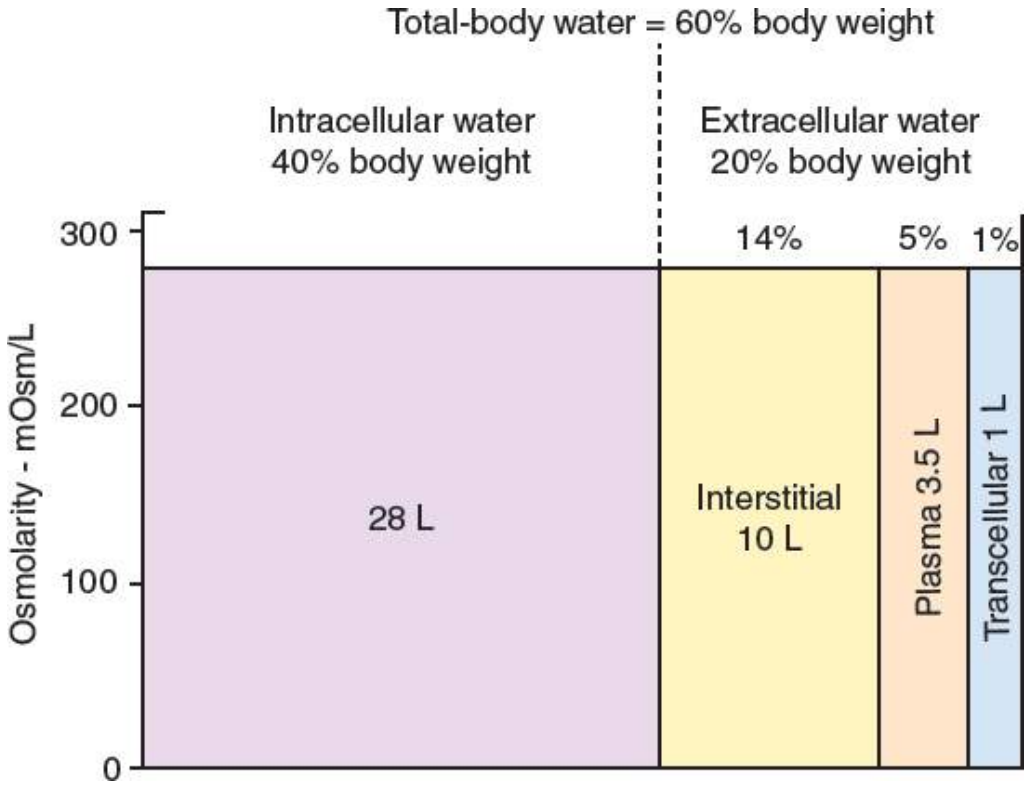

Figure 10-1 • Approximate sizes of body compartments in a 70-kg adult. Reprinted with permission from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed., Fig. 8-4, p. 162). Philadelphia, PA: Wolters Kluwer.

Early evidence of a third-space fluid shift is a decrease in urine output despite adequate fluid intake. Urine output decreases because fluid shifts out of the intravascular space; the kidneys then receive less blood and attempt to compensate by decreasing urine output. Other signs and symptoms of third spacing that indicate an intravascular fluid volume deficit (FVD) include increased heart rate, decreased blood pressure, decreased central venous pressure, edema, increased body weight, and imbalances in fluid intake and output (I&O). Third-space fluid is reabsorbed back into the bloodstream over a period of a few days to a few weeks. However, the acute volume depletion must be restored to prevent further complications (Sterns, 2017a).

Electrolytes

Electrolytes in body fluids are active chemicals (cations that carry positive charges and anions that carry negative charges). The major cations in body fluid are sodium, potassium, calcium, magnesium, and hydrogen ions. The major anions are chloride, bicarbonate, phosphate, sulfate, and negatively charged protein ions.

These chemicals unite in varying combinations. Therefore, electrolyte concentration in the body is expressed in terms of milliequivalents (mEq) per

liter, a measure of chemical activity, rather than in terms of milligrams (mg), and a unit of weight. More specifically, a milliequivalent is defined as being equivalent to the electrochemical activity of 1 mg of hydrogen. In a solution, cations and anions are equal in milliequivalents per liter.

Electrolyte concentrations in the ICF differ from those in the ECF, as reflected in Table 10-1. Because special techniques are required to measure electrolyte concentrations in the ICF, it is customary to measure the electrolytes in the most accessible portion of the ECF—namely, the plasma (Norris, 2019).

Sodium ions, which are positively charged, far outnumber the other cations in the ECF. Because sodium concentration affects the overall concentration of the ECF, sodium is important in regulating the volume of body fluid. Water follows movement of sodium in the body fluids. Retention of sodium is associated with fluid retention, and excessive loss of sodium is usually associated with decreased volume of body fluid.

As shown in Table 10-1, one of the major electrolytes in the ICF is potassium. The ECF has a low concentration of potassium, and patients can tolerate only small changes in potassium concentration. Changes in potassium within the ECF can cause cardiac rhythm disturbances and hyperkalemia can cause cardiac arrest. Therefore, the release of large stores of intracellular potassium, typically caused by trauma to the cells and tissues, can be extremely dangerous.

The body expends a great deal of energy maintaining the high extracellular concentration of sodium and the high intracellular concentration of potassium. It does so by means of a cell membrane pump that exchanges sodium and potassium ions, termed the sodium–potassium pump (see discussion later in this chapter).

Osmosis, Osmolality, and Osmolarity

When two different solutions are separated by a membrane that is semi-permeable; fluid shifts from the region of less concentrated solution to a more concentrated solution, until the solutions are of equal concentration. This diffusion of water caused by fluid and solute concentration gradients is known as **osmosis** (Fig. 10-2). Osmolality and osmolarity are terms that describe the concentration of solutes or dissolved particles in a solution. **Osmolality** is the number of milliosmoles of solute (the standard unit of osmotic pressure) per kilogram of solvent; it is expressed as milliosmoles per kilogram (mOsm/kg). **Osmolarity** is the number of milliosmoles (the standard unit of osmotic pressure) per liter of solution; it is expressed as milliosmoles per liter (mOsm/L). The term *osmolality* is used more often than *osmolarity* to evaluate the solutes in the blood or urine (Emmett & Palmer, 2018a).

Regulation of Fluid within the Body Compartments

Normal movement of fluids through the capillary wall into the tissues depends on Starling's Laws of Capillary Forces. Capillary forces are the two forces at every capillary membrane: hydrostatic pressure (also called hydraulic pressure) and osmotic pressure. **Hydrostatic pressure** is the pressure exerted by fluid on the walls of the blood vessel, and osmotic pressure is the pressure exerted by the solutes within the plasma. Hydrostatic pressure pushes fluid out of the capillary toward the ICF. Osmotic pressure pulls fluid into the capillary from the ICF. These forces oppose each other at every capillary membrane and balance each other out in healthy (homeostatic) conditions. The direction of fluid movement depends on the differences in the two opposing forces of hydrostatic and osmotic pressure (Fig. 10-3). If hydrostatic pressure is greater than osmotic pressure, then the movement of fluid is from ECF toward the ICF.

TABLE 10-1 Concentrations of Extracellular and Intracellular Electrolytes in Adults

Electrolyte	Extracellular Concentration*		Intracellular Concentration*	
	Conventional Units	SI Units (mmol/L)	Conventional Units	SI Units (mmol/L)
Sodium	135–145 mEq/L	135–145	10–14 mEq/L	10–14
Potassium	3.5–5.0 mEq/L	3.5–5.0	140–150 mEq/L	140–150
Chloride	98–106 mEq/L	98–106	3–4 mEq/L	3–4
Bicarbonate	24–31 mEq/L	24–31	7–10 mEq/L	7–10
Calcium	8.8–10.5 mg/dL	2.2–2.6	<1 mEq/L	<0.25
Phosphorus	2.5–4.5 mg/dL	0.8–1.45	Variable	Variable
Magnesium	1.8–3.6 mg/dL	0.75–1.07	40 mEq/kg†	20

*Values may vary among laboratories, depending on the method of analysis used.
†Values vary among various tissues and with nutritional status.
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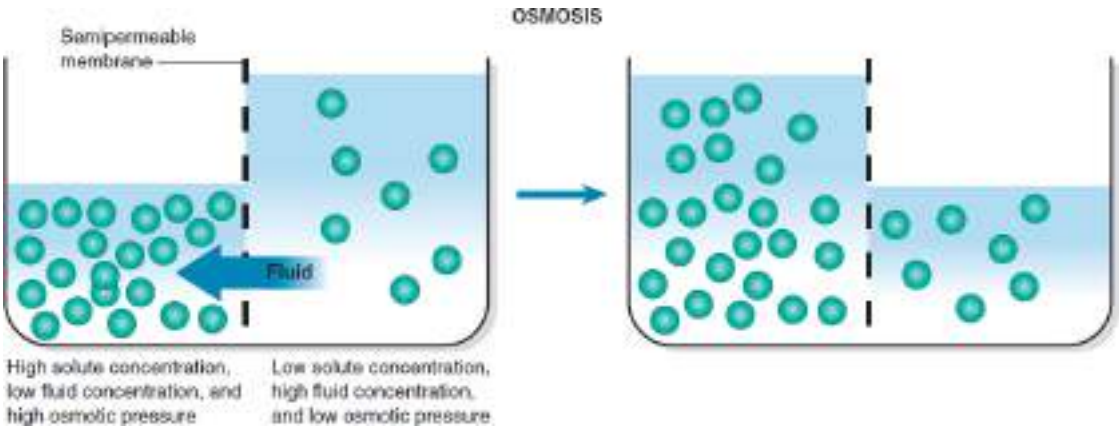

Figure 10-2 • Osmosis: when two different solutions are separated by a semi-permeable fluid shifts from the region of less concentrated solution to a more concentrated solution, until the solutions are of equal concentration.

Oncotic Pressure

Osmotic pressure specifically exerted by the albumin within the bloodstream is termed **colloid oncotic pressure** or **colloid osmotic pressure.** A **colloid** is fluid consisting of nonsoluble substances that are evenly distributed within a solvent. Blood is an example of a colloid solution. It is a mixture of blood cells and plasma which contains water, proteins, enzymes, and other solutes.

Crystalloid versus Colloid Solutions

Fluid replacement in the body depends on what type of fluid is lost. If a large amount of blood is lost, for example, the preferred treatment is replacement with matching blood (commonly packed red blood cells). However, crystalloid or colloid solutions can be used to temporarily replace blood or replenish fluid losses from the body. **Crystalloid** solutions are mineral ions dissolved in water. Examples include normal saline (0.9% NaCl), half normal saline (0.45% NaCl), and lactated Ringer's solution (Plasma-Lyte). Crystalloid solutions are commonly used to replace fluid in hypovolemia. Examples of colloid solutions include albumin solutions, hyperoncotic starch, and dextran. Colloid solutions are commonly used as temporary blood replacement until the correct type of blood is available for infusion (Mandel & Palevsky, 2019).

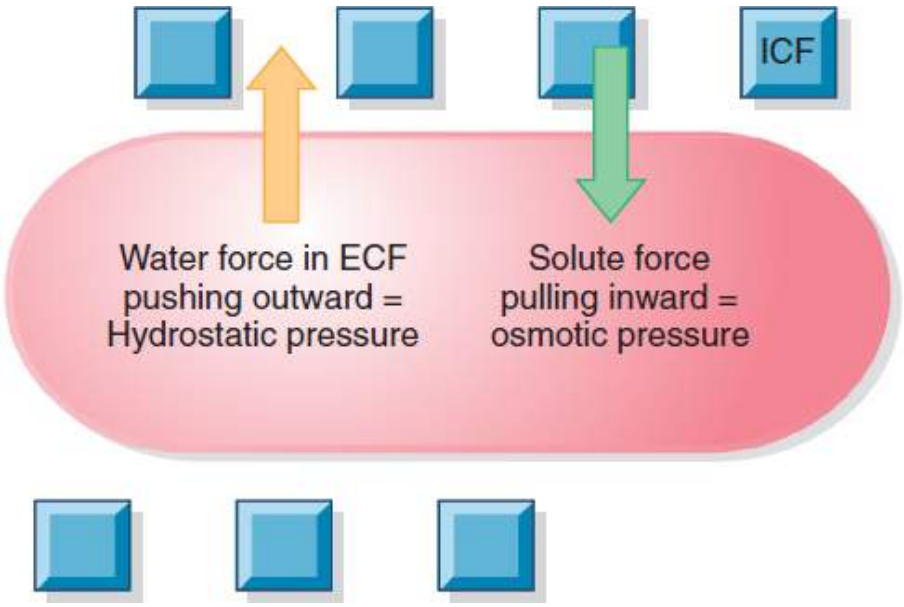

Figure 10-3 • The forces of osmotic and hydrostatic pressure constantly oppose each other. ECF, extracellular fluid; ICF, intracellular fluid.

Tonicity

Tonicity is the ability of solutes to cause an osmotic driving force that promotes water movement from one compartment to another. Movement of water is either from ICF to ECF or ECF to ICF. The tonicity of a solution can be used to drive water movement between compartments to change the state of cellular hydration and cell size. Tonicity most commonly refers to the NaCl content of the solution. The tonicity of a solution is determined by how it compares to physiologic fluid which is 0.9% NaCl (Sterns, 2017b). Fluids can be isotonic, hypotonic, or hypertonic compared to physiologic fluid of 0.9% NaCl.

Tonicity commonly pertains to intravenous (IV) solutions. IV solutions of different tonicities can be infused into the bloodstream to produce movement of water from one compartment to the other.

Isotonic solutions are composed of 0.9% NaCl; the same sodium and chloride concentration as the bloodstream and the same water concentration as the bloodstream. Isotonic solutions do not provoke water movement between ICF or ECF compartments. Isotonic solutions expand the plasma volume of the blood (Sterns, 2017b).

Hypotonic solutions are composed of less sodium chloride concentration compared to the blood; for example, 0.45% NaCl or 0.225% NaCl. Hypotonic solutions contain less solute but more water than the bloodstream. IV hypotonic solution infusions can be used to move water from the ECF into the ICF. IV hypotonic solutions can be used to hydrate a patient as they contain high water concentration (Sterns, 2017b).

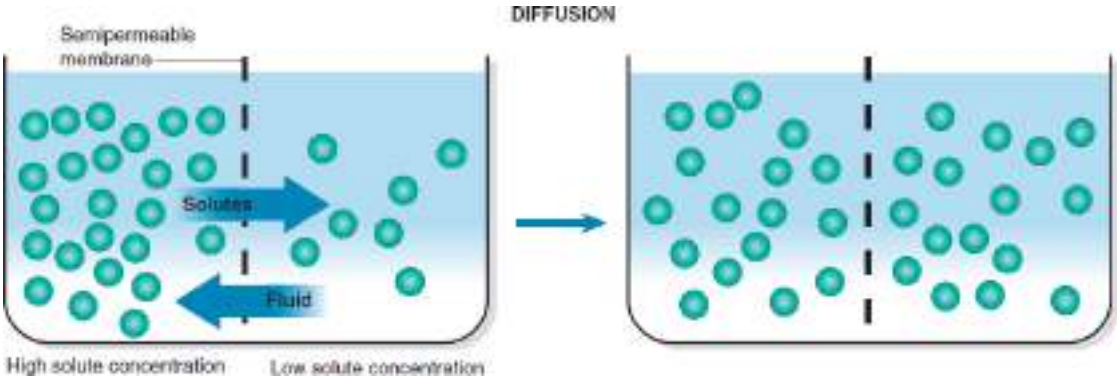

Figure 10-4 • Diffusion: movement of solutes from an area of greater concentration to an area of lesser concentration, leading ultimately to equalization of the solute concentrations.

Hypertonic solutions are composed of greater concentration of NaCl compared to blood (e.g., 3% NaCl). Hypertonic solutions contain more solute concentration and less water than the bloodstream. IV hypertonic solution can be infused into the bloodstream to pull water from the ICF into the ECF. The movement of water from ICF to ECF will cause dehydration of the cells. This is useful in disorders of severe edema; particularly cerebral edema, which requires immediate treatment. Sodium, glucose, and mannitol are examples of solutes capable of affecting water movement from ICF to ECF. Mannitol, a nonresorbable sugar alcohol, in water is an IV solution that can be used to move water from ICF to ECF rapidly. IV mannitol can induce a condition termed osmotic diuresis; it is most commonly used to decrease cerebral edema (Brater & Ellison, 2019). (See discussion of parenteral therapy later in this chapter.)

Osmotic diuresis is the increase in urine output caused by the excretion of solutes, such as glucose or mannitol. In high concentrations, glucose or mannitol can act as solutes within the bloodstream. These solutes exert a force that pulls water out of the ICF and brings it into the ECF (bloodstream). The water then is filtered out of the bloodstream at the kidneys and excreted into the urine. The urine contains extra water that is derived from the ICF; this increased urine volume is called diuresis (Brater & Ellison, 2019).

Diffusion

Diffusion is the natural tendency of a substance to move from an area of higher concentration to one of lower concentration (Fig. 10-4). It occurs through the random movement of ions and molecules. Examples of diffusion are the exchange of oxygen (O_2) and carbon dioxide (CO_2) between the pulmonary capillaries and alveoli and the tendency of sodium to move from the ECF compartment, where the sodium concentration is high, to the ICF, where its concentration is low (Hall, 2016).

Filtration

Hydrostatic pressure in the capillaries tends to filter fluid out of the intravascular compartment into the interstitial fluid. Movement of water and solutes occurs from an area of high hydrostatic pressure to an area of low hydrostatic pressure. The kidneys filter approximately 180 L of plasma per day. Another example of filtration is the passage of water and electrolytes from the capillary bed to the interstitial fluid; in this instance, the hydrostatic pressure results from the pumping action of the heart (Hall, 2016).

Sodium–Potassium Pump

The sodium concentration is greater in the ECF than in the ICF; because of this, sodium tends to enter the cell by diffusion. To maintain cellular function, more potassium needs to be inside the cell and more sodium needs to be outside the cell. The sodium–potassium pump maintains the electrolyte gradient of high extracellular Na^+ compared to low intracellular Na^+, and high intracellular K^+ compared to low extracellular K^+. The pump maintains the different concentrations of cations Na^+ and K^+ in and out of the cell. For every 3 Na^+ pumped out of the cell, 2 K^+ ions are pumped into the cell (Pirahanchi & Aeddula, 2019).

The sodium–potassium pump uses energy to maintain this electrolyte gradient and is powered by the enzyme termed Na^+K^+-ATPase. The sodium–potassium pump performs **active transport** which actively moves sodium from the ICF into the ECF and actively moves potassium from the ECF to the ICF. Active transport is the use of energy to create movement against a concentration gradient (Hall, 2016; Norris, 2019).

Systemic Routes of Gains and Losses

Water and electrolytes are gained in various ways. Healthy people gain fluids by drinking and eating, and their daily average intake and output (I & O) of water are approximately equal (Table 10-2).

TABLE 10-2 Sources of Body Water Gains and Losses in the Adult

Intake (mL)		Output (mL)	
Oral intake		Urine	1500
As water	1000	Insensible losses	
In food	1300	Lungs	300
Water of oxidation	200	Skin	500
		Feces	200
Total gain[a]	2500	Total loss[a]	2500

[a]Approximate volumes.

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health state* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Kidneys

The daily urine volume excreted by the adult varies according to hydration status. A well-hydrated person excretes 1 to 2 L urine per day. A general rule is that the output is approximately 1 mL of urine per kilogram of body weight per hour (1 mL/kg/h) in all age groups (Sterns, 2017a). For example, a 70-kg adult will excrete 70 mL/h; over 24 hours this equals approximately 1680 mL of urine.

Skin

Perspiration is visible water and electrolyte loss through the skin (sweating). The chief solutes in sweat are sodium, chloride, and potassium. Actual sweat losses can vary from 0 to 1000 mL or more every hour, depending on factors such as the environmental and body temperature. Continuous water loss by evaporation through the skin (approximately 500 mL/day) occurs through perspiration, referred to as insensible water loss (Norris, 2019). Fever, high environmental temperature, and exercise greatly increase insensible water loss through the skin. Burn injury, which causes the loss of the natural skin barrier, also causes a large water loss (Sterns, 2017b).

Lungs

The lungs normally eliminate water vapor, also referred to as insensible water loss, at a rate of approximately 300 mL daily (Norris, 2019). The loss is much greater with increased respiratory rate or depth, or in a dry climate. Similar to water loss through the skin, fever, high environmental temperature, and exercise all increase insensible water loss through the lungs.

Gastrointestinal Tract

Loss of fluid from the gastrointestinal (GI) tract is about 100 to 200 mL daily. Approximately 8 L of fluid circulates through the GI system every 24 hours.

However, most of the fluid is reabsorbed into the bloodstream from the small intestine. Diarrhea and fistulas of the intestine can cause large losses of fluids (Sterns, 2018a).

Quality and Safety Nursing Alert

When fluid balance is critical, all routes of systemic gain and loss must be recorded and all volumes compared. Organs of fluid loss include the kidneys, skin, lungs, and GI tract.

Laboratory Tests for Evaluating Fluid Status

Serum osmolality primarily reflects the concentration of sodium, although blood urea nitrogen (BUN) and glucose also play a major role in determining serum osmolality. Urine osmolality is determined by urea, creatinine, and uric acid. When measured with serum osmolality, urine osmolality is the most reliable indicator of urine concentration. In healthy adults, normal serum osmolality is 275 to 290 mOsm/kg (Emmett & Palmer, 2018a). The value of osmolarity is usually within 10 mOsm of the value of osmolality (Emmett & Palmer, 2018a). Factors that increase and decrease serum and urine osmolality are identified in Table 10-3. Serum osmolality may be measured directly through laboratory tests or estimated at the bedside by doubling the serum sodium level or by using the following formula:

$$Na^{+} \times 2 = \frac{\text{Glucose}}{18} + \frac{\text{BUN}}{3} = \text{Approximate value of serum osmolality}$$

Urine specific gravity measures the density of urine compared to water. It is a measure of the concentration of solutes in the urine. It is one way to assess the kidneys' ability to excrete or conserve water. The specific gravity of urine is compared to that of distilled water, which has a specific gravity of 1.000. The normal range of urine specific gravity is 1.005 to 1.030 (Van Leeuwen & Bladh, 2017). Urine with a specific gravity of 1.005 is very dilute or high in water content, whereas urine with a specific gravity of 1.030 is very concentrated or low in water content. Under normal conditions, a well-hydrated person excretes urine with a low specific gravity, whereas a dehydrated person excretes urine with high specific gravity. Urine specific gravity can be measured by sending approximately 20 mL of urine to the laboratory for urinalysis testing or assessed using a urine dipstick test. Specific gravity is a less reliable indicator of urine concentration than urine osmolality; increased glucose or protein in urine can cause a falsely elevated specific

gravity. Factors that increase or decrease urine osmolality are the same as those for urine specific gravity (Sterns, 2017a).

TABLE 10-3 Factors Affecting Serum and Urine Osmolality

Fluid	Factors Increasing Osmolality	Factors Decreasing Osmolality
Serum (275–290 mOsm/kg water)	Severe dehydration Free water loss Diabetes insipidus Hypernatremia Hyperglycemia Stroke or head injury Acute tubular necrosis Consumption of methanol or ethylene glycol (antifreeze) High ion gap metabolic acidosis Mannitol therapy Advanced liver disease Alcoholism Burns	Fluid volume excess Syndrome of inappropriate antidiuretic hormone (SIADH) Acute kidney injury Diuretic use Adrenal insufficiency Hyponatremia Overhydration Paraneoplastic syndrome associated with lung cancer
Urine (200–800 mOsm/kg water)	Fluid volume deficit SIADH Congestive heart failure Acidosis Prerenal kidney injury	Fluid volume excess Diabetes insipidus Hyponatremia Aldosteronism Pyelonephritis Acute tubular necrosis

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Wolters Kluwer.

BUN is a laboratory value that measures the amount of urea in the bloodstream. The normal range of BUN is 10 to 20 mg/dL (3.6 to 7.2 mmol/L). BUN level can vary with renal function, amount of cellular breakdown, protein intake, and hydration status. If urine output decreases, as occurs in renal dysfunction, then urea is not excreted and accumulates in the bloodstream causing an increase. Increased BUN can also occur if water content in the bloodstream decreases due to dehydration. If a person is consuming a high protein diet, there is an increased amino acid content in the bloodstream, which in turn increases nitrogen content of the blood, thereby increasing BUN (Inker & Perrone, 2018).

Additional factors that increase BUN include GI bleeding, fever, and sepsis. Factors that decrease BUN include end-stage liver disease, a low protein diet, starvation (due to low protein), and any condition that results in expanded fluid volume which dilutes urea in the blood (e.g., pregnancy). Because of all these variables, BUN is not an optimal gauge of kidney function (Inker & Perrone, 2018).

Creatinine is a breakdown product of muscle metabolism that is almost totally cleared from the bloodstream and excreted by the kidney. It is a better indicator of renal function than BUN because it does not vary with protein intake or hydration status. The normal serum creatinine is approximately 0.7 to 1.4 mg/dL (62 to 124 mmol/L); however, its concentration depends on lean body mass and varies from person to person. Serum creatinine levels increase when renal function decreases in most people and is an accurate gauge of kidney function (Norris, 2019).

Hematocrit measures the percentage of red blood cells (RBCs) (erythrocytes) in a volume of whole blood and normally ranges from 42% to 52% in men and 35% to 47% in women. Conditions that increase the hematocrit value are dehydration and polycythemia. Dehydration causes decreased water content of the blood which concentrates the RBCs in the bloodstream. Polycythemia is a disorder in which there is an abnormally high number of RBCs made by the bone marrow, which in turn increases the number of RBCs in the bloodstream. Conversely, over hydration (which increases the volume of water within the bloodstream) will decrease the hematocrit. Anemia (which is a lack of sufficient production of RBCs by the bone marrow) causes decreased hematocrit (Schrier, 2018).

Urine sodium values change with sodium intake and the status of fluid volume: As sodium intake increases, excretion increases; as the circulating fluid volume decreases, sodium is conserved. Normal urine sodium levels range from 75 to 200 mEq/24 h (75 to 200 mmol/24 h). A random specimen usually contains more than 40 mEq/L of sodium. Urine sodium levels are used to assess volume status and are useful in the diagnosis of hyponatremia and acute kidney injury (Sterns, 2017a).

Homeostatic Mechanisms

The body is equipped with remarkable homeostatic mechanisms to keep the composition and volume of body fluid within narrow limits of normal. Organs involved in homeostasis include the kidneys, heart, lungs, pituitary gland, adrenal glands, and parathyroid glands (Norris, 2019).

Kidney Functions

Vital to the regulation of fluid and electrolyte balance, the kidneys normally filter 180 L of plasma every day in the adult and excrete 1 to 2 L of urine (Inker & Perrone, 2018). They act both autonomously and in response to hormones, such as aldosterone and antidiuretic hormone (ADH) (Norris, 2019). Major functions of the kidneys in maintaining normal fluid balance include the following:

- Regulation of ECF volume and osmolality by selective retention and excretion of body fluids

- Regulation of normal electrolyte levels in the ECF by selective electrolyte retention and excretion of hydrogen ions
- Regulation of pH of the ECF by retention and excretion of hydrogen ions
- Excretion of metabolic wastes and toxic substances (Inker & Perrone, 2018)

Given these functions, failure of the kidneys results in multiple fluid and electrolyte abnormalities.

Heart and Blood Vessel Functions

The pumping action of the heart circulates blood through the kidneys under sufficient pressure to allow for urine formation. Failure of this pumping action interferes with renal perfusion and thus with water and electrolyte regulation.

Lung Functions

The lungs are also vital in maintaining homeostasis. Through exhalation, the lungs remove approximately 300 mL of water daily in the normal adult as insensible water loss (Sterns, 2017a). Abnormal conditions, such as hyperventilation (abnormally deep respiration) or continuous coughing, increase this water loss. The lungs also play a major role in acid–base balance. Because the lungs regulate carbon dioxide (CO_2), which directly influences acid content of the bloodstream, they influence acid–base balance. When the lungs have a decrease in breathing rate, CO_2 is retained in the alveoli and bloodstream, which increases acid content of the blood. When the lungs have an increase in breathing rate, CO_2 is blown off, lost from the bloodstream, which decreases acid content of the blood (Norris, 2019).

Pituitary Functions

The hypothalamus manufactures ADH, which is stored in the posterior pituitary gland and released as needed to conserve water. ADH is secreted by the pituitary gland in reaction to dehydration or blood loss and acts at the nephrons. At the collecting duct of the nephron, ADH causes increased reabsorption of water from the tubules into the bloodstream (Norris, 2019). This increases the water content of the bloodstream (Fig. 10-5).

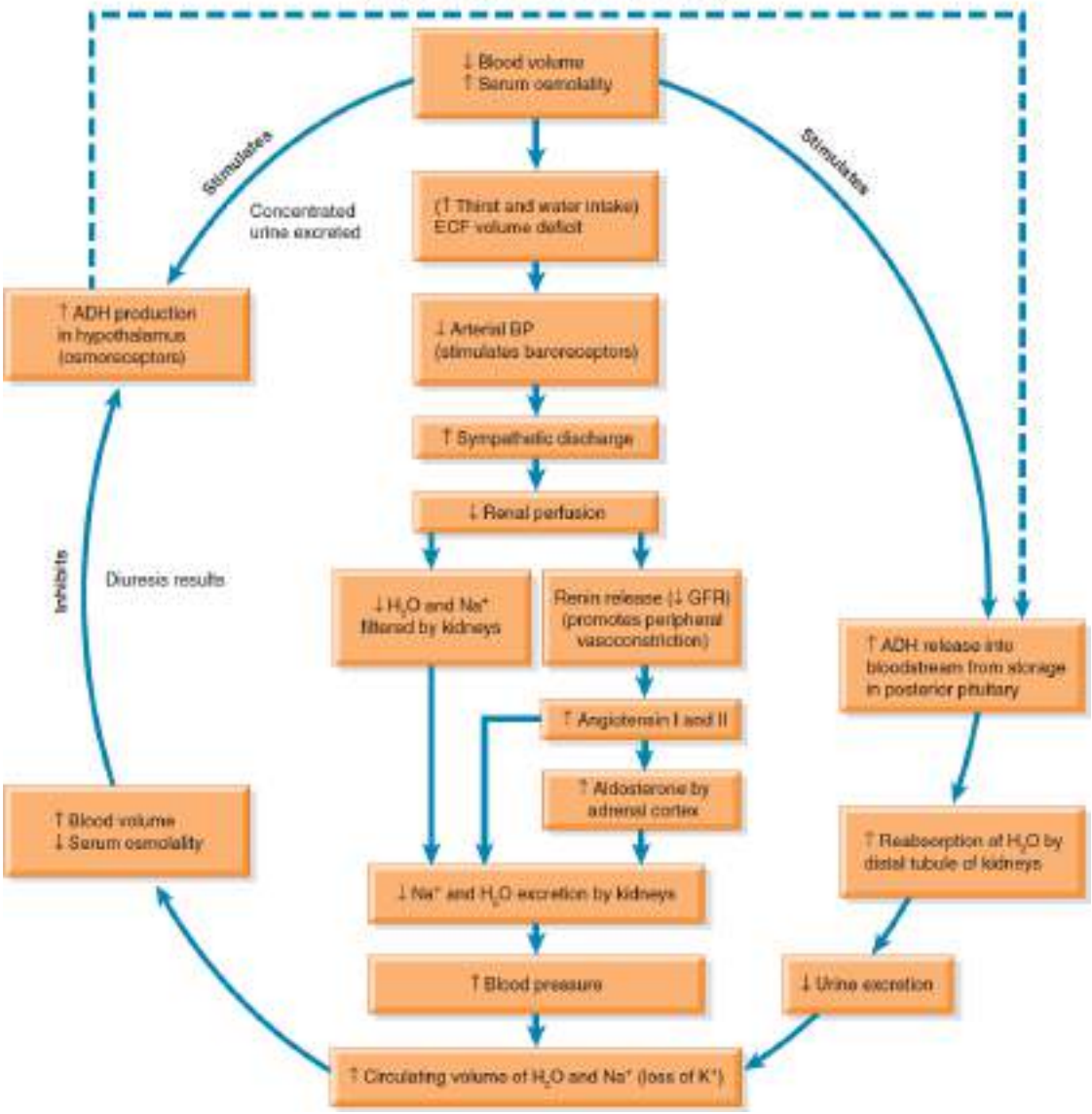

Figure 10-5 • Fluid regulation cycle. ADH, antidiuretic hormone; BP, blood pressure; ECF, extracellular fluid; GFR, glomerular filtration rate.

Adrenal Functions

Aldosterone, a mineralocorticoid secreted by the zona glomerulosa (outer zone) of the adrenal cortex, has a profound effect on fluid balance. Increased secretion of aldosterone causes sodium retention (and thus water retention) and potassium loss. Conversely, decreased secretion of aldosterone causes sodium and water loss and potassium retention.

Cortisol, another adrenocortical hormone, has less mineralocorticoid action. However, when secreted in large quantities (or administered as corticosteroid therapy), it can also produce sodium and fluid retention (Norris, 2019).

Parathyroid Functions

The parathyroid glands, embedded in the thyroid gland, regulate calcium and phosphate balance by means of parathyroid hormone (PTH). PTH influences reabsorption of calcium from the bones into the bloodstream, calcium absorption from the intestine, and calcium reabsorption into the bloodstream from the renal tubules (Norris, 2019).

Baroreceptors

The baroreceptors are located in the left atrium and the carotid and aortic arches. These receptors respond to changes in the circulating blood volume and regulate sympathetic and parasympathetic neural activity as well as endocrine activities.

As arterial pressure decreases, baroreceptors transmit fewer impulses from the carotid and the aortic arches to the vasomotor center. A decrease in impulses stimulates the sympathetic nervous system, which stimulates the sinoatrial (SA) node in the heart. The outcome is an increase in heart rate, conduction, and contractility and an increase in blood pressure. Sympathetic stimulation constricts renal arterioles, which in turn triggers renin release and stimulation of the renin–angiotensin–aldosterone system (see next section for further discussion) (Hall, 2016).

Renin–Angiotensin–Aldosterone System

When the kidneys sense low perfusion or diminished blood pressure, they secrete renin from the juxtaglomerular apparatus, which triggers the renin–angiotensin–aldosterone system. This system is one of the body's most important compensatory mechanisms in maintaining fluid balance. Renin circulates to the liver and converts angiotensinogen, a protein synthesized by the liver, into angiotensin I. Angiotensin-converting enzyme (ACE) converts angiotensin I to angiotensin II. Angiotensin II stimulates potent peripheral arterial vasoconstriction which increases arterial blood pressure. Angiotensin II also stimulates the adrenal gland to secrete aldosterone. Aldosterone increases sodium and water reabsorption at the nephron into the bloodstream. This raises blood volume and blood pressure. Aldosterone also stimulates secretion of potassium into the nephron tubules, which in turn causes potassium excretion by the kidney (Norris, 2019).

Antidiuretic Hormone and Thirst

ADH and the thirst mechanism have important roles in maintaining sodium concentration and oral intake of fluids. Oral intake is controlled by the thirst center located in the hypothalamus. As serum concentration or osmolality increases or blood volume decreases, neurons in the hypothalamus are stimulated by intracellular dehydration; thirst then occurs, and the person

increases their intake of oral fluids. When increased osmolality is sensed by the brain, the posterior pituitary is stimulated to release ADH. ADH acts at the kidney nephrons to increase water reabsorption into the bloodstream. ADH raises blood volume and decreases urine output (Hall, 2016; Norris, 2019).

Osmoreceptors

Located on the surface of the hypothalamus, osmoreceptors sense changes in sodium concentration. As osmotic pressure increases, the neurons become dehydrated and quickly release impulses to the posterior pituitary, which increases the release of ADH, which then travels in the blood to the kidneys, where it alters permeability to water, causing increased reabsorption of water and decreased urine output. The retained water dilutes the ECF and returns its concentration to normal. Restoration of normal osmotic pressure provides feedback to the osmoreceptors to inhibit further ADH release (Hall, 2016) (see Fig. 10-5).

Natriuretic Peptides

Natriuretic peptide hormones affect fluid volume and cardiovascular function through natriuresis (the excretion of sodium), direct vasodilation, and the opposition of the renin–angiotensin–aldosterone system. The most common natriuretic peptides include atrial natriuretic peptide (ANP), brain natriuretic peptide (BNP), and *N*-terminal fragment of pro-brain natriuretic peptide (NT-pro BNP) (Chen & Colucci, 2017). ANP is synthesized, stored, and released by muscle cells of the atria of the heart. BNP and NT-pro BNP are released mainly by ventricular muscle cells of the heart. BNP and NT-pro BNP levels are often measured in the clinical diagnosis and management of heart failure (see Chapter 25). NT-pro BNP has a longer half-life than BNP, so its level remains elevated in the bloodstream for a longer period of time than BNP. Natriuretic peptides are also secreted in other disorders including renal failure, coronary heart disease, valvular heart disease, constrictive pericarditis, pulmonary hypertension, and sepsis. Natriuretic peptides decrease water and sodium in the circulatory system which in turn decreases blood pressure. Their action is directly opposite that of the renin–angiotensin–aldosterone system (Fig. 10-6).

There are two other natriuretic peptides that are not usually measured clinically. C-type natriuretic peptide (CNP) is distributed within the brain, ovary, uterus, testis, and epididymis. D-type natriuretic peptide (DNP) has structural similarities to ANP, BNP, and CNP.

Gerontologic Considerations

Normal physiologic changes of aging include reduced cardiac, renal, and respiratory function. Body fat changes, body water content decreases, and muscle mass decreases. These changes of aging may alter the older adult's responses to fluid and electrolyte changes and acid–base disturbances. Decreased respiratory function and renal function can cause impaired acid–base balance in older adults with major illness or trauma. Decreased renal function that occurs with age can also cause slightly elevated serum creatinine. Decreased muscle mass that occurs with aging leads to decreased daily breakdown of muscle, which reduces serum creatinine. Therefore, high–normal and minimally elevated serum creatinine values may indicate substantially reduced renal function in older adults (Cash & Glass, 2018).

In addition, the use of multiple medications by older adults can affect renal and cardiac function and body water content, thereby increasing susceptibility to fluid and electrolyte disturbances. Routine procedures, such as the vigorous administration of laxatives or enemas before colon x-ray studies, may produce a serious FVD, necessitating the use of IV fluids to prevent hypotension and other effects of hypovolemia.

Alterations in fluid and electrolyte balance that may produce minor changes in young and middle-aged adults may produce profound changes in older adults. In many older patients, the clinical manifestations of fluid and electrolyte disturbances may be subtle or atypical. For example, fluid deficit may not trigger thirst sensation and can lead to delirium in the older adult (see Chapter 8). Rapid infusion of an excessive volume of IV fluids can cause fluid overload and cardiac failure in older patients. These reactions are likely to occur more quickly and with the administration of smaller volumes of fluid than in healthy young and middle-aged adults because of the decreased cardiac reserve and reduced renal function that accompany aging (Cash & Glass, 2018).

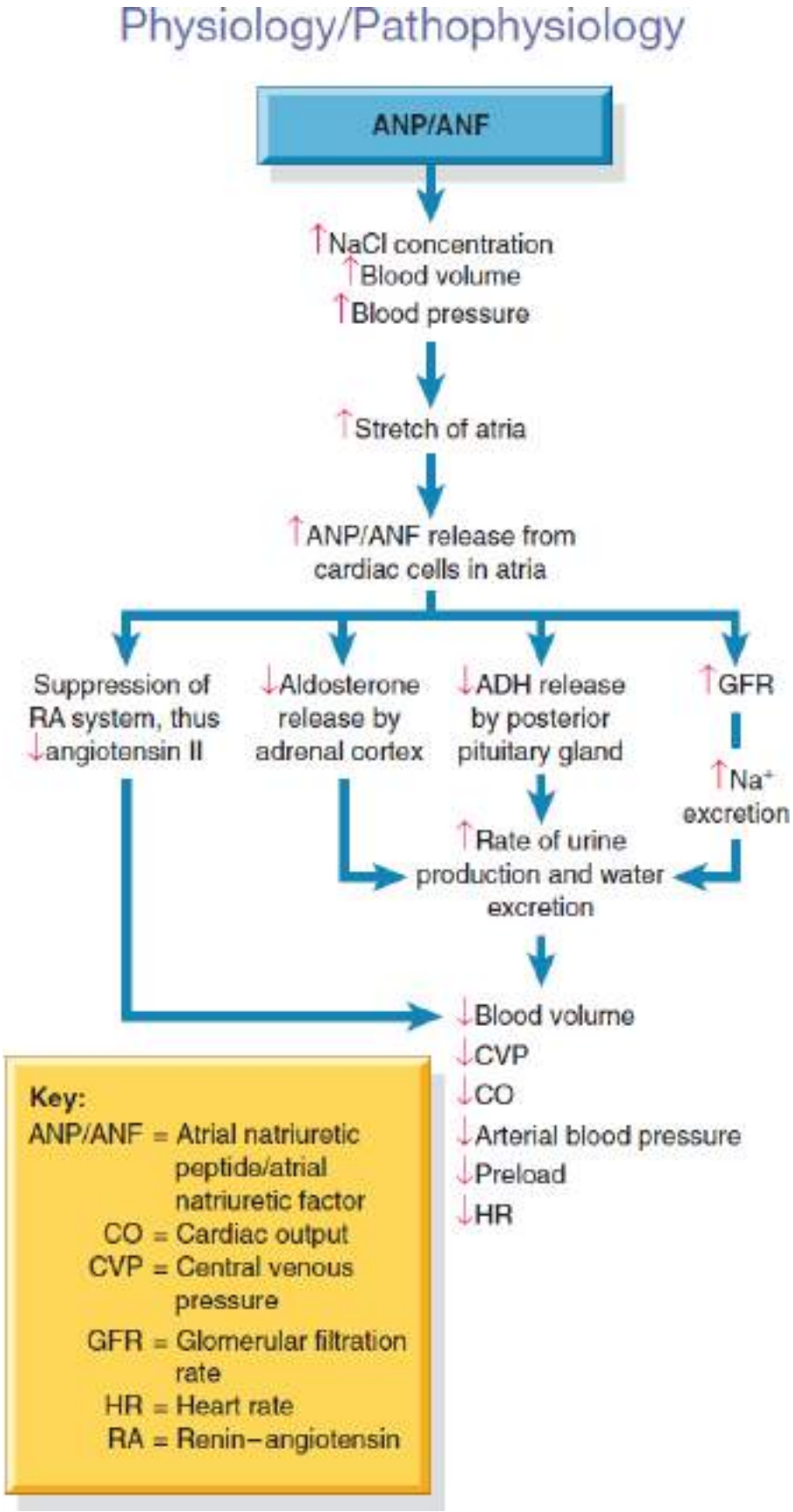

Figure 10-6 • Role of atrial natriuretic peptide in maintenance of fluid balance.

Dehydration is the rapid loss of body weight due to the loss of either water or sodium. This results in an elevated sodium concentration (Sterns, 2017c). Dehydration in older adults is common because of decreased kidney mass, decreased glomerular filtration rate, decreased renal blood flow, decreased ability to concentrate urine, inability to conserve sodium, decreased excretion of potassium, and a decrease of total-body water. Loss of subcutaneous tissue and resultant thinning of the skin occurs with aging; the dermis is dehydrated and loses strength and elasticity.

FLUID VOLUME DISTURBANCES

Hypovolemia

FVD, or hypovolemia, occurs when loss of ECF volume exceeds the intake of fluid. It occurs when water and electrolytes are lost in the same proportion as they exist in normal body fluids; thus, the ratio of serum electrolytes to water remains the same. FVD should not be confused with dehydration, which refers to loss of water alone, with increased serum sodium levels. FVD may occur alone or in combination with other imbalances. Serum electrolyte concentrations can remain normal, increase, or increase in FVD (Sterns, 2017a).

Pathophysiology

FVD results from loss of body fluids and occurs more rapidly when coupled with decreased fluid intake. FVD can also develop with a prolonged period of inadequate intake. Causes of FVD include abnormal fluid losses, such as those resulting from vomiting, diarrhea, GI suctioning, and sweating; decreased intake, as in nausea or lack of access to fluids; and third-space fluid shifts, or the movement of fluid from the vascular system to other body spaces (e.g., with edema formation in burns, ascites with liver dysfunction). Additional causes include diabetes insipidus (a decreased ability to concentrate urine due to either a deficit of ADH or nephron resistance to ADH), adrenal insufficiency, osmotic diuresis, hemorrhage, and coma (Sterns, 2017a).

Clinical Manifestations

FVD can develop rapidly, and its severity depends on the degree of fluid loss. Clinical signs and symptoms and laboratory findings are presented in Table 10-4.

Assessment and Diagnostic Findings

Laboratory data used to evaluate fluid volume status include BUN and its relation to serum creatinine concentration. Normal BUN to serum creatinine concentration ratio is 10:1. A volume-depleted patient has a BUN elevated out of proportion to the serum creatinine (ratio greater than 20:1) because urea becomes concentrated in FVD (Sterns, 2017a).

The presence and cause of hypovolemia may be determined through the health history and physical examination. In addition, the hematocrit level is greater than normal because there is a decreased plasma volume, which concentrates the volume of RBCs.

Serum electrolyte changes may also exist. Potassium and sodium levels can be reduced (hypokalemia, hyponatremia) or elevated (hyperkalemia, hypernatremia).

- Hypokalemia can occur with GI and renal losses as these organs are major regulators of potassium.
- Hyperkalemia can occur with adrenal insufficiency due to aldosterone deficiency which causes lack of potassium excretion.
- Hyponatremia can occur with increased thirst and ADH release, which increases water content of the bloodstream.
- Hypernatremia can result from increased insensible water losses and diabetes insipidus.

TABLE 10-4 Fluid Volume Disturbances

Imbalance	Contributing Factors	Signs/Symptoms and Laboratory Findings
Fluid volume deficit (hypovolemia)	Loss of water and electrolytes, as in vomiting, diarrhea, fistulas, fever, excess sweating, burns, blood loss, gastrointestinal suction, and third-space fluid shifts; and decreased intake, as in anorexia, nausea, and inability to gain access to fluid. Diabetes insipidus and uncontrolled diabetes both contribute to a depletion of extracellular fluid volume.	Acute weight loss, ↓ skin turgor, oliguria, concentrated urine, capillary filling time prolonged, low CVP, ↓ BP, flattened neck veins, dizziness, weakness, thirst and confusion, ↑ pulse, muscle cramps, sunken eyes, nausea, increased temperature; cool, clammy, pale skin *Labs indicate:* ↑ hemoglobin and hematocrit, ↑ serum and urine osmolality and specific gravity, ↓ urine sodium, ↑ BUN and creatinine, ↑ urine specific gravity and osmolality
Fluid volume excess (hypervolemia)	Compromised regulatory mechanisms, such as kidney injury, heart failure, and cirrhosis; overzealous administration of sodium-containing fluids; and fluid shifts (i.e., treatment of burns). Prolonged corticosteroid therapy, severe stress, and hyperaldosteronism augment fluid volume excess.	Acute weight gain, peripheral edema and ascites, distended jugular veins, crackles, elevated CVP, shortness of breath, ↑ BP, bounding pulse and cough, ↑ respiratory rate, ↑ urine output *Labs indicate:* ↓ hemoglobin and hematocrit, ↓ serum and urine osmolality, ↓ urine sodium and specific gravity

BP, blood pressure; BUN, blood urea nitrogen; CVP, central venous pressure; ↓, decreased; ↑, increased.

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Oliguria, the excretion of less than 400 mL urine per day in the adult, may or may not be present in hypovolemia. Urine specific gravity will change in relation to the kidneys' attempt to conserve water. If the kidney does not reabsorb water, urine contains more water, and urine specific gravity is low. If the kidney does reabsorb water, urine will be concentrated and specific gravity increases. Due to lack of ADH in diabetes insipidus, urine water content increases, which decreases urine specific gravity. Aldosterone is secreted when fluid volume is low, causing reabsorption of sodium and chloride and resulting in decreased urinary sodium and chloride. When the kidneys conserve water, urine osmolality can increase to greater than 450 mOsm/kg and urine specific gravity increases (Sterns, 2017a). Normal values for laboratory data are listed in Appendix A on thePoint.

Gerontologic Considerations

Increased sensitivity to fluid and electrolyte changes in older patients requires careful physical assessment, measurement of I&O of fluids from all sources, assessment of daily weight, careful monitoring of side effects and interactions of medications, and prompt reporting and management of disturbances. In most adult patients, it is useful to monitor skin turgor to detect subtle changes. However, assessment of skin turgor is not as valid in older adults because the skin has lost elasticity; therefore, other assessment measures (e.g., slowness in filling of veins of the hands and feet) become more useful in detecting FVD (Cash & Glass, 2018; Weber & Kelley, 2018).

The nurse also performs a functional assessment of the older patient's ability to determine fluid and food needs and to obtain adequate intake in addition to assessments discussed earlier in this chapter. For example, the nurse assesses whether or not the patient is cognitively intact, able to ambulate and to use both arms and hands to reach fluids and foods, and able to swallow with an intact gag reflex. Results of this functional assessment have a direct bearing on how the patient will be able to meet their own need for fluids and foods (Weber & Kelley, 2018). During an older patient's hospital stay, the nurse provides fluids if the patient is unable to carry out self-care activities.

The nurse should also recognize that some older patients deliberately restrict their fluid intake to avoid episodes of urinary incontinence. In this situation, the nurse should identify interventions to deal with the incontinence, such as encouraging the patient to wear protective clothing or devices, to carry a urinal in the car, or to pace fluid intake to allow access to toilet facilities during the day. Older adults without cardiovascular or renal dysfunction should be reminded to drink adequate fluids, particularly in very warm or humid weather (Cash & Glass, 2018).

Medical Management

When planning the correction of fluid loss for the patient with FVD, the primary provider considers the patient's maintenance requirements and other factors (e.g., fever) that can influence fluid needs. If the deficit is not severe, the oral route is preferred, provided the patient can drink. However, if fluid losses are acute or severe, the IV route is required. Isotonic electrolyte crystalloid solutions (e.g., lactated Ringer's solution or 0.9% sodium chloride) are frequently the first-line choice to treat the hypotensive patient with FVD because they expand plasma volume. As soon as the patient becomes normotensive, a hypotonic electrolyte solution (e.g., 0.45% sodium chloride) is often used to provide both electrolytes and water for renal excretion of metabolic wastes (Sterns, 2017a; Sterns, 2017b). These and additional fluids are listed in Table 10-5.

Accurate and frequent assessments of I&O, weight, vital signs, central venous pressure, level of consciousness, breath sounds, and skin color are monitored to determine when therapy should be slowed to avoid volume overload. The rate of fluid administration is based on the severity of loss and the patient's hemodynamic response to volume replacement (Sterns, 2017a; Sterns, 2017b).

If the patient with severe FVD is not excreting enough urine and is therefore oliguric, the primary provider needs to determine whether the depressed renal function is caused by reduced renal blood flow secondary to FVD (prerenal azotemia) or, more seriously, by acute tubular necrosis (intrarenal azotemia) from prolonged FVD (Norris, 2019). The test used in this situation is referred to as a fluid challenge test. During a fluid challenge test, volumes of fluid are given at specific rates and intervals while the patient's hemodynamic response to this treatment is monitored (i.e., vital signs, breath sounds, orientation status, central venous pressure, urine output) (Sterns, 2017b).

TABLE 10-5 Select Water and Electrolyte Solutions

Solution	Considerations
Isotonic Solutions	
0.9% NaCl (isotonic, also called *normal saline* [NS]) Na^+ 154 mEq/L Cl^- 154 mEq/L (308 mOsm/L) Also available with varying concentrations of dextrose (a 5% dextrose concentration is commonly used)	• An isotonic solution that expands the extracellular fluid (ECF) volume; used in hypovolemic states, resuscitative efforts, shock, diabetic ketoacidosis, metabolic alkalosis, hypercalcemia, mild Na^+ deficit • Supplies an excess of Na^+ and Cl^-; can cause fluid volume excess and hyperchloremic acidosis if used in excessive volumes, particularly in patients with compromised renal function, heart failure, or edema • When mixed with 5% dextrose, the resulting solution becomes temporarily hypertonic in relation to plasma and, in addition to the previously described electrolytes, provides 170 cal/L. After dextrose is metabolized it leaves an isotonic solution. • Only solution that may be given with blood products • Tonicity similar to plasma
Lactated Ringer's solution Na^+ 130 mEq/L K^+ 4 mEq/L Ca^{++} 3 mEq/L Cl^- 109 mEq/L Lactate (metabolized to bicarbonate) 28 mEq/L (274 mOsm/L) Also available with varying concentrations of dextrose (the most common is 5% dextrose)	• An isotonic solution that contains multiple electrolytes in roughly the same concentration as found in plasma (note that solution is lacking in Mg^{++}); provides 9 cal/L • Used in the treatment of hypovolemia, burns, fluid lost as bile or diarrhea, and for acute blood loss replacement • Lactate is rapidly metabolized into HCO_3^- in the body. Lactated Ringer's solution should not be used in lactic acidosis because the ability to convert lactate into HCO_3^- is impaired in this disorder • Not to be given with a pH >7.5 because bicarbonate is formed as lactate breaks down, causing alkalosis • Should not be used in kidney injury because it contains potassium and can cause hyperkalemia • Tonicity similar to plasma
5% dextrose in water (D_5W) No electrolytes 50 g of dextrose	• An isotonic solution that supplies 170 cal/L and free water to aid in renal excretion of solutes • Used in treatment of hypernatremia, fluid loss, and dehydration • Should not be used in excessive volumes in the early postoperative period (when antidiuretic hormone secretion is increased due to stress reaction) • Should not be used solely in treatment of fluid volume deficit because it dilutes plasma electrolyte concentrations • Contraindicated in head injury because it may cause increased intracranial pressure

	• Should not be used for fluid resuscitation because it can cause hyperglycemia • Should be used with caution in patients with renal or cardiac disease because of risk of fluid overload • Electrolyte-free solutions may cause peripheral circulatory collapse, anuria in patients with sodium deficiency, and increased body fluid loss • Converts to hypotonic solution as dextrose is metabolized by body. Over time, D_5W without NaCl can cause water intoxication (intracellular fluid volume excess [FVE]) because the solution is hypotonic • Fluid therapy for an extended period of time without electrolytes may result in hypokalemia
Hypotonic Solutions 0.45% NaCl (half-strength saline) Na^+ 77 mEq/L Cl^- 77 mEq/L (154 mOsm/L) Also available with varying concentrations of dextrose (the most common is a 5% concentration)	• Provides Na^+, Cl^-, and free water • Free water is desirable to aid the kidneys in elimination of solute • Lacking in electrolytes other than Na^+ and Cl^- • When mixed with 5% dextrose, the solution becomes slightly hypertonic to plasma temporarily until dextrose is metabolized. It leaves a hypotonic solution after dextrose metabolism. Provides 170 cal/L • Used to treat hypertonic dehydration, Na^+ and Cl^- depletion, and gastric fluid loss • Not indicated for third-space fluid shifts or increased intracranial pressure • Administer cautiously, because hypotonic solution can cause fluid shifts from vascular system into cells, resulting in cardiovascular collapse and increased intracranial pressure
Hypertonic Solutions 3% NaCl (hypertonic saline) Na^+ 513 mEq/L Cl^- 513 mEq/L (1026 mOsm/L) 5% NaCL (hypertonic solution) Na^+ 855 mEq/L Cl^- 855 mEq/L (1710 mOsm/L) IV Mannitol 5–25% (hypertonic solution) (1372 mOsm/L contained in 25% solution)	• Used to increase ECF volume, decrease cellular swelling • Highly hypertonic solution used only in critical situations to treat hyponatremia • Must be given slowly and cautiously, because it can cause intravascular volume overload and pulmonary edema • Assists in removing intracellular fluid excess • Highly hypertonic solution used to treat symptomatic hyponatremia • Administer slowly and cautiously because it can cause intravascular volume overload and pulmonary edema • Supplies no calories

Colloid Solutions	
Dextran in NS or D_5W Available in low-molecular-weight (Dextran 40) and high-molecular-weight (Dextran 70) forms	• Colloid solution used as volume/plasma expander for intravascular part of ECF • Affects clotting by coating platelets and decreasing ability to clot • Remains in circulatory system up to 24 h • Used to treat hypovolemia in early shock to increase pulse pressure, cardiac output, and arterial blood pressure • Improves microcirculation by decreasing red blood cell aggregation • Contraindicated in hemorrhage, thrombocytopenia, renal disease, and severe dehydration • Not a substitute for blood or blood products

An example of a typical fluid challenge test involves administering 100 to 200 mL of normal saline solution over 15 minutes. The goal is to provide fluids rapidly enough to attain adequate tissue perfusion without compromising the cardiovascular system. The response by a patient with FVD but normal renal function is increased urine output and an increase in blood pressure and central venous pressure.

Shock can occur when the volume of fluid lost exceeds 25% of the intravascular volume or when fluid loss is rapid (Mandel & Palevsky, 2019). (Shock and its causes and treatment are discussed in detail in Chapter 11.)

Nursing Management

To assess for FVD, the nurse monitors and measures fluid I&O at least every 8 hours, and sometimes hourly. Maintaining an accurate I&O is a particular challenge with patients in critical-care settings. As FVD develops, body fluid losses exceed fluid intake through excessive urination (polyuria), diarrhea, vomiting, or other mechanisms. Once FVD has developed, the kidneys attempt to conserve body fluids, leading to a urine output of less than 1 mL/kg/h in an adult. Urine in this instance is concentrated and represents a healthy renal response.

Vital signs should be closely monitored in FVD.

Quality and Safety Nursing Alert

The nurse observes for a weak, rapid pulse and orthostatic hypotension (i.e., a decrease in systolic pressure exceeding 20 mm Hg when the patient moves from a lying to a sitting position).

A decrease in body temperature often accompanies FVD, unless there is a concurrent infection.

Skin and tongue turgor are monitored on a regular basis. In a healthy person, pinched skin immediately returns to its normal position when released (Weber & Kelley, 2018). This elastic property, referred to as turgor, is partially dependent on interstitial fluid volume. In a person with FVD, the skin flattens more slowly after the pinch is released. In a person with severe FVD, the skin may remain elevated for many seconds. Tissue turgor is best measured by pinching the skin over the sternum, dorsal surface of the hand, inner aspects of the thighs, or forehead. It is important to recognize skin turgor is normally diminished in old age. Tongue turgor is not affected by age, and evaluating this may be more valid than evaluating skin turgor (Sterns, 2017a). In a normal person, the tongue has one longitudinal furrow. In the person with FVD, there are additional longitudinal furrows and the tongue is smaller because of fluid loss. The degree of oral mucous membrane moisture is also assessed; a dry mouth may indicate either FVD or mouth breathing.

Quality and Safety Nursing Alert

It is useful to monitor daily body weight when monitoring fluid volume; an acute loss of 0.5 kg (1.1 lb) represents a fluid loss of approximately 500 mL. One liter (1000 mL) of fluid weighs approximately 1 kg, or 2.2 lb. A weight loss or gain of 1–2 lb/day is mainly due to water loss or gain.

Urine concentration is monitored by measuring the urine specific gravity. In a volume-depleted patient, the urine specific gravity should be greater than 1.020, indicating healthy renal conservation of fluid. Dark amber-colored urine is highly concentrated; whereas, clear yellow urine indicates a dilute urine.

Mental function is eventually affected, resulting in confusion, lack of cognition, and delirium in severe FVD as a result of decreasing cerebral perfusion. Behavioral changes are particularly evident in older adults with FVD. Decreased peripheral perfusion can result in cold extremities. In patients with relatively normal cardiopulmonary function, a low central venous pressure is indicative of hypovolemia (Sterns, 2017a). Patients with acute cardiopulmonary decompensation require more extensive hemodynamic monitoring of pressures in both sides of the heart to determine whether hypovolemia exists. Hemodynamic monitoring is particularly important in critically ill patients (Mandel & Palevsky, 2019) (see Chapters 11 and 21).

Preventing Hypovolemia

To prevent FVD, the nurse identifies patients at risk and takes measures to minimize fluid losses. For example, if the patient has diarrhea, measures should be implemented to control diarrhea and replacement fluids given. This includes administering antidiarrheal medications and small volumes of oral fluids at frequent intervals.

Correcting Hypovolemia

When possible, oral fluids are given to help correct FVD, with consideration given to the patient's likes and dislikes. The type of fluid the patient has lost is also considered, and fluids most likely to replace the lost electrolytes are appropriate. If the patient is reluctant to drink because of oral discomfort, the nurse assists with frequent mouth care and provides nonirritating fluids. The patient may be offered small volumes of oral rehydration solutions (e.g., Rehydralyte, Elete, and Cytomax). These solutions provide fluid, glucose, and electrolytes in concentrations that are easily absorbed. If nausea is present, an antiemetic may be needed before oral fluid replacement can be tolerated (Sterns, 2017a; Sterns, 2017b).

If the deficit cannot be corrected by oral fluids, therapy may need to be initiated by an alternative route (enteral or parenteral) until adequate circulating blood volume and renal perfusion are achieved. Isotonic fluids are prescribed to increase ECF volume (Sterns, 2017b).

Hypervolemia

Fluid volume excess (FVE), or hypervolemia, refers to an expansion of the ECF caused by the abnormal retention of water and sodium in approximately the same proportions in which they normally exist in the ECF. It is most often secondary to an increase in the total-body sodium content, which, in turn, leads to an increase in total-body water. This can be referred to as an isotonic accumulation of fluids. Because there is isotonic retention of body substances, the serum sodium concentration remains essentially normal.

Pathophysiology

FVE may be related to simple fluid overload or diminished function of the homeostatic mechanisms responsible for regulating fluid balance. Contributing factors can include heart failure, kidney dysfunction, and cirrhosis of the liver. Another contributing factor is consumption of excessive amounts of table or other sodium salts. Excessive administration of sodium-containing fluids in a patient with impaired regulatory mechanisms may predispose them to a serious FVE as well (Sterns, 2018a).

Clinical Manifestations

Clinical manifestations of FVE result from expansion of the ECF and may include edema, distended jugular veins, and crackles (abnormal lung sounds due to interstitial pulmonary fluid). In patients who are ambulatory, edema is most evident in the ankles; in patients who are supine, edema occurs over the sacrum (Weber & Kelley, 2018). Further discussion of clinical signs and symptoms and laboratory findings can be found in Table 10-4.

Assessment and Diagnostic Findings

Laboratory data useful in diagnosing FVE include BUN and hematocrit levels. In FVE, both of these values may be decreased because of plasma dilution. In chronic kidney disease, both serum osmolality and the sodium level are decreased due to excessive retention of water. The urine sodium level is increased if the kidneys are attempting to excrete excess volume. A chest x-ray may reveal pulmonary congestion in FVE. Hypervolemia occurs when aldosterone is chronically stimulated—for example, in conditions such as cirrhosis, heart failure, and nephrotic syndrome. Aldosterone increases both sodium and water reabsorption into the bloodstream from the nephron; therefore, the urine sodium level is normal in these conditions (Emmett & Palmer, 2019; Sterns, 2018a).

Medical Management

Management of FVE is directed at the causes, and if related to excessive administration of sodium-containing fluids, discontinuing the infusion may be all that is needed. Symptomatic treatment consists of administering diuretics and restricting fluids and sodium. Diuretics are medications that reduce sodium and water reabsorption at the nephron and thereby enhance water loss via the kidneys (Brater & Ellison, 2019).

Pharmacologic Therapy

Diuretics are prescribed when dietary restriction of sodium alone is insufficient to reduce edema. The choice of diuretic is based on the severity of the hypervolemic state, the degree of impairment of renal function, and the potency of the diuretic. Thiazide diuretics block sodium and water reabsorption into the bloodstream at the distal tubule of the nephron, where 5% to 10% of sodium is normally reabsorbed. This leads to a small amount of sodium and water loss via the urine. Loop diuretics, such as furosemide, bumetanide, or torsemide, can cause a greater loss of both sodium and water because they block sodium reabsorption in the ascending limb of the loop of Henle, where 20% to 30% of filtered sodium is normally reabsorbed.

Generally, thiazide diuretics, such as hydrochlorothiazide, are prescribed for mild to moderate hypervolemia and loop diuretics for severe hypervolemia (Brater & Ellison, 2019).

Electrolyte imbalances may result from side effects of diuretics. Hypokalemia can occur with all diuretics except those that inhibit aldosterone. Potassium supplements can be prescribed with diuretics to avoid this complication. Hyperkalemia can occur with diuretics that inhibit aldosterone (e.g., spironolactone, a potassium-sparing diuretic), especially in patients with decreased renal function. Hyponatremia occurs with diuresis due to increased release of ADH secondary to reduction in circulating volume. Decreased magnesium levels occur with administration of loop and thiazide diuretics due to decreased reabsorption and increased excretion of magnesium by the kidney (Brater & Ellison, 2019; Vallerand & Sanoski, 2019).

Azotemia (increased nitrogen levels in the blood) can occur with FVE when urea and creatinine are not excreted due to decreased perfusion by the kidneys and decreased excretion of waste, as occurs in renal failure. High uric acid levels (hyperuricemia) can also occur from increased reabsorption and decreased excretion of uric acid by the kidneys.

Dialysis

If renal function is so severely impaired that pharmacologic agents cannot act efficiently, other modalities are considered to remove sodium and fluid from the body. Hemodialysis or peritoneal dialysis may be used to remove nitrogenous wastes and control potassium and acid–base balance, and to remove sodium and fluid. Continuous renal replacement therapy may also be required (see Chapter 48 for a discussion of these treatment modalities).

Nutritional Therapy

Treatment of FVE usually involves dietary restriction of sodium. An average daily diet not restricted in sodium contains 6 to 15 g of salt, whereas low sodium diets can range from a mild restriction (less than 2000 mg/day) to as little as 250 mg of sodium per day, depending on the patient's needs. A mild sodium-restricted diet allows only light salting of food (about half the usual amount) in cooking and at the table, and no addition of salt to commercially prepared foods that are already seasoned. Foods high in sodium must be avoided. It is the sodium salt (sodium chloride) rather than sodium itself that contributes to edema. Therefore, patients are instructed to read food labels carefully to determine salt content (Olendzki, 2017).

Because about half of ingested sodium is in the form of seasoning, seasoning substitutes can play a major role in decreasing sodium intake. Lemon juice, onions, and garlic are excellent substitute flavorings, although some patients prefer salt substitutes. Most salt substitutes contain potassium

and must therefore be used cautiously by patients taking potassium-sparing diuretics (e.g., spironolactone, triamterene, amiloride). These substitutes should not be used in conditions associated with potassium retention, such as advanced kidney disease. Salt substitutes containing ammonium chloride can be harmful to patients with liver damage (Olendzki, 2017; Vallerand & Sanoski, 2019).

In some communities, drinking water may contain too much sodium for a sodium-restricted diet. Depending on its source, water may contain as little as 1 mg or more than 1500 mg of sodium per quart. Patients may need to use distilled water if the local water supply is very high in sodium. Bottled water can have a sodium content that ranges from 0 to 1200 mg/L; therefore, if sodium is restricted, the label must be carefully examined for sodium content before purchasing and drinking bottled water. Also, patients on sodium-restricted diets should be cautioned to avoid water softeners that add sodium to water in exchange for other ions, such as calcium. Protein intake may be increased in patients who are malnourished or who have low serum protein levels in an effort to increase capillary oncotic pressure. Increasing oncotic pressure in the bloodstream will pull fluid out of the tissues into vessels for excretion by the kidneys (Sterns, 2018a).

Nursing Management

To assess for FVE, the nurse measures I&O at regular intervals to identify excessive fluid retention. The patient is weighed daily, and rapid weight gain is noted. Breath sounds are assessed at regular intervals in at-risk patients, particularly if parenteral fluids are being given. The nurse monitors the degree of edema in the most dependent parts of the body, such as the feet and ankles in ambulatory patients and the sacral region in patients confined to bed. Pitting edema is assessed by pressing a finger into the affected part, creating a pit or indentation that is evaluated on a scale of 1+ (minimal) to 4+ (severe) (see Chapter 25, Fig. 25-2). Peripheral edema is monitored by measuring the circumference of the extremity with a tape measure marked in millimeters (Weber & Kelley, 2018).

Quality and Safety Nursing Alert

An acute weight gain of 1 kg (2.2 lb) is equivalent to a gain of approximately 1 L of fluid.

Preventing Hypervolemia

Specific interventions vary with the underlying condition and the degree of FVE. However, most patients require sodium-restricted diets in some form,

and adherence to the prescribed diet is encouraged. Patients are instructed to avoid over-the-counter (OTC) medications without first checking with a health care provider, because they may contain sodium (e.g., Alka-Seltzer). If fluid retention persists despite adherence to a prescribed diet, hidden sources of sodium, such as the water supply or use of water softeners, should be considered.

Detecting and Controlling Hypervolemia

It is important to detect FVE before the condition becomes severe. Interventions include promoting rest, restricting sodium intake, monitoring parenteral fluid therapy, and administering appropriate medications.

Regular rest periods may be beneficial, because bed rest favors diuresis of fluid. The mechanism is related to diminished venous pooling and the subsequent increase in effective circulating blood volume and renal perfusion. Sodium and fluid restriction should be instituted as indicated. Because most patients with FVE require diuretics, the patient's response to these agents is monitored. The rate of parenteral fluids and the patient's response to these fluids are also closely monitored (Frandsen & Pennington, 2018). If dyspnea or orthopnea is present, the patient is placed in a semi-Fowler position to promote lung expansion. The patient is turned and repositioned at regular intervals because edematous tissue is more prone to skin breakdown than normal tissue. Because conditions predisposing to FVE are likely to be chronic, patients are taught to monitor their response to therapy by documenting fluid I&O and body weight changes. The importance of adhering to the treatment regimen is emphasized.

Educating Patients About Edema

Because edema is a common manifestation of FVE, patients need to recognize its symptoms and understand its importance. The nurse gives special attention to edema when instructing the patient with FVE. Edema can occur as a result of increased capillary fluid pressure, decreased capillary oncotic pressure, or increased interstitial oncotic pressure, causing expansion of the interstitial fluid compartment (Hall, 2016). Edema can be localized (e.g., in the ankle, as in rheumatoid arthritis) or generalized (as in cardiac failure and kidney injury) (Sterns, 2018b). Severe generalized edema is called *anasarca.*

Edema occurs when there is a change in the capillary membrane, increasing the formation of interstitial fluid or decreasing the removal of interstitial fluid. Sodium retention is a frequent cause of the increased ECF volume. Burns and infection are examples of conditions associated with increased interstitial fluid volume. Obstruction to lymphatic outflow, a plasma albumin level less than 1.5 to 2 g/dL, or a decrease in plasma oncotic pressure contributes to increased

interstitial fluid volume. If there is decreased cardiac output as in heart failure, the kidneys sense low perfusion and secrete renin which triggers the renin–angiotensin–aldosterone system that increases sodium and water retention (Sterns, 2018b). A thorough medication history is necessary to identify any medications that could cause edema, such as nonsteroidal anti-inflammatory drugs (NSAIDs), estrogens, corticosteroids, and antihypertensive agents (Vallerand & Sanoski, 2019).

Ascites is a type of edema in which fluid accumulates in the peritoneal cavity; it results from heart failure, nephrotic syndrome, cirrhosis, and some malignant tumors. The patient commonly reports shortness of breath and a sense of pressure because of pressure on the diaphragm.

The goal of treatment is to preserve or restore the circulating intravascular fluid volume. Thus, in addition to treating the cause of the edema, other treatments may include diuretic therapy, restriction of fluids and sodium, elevation of the extremities, application of anti-embolic stockings, paracentesis (pulling fluid out of the peritoneal cavity using a needle and syringe), dialysis, and continuous renal replacement therapy in cases of kidney injury or life-threatening fluid volume overload (Sterns, 2018b).

ELECTROLYTE IMBALANCES

Disturbances in electrolyte balances are common in clinical practice and may need to be corrected based on history, physical examination findings, and laboratory values (with comparison to previous values).

Sodium Imbalances

Sodium (Na^+) is the most abundant electrolyte in the ECF; its concentration ranges from 135 to 145 mEq/L (135 to 145 mmol/L), and it is the primary determinant of ECF volume and osmolality. Sodium has a major role in controlling water distribution throughout the body, because it does not easily cross the plasma membrane and because of its abundance and high concentration in the body. Sodium is regulated by ADH, thirst, and the renin–angiotensin–aldosterone system. A loss or gain of sodium is usually accompanied by a loss or gain of water. Sodium also functions in establishing the electrochemical state necessary for muscle contraction and the transmission of nerve impulses (Hall, 2016).

The syndrome of inappropriate secretion of antidiuretic hormone (SIADH) may be associated with sodium imbalance. When there is a decrease in the circulating plasma osmolality, blood volume, or blood pressure, ADH (also

called arginine vasopressin [AVP]) is released from the posterior pituitary. Oversecretion of ADH can cause SIADH. Patients at risk for SIADH include older adults; those who have had brain surgery or have a brain tumor, pulmonary malignancy, or acquired immune deficiency syndrome (AIDS); those on mechanical ventilation; and those taking selective serotonin reuptake inhibitors (SSRIs) (Sterns, 2017d). (SIADH is discussed in more detail in Chapter 45.)

Sodium imbalance can develop under simple or complex circumstances. The two most common sodium imbalances are sodium deficit and sodium excess (Table 10-6).

TABLE 10-6 Sodium Imbalances

Imbalance	Contributing Factors	Signs/Symptoms and Laboratory Findings
Sodium deficit (hyponatremia) Serum sodium <135 mEq/L	Loss of sodium, as in use of diuretics, loss of GI fluids, renal disease, and adrenal insufficiency. Gain of water, as in excessive administration of D_5W and water supplements for patients receiving hypotonic tube feedings; disease states associated with SIADH, such as head trauma and oat-cell lung tumor; medications associated with water retention (oxytocin and certain tranquilizers); and psychogenic polydipsia. Hyperglycemia and heart failure cause a loss of sodium.	Anorexia, nausea and vomiting, headache, lethargy, dizziness, confusion, muscle cramps and weakness, muscular twitching, seizures, papilledema, dry skin, ↑ pulse, ↓ BP, weight gain, edema *Labs indicate:* ↓ serum and urine sodium, ↓ urine specific gravity and osmolality
Sodium excess (hypernatremia) Serum sodium >145 mEq/L	Fluid deprivation in patients who cannot respond to thirst, hypertonic tube feedings without adequate water supplements, diabetes insipidus, heatstroke, hyperventilation, watery diarrhea, burns, and diaphoresis. Excess corticosteroid, sodium bicarbonate, and sodium chloride administration, and saltwater nonfatal drowning victims.	Thirst, elevated body temperature, swollen dry tongue and sticky mucous membranes, hallucinations, lethargy, restlessness, irritability, simple partial or tonic–clonic seizures, pulmonary edema, hyperreflexia, twitching, nausea, vomiting, anorexia, ↑ pulse, and ↑ BP *Labs indicate:* ↑ serum sodium, ↓ urine sodium, ↑ urine specific gravity and osmolality, ↓ CVP

BP, blood pressure; CVP, central venous pressure; ↓, decreased; D_5W, dextrose 5% in water; GI, gastrointestinal; ↑, increased; SIADH, syndrome of inappropriate secretion of antidiuretic hormone.

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health state* (10th ed.). Philadelphia, PA: Wolters Kluwer.

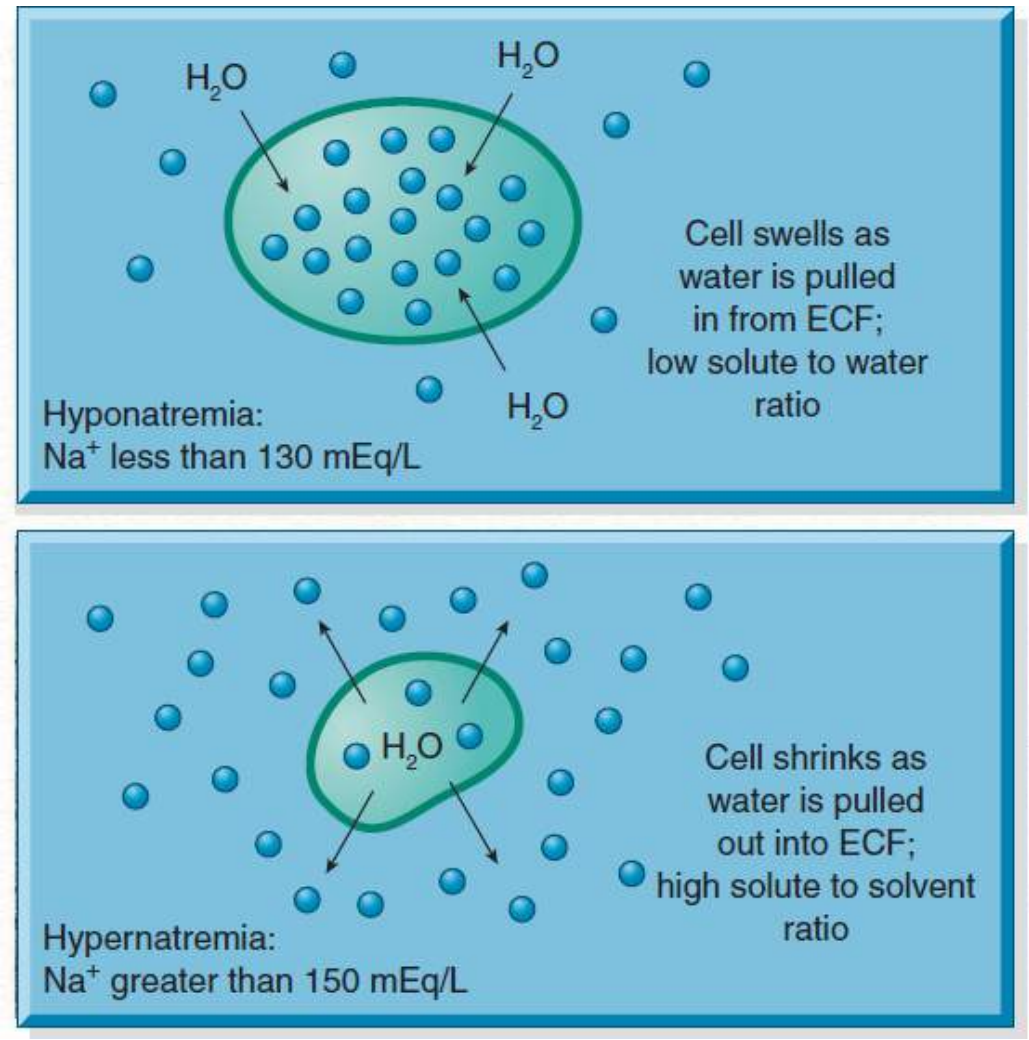

Figure 10-7 • Effect of extracellular sodium level on cell size.

Sodium Deficit (Hyponatremia)

Hyponatremia refers to a serum sodium level that is less than 135 mEq/L (135 mmol/L) (Sterns, 2017e). Hyponatremia can present as an acute or chronic form. Acute hyponatremia is commonly the result of a fluid overload in a surgical patient. This is a dilutional hyponatremia because the excess water dilutes the sodium in the bloodstream. Chronic hyponatremia is seen more frequently in patients outside the hospital setting, has a longer duration, and has less serious neurologic sequelae. Another type of hyponatremia is exercised-associated hyponatremia, which is more frequently found in women and those of smaller stature. It can occur during extreme temperatures, because of excessive fluid intake before exercise, or prolonged exercise that results in excess loss of sodium through perspiration (Apostu, 2014; McDermott, Anderson, Armstrong, et al., 2017).

Pathophysiology

Hyponatremia primarily occurs due to an imbalance of water rather than sodium. Checking the urine sodium value can assist in differentiating renal from nonrenal causes of hyponatremia. Low sodium in the urine occurs as the nephrons of the kidney retain sodium to compensate for nonrenal fluid loss (i.e., vomiting, diarrhea, sweating). High sodium concentration in the urine is associated with renal salt wasting that occurs in renal dysfunction or diuretic use. In dilutional hyponatremia, the ECF volume has excess water but there is no edema, and the excess water dilutes the sodium (Sterns, 2017e).

A deficiency of aldosterone, as occurs in adrenal insufficiency, also predisposes to sodium deficiency. Lack of aldosterone causes lack of sodium and water reabsorption into the bloodstream at the nephrons. In addition, the use of certain medications, such as anticonvulsants (e.g., carbamazepine, oxcarbazepine, levetiracetam), SSRIs (e.g., fluoxetine, sertraline, paroxetine), or desmopressin acetate, have side effects that increase the risk of hyponatremia (Liamis, Megapanou, Elisaf, et al., 2019).

Clinical Manifestations

Clinical manifestations of hyponatremia depend on the cause, magnitude, and speed with which the deficit occurs. Poor skin turgor, dry mucosa, headache, decreased saliva production, orthostatic fall in blood pressure, nausea, vomiting, and abdominal cramping can occur. Neurologic changes, including altered mental status, status epilepticus, and coma, are related to the cellular swelling and cerebral edema associated with hyponatremia. As the extracellular sodium level decreases, the cellular fluid becomes relatively more concentrated and pulls water into the cells (Fig. 10-7). In general, patients with an acute decrease in serum sodium levels have more cerebral edema and higher mortality rates than do those with more slowly developing hyponatremia. Acute decreases in sodium, developing in less than 48 hours, may be associated with cerebral edema. Cerebral edema can lead to compression of brain stem structures and brain herniation. Chronic decreases in sodium, developing over 48 hours or more, can occur in status epilepticus and other neurologic conditions (Sterns, 2017e).

Clinical features of hyponatremia associated with sodium loss and water gain include anorexia, muscle cramps, and a feeling of exhaustion. The severity of symptoms increases with the degree of hyponatremia and the speed with which it develops. When the serum sodium level decreases to less than 115 mEq/L (115 mmol/L), signs of increasing intracranial pressure, such as lethargy, confusion, muscle twitching, focal weakness, hemiparesis, papilledema, seizures, and death, may occur (Sterns, 2017e).

Assessment and Diagnostic Findings

Targeted assessment includes the history and physical examination with a focused neurologic examination; evaluation of signs and symptoms as well as laboratory test results; identification of current IV fluids, if applicable; and a review of all medications the patient is taking. Regardless of the cause of hyponatremia, the serum sodium level is less than 135 mEq/L; in SIADH, it may be lower than 100 mEq/L (100 mmol/L). Serum osmolality is usually decreased. When hyponatremia is due to lack of sodium ingestion, the urinary sodium content is less than 20 mEq/L (20 mmol/L) and the specific gravity is low (1.002 to 1.004). However, when hyponatremia is due to SIADH, the urinary sodium content is greater than 20 mEq/L, and the urine specific gravity is usually greater than 1.012. Although the patient with SIADH retains water abnormally there is no peripheral edema; instead, fluid accumulates inside the cells. This phenomenon sometimes manifests as pitting edema (Sterns, 2017d).

Medical Management

The key to treating hyponatremia is an assessment that focuses on the clinical symptoms of the patient and signs of hyponatremia (including laboratory values). As a general rule, treating the underlying condition will bring the sodium level back to normal.

Sodium Replacement

The most common treatment for hyponatremia is careful administration of sodium by mouth, nasogastric tube, or a parenteral route. For patients who can eat and drink, sodium is easily replaced, because sodium is consumed abundantly in a normal diet. For those who cannot consume sodium, lactated Ringer's solution or isotonic saline (0.9% sodium chloride) solution may be prescribed. Serum sodium must not be increased by more than 12 mEq/L in 24 hours to avoid neurologic damage due to demyelination (Jain, Phadke, Chauhan, et al., 2018). This condition may occur when the serum sodium concentration is overcorrected (exceeding 140 mEq/L) too rapidly or in the presence of hypoxia or anoxia. It may produce lesions that show symmetric myelin destruction affecting all fiber tracts that can present with altered cognition and decreased alertness, ataxia, paraparesis, dysarthria, horizontal gaze paralysis, pseudobulbar palsy, and coma. The usual daily sodium requirement in adults is approximately 100 mEq, provided there are not excessive losses (Sterns, 2020). Select water and electrolyte solutions are described in Table 10-5.

In SIADH, the administration of hypertonic saline solution alone cannot change the plasma sodium concentration. Excess sodium would be excreted rapidly in highly concentrated urine. With the addition of the diuretic furosemide, urine is not concentrated and isotonic urine is excreted to effect a change in water balance. In patients with SIADH, in whom water restriction is

difficult, lithium can antagonize the osmotic effect of ADH on the nephrons' collecting ducts (Sterns, 2017d).

Water Restriction

In patients with normal or excess fluid volume, hyponatremia is usually treated effectively by restricting fluid. However, if neurologic symptoms are severe (e.g., seizures, delirium, coma), or in patients with traumatic brain injury, it may be necessary to administer small volumes of a hypertonic sodium solution with the goal of alleviating cerebral edema. Incorrect use of these fluids is extremely dangerous, because 1 L of 3% sodium chloride solution contains 513 mEq of sodium and 1 L of 5% sodium chloride solution contains 855 mEq of sodium. The recommendation for hypertonic saline administration in patients with craniocerebral trauma is 3% saline between 0.10 and 1.0 mL/kg of body weight per hour (Sterns, 2017d).

Quality and Safety Nursing Alert

In patients with hyponatremia, highly hypertonic sodium solutions (2–23% sodium chloride) should be administered slowly. The patient needs close monitoring, because only small volumes are needed to elevate the serum sodium concentration.

Pharmacologic Therapy

AVP receptor antagonists (also called ADH receptor antagonists) are pharmacologic agents that treat hyponatremia by blocking the effect of ADH at the nephron, which in turn allows diuresis to occur and leads to water excretion. Use of IV conivaptan HCl, an AVP receptor antagonist, is limited to the treatment of hospitalized patients. It may be a useful therapy for those patients with moderate to severe symptomatic hyponatremia but is contraindicated in patients with seizures, delirium, or coma, which warrants the use of hypertonic saline. Tolvaptan is an oral medication indicated for clinically significant hypervolemic and euvolemic hyponatremia that must be initiated and monitored in the hospital setting (Frandsen & Pennington, 2018; Vallerand & Sanoski, 2019).

Nursing Management

The nurse needs to identify and monitor patients at risk for hyponatremia. The nurse monitors I&O as well as daily body weight. I&O can be used to identify excess water input or lack of sufficient water output.

The nurse needs to get a thorough history to identify if the patient is a performance athlete. Performance athletes (i.e., marathon runners) may use

salt tablets to compensate for loss of sodium with sweating, hoping to decrease sodium loss during prolonged exercise; however, there is no evidence that this practice works and it is not recommended (Hew-Butler, Loi, Pani, et al., 2017).

Hyponatremia is a frequently overlooked cause of confusion in older patients, who are at increased risk because of decreased renal function and subsequent inability to excrete excess fluids. Administration of prescribed and OTC medications that cause sodium loss or water retention is often the predisposing factor. A diminished sense of thirst or decreased ability to access food or fluids may also contribute to the problem (Cash & Glass, 2018).

Detecting and Controlling Hyponatremia

Early detection and treatment of hyponatremia are necessary to prevent serious consequences. For patients at risk, the nurse closely monitors fluid I&O as well as daily body weight. It is also necessary to monitor laboratory values (i.e., sodium) and be alert for GI manifestations such as anorexia, nausea, vomiting, and abdominal cramping. The nurse must be alert for central nervous system changes, such as lethargy, confusion, muscle twitching, and seizures. Neurologic signs are associated with very low sodium levels that have fallen rapidly because of fluid overloading. Serum sodium is monitored very closely in patients who are at risk for hyponatremia; when indicated, urine sodium and specific gravity are also monitored.

For a patient with abnormal losses of sodium who can consume a general diet, the nurse encourages foods and fluids with high sodium content to control hyponatremia. For example, broth made with one beef cube contains approximately 900 mg of sodium; 8 oz of tomato juice contains approximately 700 mg of sodium. The nurse also needs to be familiar with the sodium content of parenteral fluids (see Table 10-5).

If the primary cause of hyponatremia is water retention, it is safer to restrict fluid intake than to administer sodium. In normovolemia or hypervolemia, administration of sodium predisposes a patient to fluid volume overload. In severe hyponatremia, the aim of therapy is to elevate the serum sodium level only enough to alleviate neurologic signs and symptoms. It is generally recommended that the serum sodium concentration be increased to no greater than 125 mEq/L (125 mmol/L) with a hypertonic saline solution (Sterns, 2020).

Quality and Safety Nursing Alert

When administering fluids to patients with cardiovascular disease, the nurse assesses for hemodynamic signs of circulatory overload (e.g., cough, dyspnea, jugular venous distention, dependent edema, 1–2 lb weight gain in 24 h). The lungs should be auscultated for crackles as this can indicate pulmonary edema.

For the patient taking lithium, the nurse observes for lithium toxicity, particularly when sodium is lost. In such instances, supplemental salt and fluid are given. Because diuretics promote sodium loss, the patient taking lithium is instructed not to use diuretics without close medical supervision. For all patients on lithium therapy, normal salt and oral fluid intake (approximately 6- to 15-g sodium and 2.5- to 3.0-L fluid/day) should be encouraged and a sodium restricted diet should be avoided (Frandsen & Pennington, 2018; Vallerand & Sanoski, 2019).

Excess water supplements are avoided in patients receiving isotonic or hypotonic enteral feedings, particularly if abnormal sodium loss occurs or water is being abnormally retained (as in SIADH). Actual fluid needs are determined by evaluating fluid I&O, urine specific gravity, and serum sodium levels.

Sodium Excess (Hypernatremia)

Hypernatremia is a serum sodium level higher than 145 mEq/L (145 mmol/L). It can be caused by a gain of sodium in excess of water or by a loss of water in excess of sodium. It can occur in patients with normal fluid volume or in those with FVD or FVE. With water loss, the patient loses more water than sodium; as a result, the serum sodium concentration increases and the increased concentration pulls fluid out of the cell. This is both an extracellular and an intracellular FVD. In sodium excess, the patient ingests or retains more sodium than water (Mushin & Mount, 2018; Sterns, 2017e).

Chart 10-1

Dysnatremia

Dysnatremia is lack of normal sodium level in the bloodstream; either hypernatremia or hyponatremia. In performance athletes who lose excessive water via perspiration, sodium can become concentrated in the bloodstream causing hypernatremia. This can lead to the following life-threatening conditions:

- Encephalopathy
- Confusion
- Disorientation
- Stupor

In performance athletes who lose excess sodium via perspiration during exercise, this can lead to excess sodium depletion from the bloodstream causing hyponatremia. This can also manifest as the following:

- Confusion
- Disorientation
- Stupor

Testing of the blood and urine can differentiate hyponatremia from hypernatremia, determine the severity of the dysnatremia, and guide appropriate therapy.

Adapted from Apostu, M. (2014). A strategy for maintaining fluid and electrolyte balance in aerobic effort. *Procedia—Social and Behavioral Sciences, 117*(2014), 323—328; Hew-Butler, T., Loi, V., Pani, A., et al. (2017). Exercise-induced hyponatremia: 2017 update. *Frontiers in Medicine (Lausanne), 4*, 21.

Pathophysiology

A common cause of hypernatremia is fluid deprivation in patients who do not respond to thirst. Most often affected are patients who are very old, very young, or cognitively impaired. Administration of hypertonic enteral feedings without adequate water supplements leads to hypernatremia, as does watery diarrhea and greatly increased insensible water loss through the lungs or skin (e.g., hyperventilation, burns). In addition, diabetes insipidus, which is a lack of ADH due to posterior pituitary dysfunction, can lead to lack of adequate reabsorption of water into the bloodstream at the level of the nephron. This leads to inadequate water volume in the bloodstream which leads to hypernatremia if the patient does not respond to thirst, or if fluids are excessively restricted (Sterns, 2017c).

Less common causes of hypernatremia are heatstroke, nonfatal drowning in seawater (which contains a sodium concentration of approximately 500 mEq/L), and malfunction of hemodialysis or peritoneal dialysis systems. IV

administration of hypertonic saline or excessive use of sodium bicarbonate also causes hypernatremia. Exertional dysnatremia can occur in performance athletes (Apostu, 2014) (Chart 10-1).

Clinical Manifestations

The clinical manifestations of hypernatremia are due to increased plasma osmolality caused by an increase in plasma sodium concentration. Water moves out of the cell into the ECF, resulting in cellular dehydration (Norris, 2019) (see Fig. 10-7). Clinical signs and symptoms as well as laboratory findings can be found in Table 10-6. Dehydration (resulting in hypernatremia) is often overlooked as the cause of mental status and behavioral changes in older patients (Cash & Glass, 2018). Body temperature may increase mildly, but it returns to normal after the hypernatremia is corrected.

A primary characteristic of hypernatremia is thirst. Thirst is a strong defender of normal serum sodium levels in healthy people. Because of thirst, hypernatremia does not occur unless the person is unconscious or cannot access water. However, those who are ill and older adults may have an impaired thirst mechanism (Cash & Glass, 2018).

Assessment and Diagnostic Findings

In hypernatremia, the serum sodium level exceeds 145 mEq/L (145 mmol/L) and the serum osmolality exceeds 300 mOsm/kg (300 mmol/L). The urine specific gravity and urine osmolality are increased as the kidneys attempt to conserve water (provided the water loss is from a route other than the kidneys). Patients with diabetes insipidus do not reabsorb water into the bloodstream at the nephron. These patients consequently develop excess urine output, dehydration, and hypernatremia. Without ADH, these patients excrete very dilute urine with a urine osmolality less than 250 mOsm/kg (Emmett & Palmer, 2018a).

Medical Management

Treatment of hypernatremia consists of a gradual lowering of the serum sodium level by the infusion of a hypotonic solution (e.g., 0.45% sodium chloride) or an isotonic nonsaline solution (e.g., dextrose 5% in water [D_5W]). D_5W can be used when water needs to be replaced without sodium. However, hypotonic sodium chloride solution (0.45% NaCl) is thought to be safer than D_5W because it allows a gradual reduction in the serum sodium level. Gradual reduction in serum sodium decreases the risk of cerebral edema. Hypotonic sodium chloride solution (0.45% NaCl) is the IV solution of choice in severe hyperglycemia with hypernatremia. A rapid reduction in the serum sodium

level that occurs with D_5W temporarily decreases the plasma osmolality below that of the fluid in the brain tissue, causing dangerous cerebral edema. Alternatively in hypernatremia, diuretics can be prescribed to treat the excess sodium (Sterns & Hoorn, 2019).

There is no consensus about the exact rate at which serum sodium levels should be reduced. As a general rule, the serum sodium level is reduced at a rate no faster than 0.5 to 1 mEq/L/h to allow sufficient time for readjustment through diffusion across fluid compartments. Desmopressin acetate, a synthetic ADH, may be prescribed to treat diabetes insipidus if it is the cause of hypernatremia (Bichet, 2017; Mushin & Mount, 2018).

Nursing Management

Fluid losses and gains are carefully monitored in patients who are at risk for hypernatremia. The nurse should assess for abnormal losses of water or low water intake and for large gains of sodium, as might occur with ingestion of OTC medications that have a high sodium content (e.g., Alka-Seltzer). In addition, the nurse obtains a medication history, because some prescription medications have a high sodium content. The nurse also notes the patient's thirst or elevated body temperature and evaluates it in relation to other clinical signs and symptoms. The patient is monitored closely for changes in behavior, such as restlessness, disorientation, and lethargy (Sterns, 2017c; Sterns & Hoorn, 2019).

Preventing Hypernatremia

The nurse attempts to prevent hypernatremia by providing oral fluids at regular intervals, particularly in patients who are unable to perceive or respond to thirst. If fluid intake remains inadequate or the patient is unconscious, the nurse consults with the primary provider to plan an alternative route for intake, either by enteral feedings or by the parenteral route. If enteral feedings are used, sufficient water should be given to keep the serum sodium and BUN within normal limits. As a rule, the higher the osmolality of the enteral feeding, the greater is the need for water supplementation (Emmett & Palmer, 2018a; Sterns & Hoorn, 2019). Some herbal medications can also increase serum sodium levels.

For patients with diabetes insipidus, adequate water intake must be ensured. If the patient is alert and has an intact thirst mechanism, merely providing access to water may be sufficient. If the patient has a decreased level of consciousness or other disability interfering with adequate fluid intake, parenteral fluid replacement may be prescribed. This therapy can be anticipated in patients with neurologic disorders, particularly in the early postoperative period (Bichet, 2017).

Correcting Hypernatremia

When parenteral fluids are necessary for managing hypernatremia, the nurse monitors the patient's response to the infusion of fluids by reviewing serial serum sodium levels and by observing for changes in neurologic status, such as confusion, disorientation, and possible decreased level of consciousness (Mushin & Mount, 2018). With a gradual decrease in the serum sodium level, neurologic status should improve. However, too rapid reduction in the serum sodium level renders the plasma temporarily hypoosmotic compared to the intracellular fluid within the brain cells. This can cause fluid in the plasma to shift into the brain cells which can produce the dangerous state of cerebral edema (Hutto & French, 2017).

Potassium Imbalances

Potassium (K^+) is the major intracellular electrolyte; in fact, 98% of the body's potassium is inside the cells. The remaining 2% is in the ECF and is important to neuromuscular and cardiac function. Potassium influences both skeletal and cardiac muscle activity. For example, alterations in K^+ concentration can change myocardial irritability and rhythm. Under the influence of the sodium–potassium pump, potassium is constantly being pumped into the cells. The normal serum potassium concentration ranges from 3.5 to 5 mEq/L (3.5 to 5 mmol/L), and even minor variations are significant (Norris, 2019). Potassium imbalances are commonly associated with various diseases, injuries, medications (e.g., NSAIDs and ACE inhibitors), and acid–base imbalances (Mount, 2017a). The two types of potassium imbalances are potassium deficit and potassium excess (Table 10-7).

TABLE 10-7 Potassium Imbalances

Imbalance	Contributing Factors	Signs/Symptoms
Potassium deficit (hypokalemia) Serum potassium <3.5 mEq/L	Diarrhea, vomiting, gastric suction, corticosteroid administration, hyperaldosteronism, carbenicillin, amphotericin B, bulimia, osmotic diuresis, alkalosis, starvation, diuretics, and digoxin toxicity	Fatigue, anorexia, nausea and vomiting, muscle weakness, polyuria, decreased bowel motility, ventricular asystole or fibrillation, paresthesias, leg cramps, ↓ BP, ileus, abdominal distention, hypoactive reflexes. *ECG:* flattened T waves, prominent U waves, ST depression, prolonged PR interval
Potassium excess (hyperkalemia) Serum potassium >5.0 mEq/L	Pseudohyperkalemia, oliguric kidney injury, use of potassium-conserving diuretics in patients with renal insufficiency, metabolic acidosis, Addison disease, crush injury, burns, stored bank blood transfusions, rapid IV administration of potassium, and certain medications such as ACE inhibitors, NSAIDs, cyclosporine	Muscle weakness, tachycardia → bradycardia, arrhythmias, flaccid paralysis, paresthesias, intestinal colic, cramps, abdominal distention, irritability, anxiety. *ECG:* tall tented T waves, prolonged PR interval and QRS duration, absent P waves, ST depression

ACE, angiotensin-converting enzyme; BP, blood pressure; ↓, decreased; ECG, electrocardiogram; →, followed by; IV, intravenous; NSAIDs, nonsteroidal anti-inflammatory drugs.

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health state* (10th ed.). Philadelphia, PA: Wolters Kluwer.

To maintain potassium balance, the renal system must function, because 80% of the potassium excreted daily leaves the body by way of the kidneys; the other 20% is lost through the bowel and in sweat. The kidneys regulate potassium balance by adjusting the amount of potassium that is excreted in the urine. As serum potassium levels increase, so does the potassium level in the renal tubular cell. A concentration gradient occurs, favoring the movement of potassium into the renal tubule and excretion of potassium in the urine. Aldosterone also increases the excretion of potassium by the kidney. Because the kidneys do not conserve potassium as well as they conserve sodium, potassium may still be lost in urine in the presence of a potassium deficit (Norris, 2019).

Potassium Deficit (Hypokalemia)

Hypokalemia (serum potassium level below 3.5 mEq/L [3.5 mmol/L]) usually indicates a deficit in total potassium stores. However, it may occur in patients

with normal potassium stores: When **alkalosis** (high blood pH) is present, a temporary shift of serum potassium into the cells occurs (see later discussion).

Pathophysiology

Potassium-losing diuretics, such as the thiazides and loop diuretics, can induce hypokalemia. Other medications that can lead to hypokalemia include corticosteroids, sodium penicillin, and amphotericin B (Vallerand & Sanoski, 2019). GI loss of potassium is another common cause of potassium depletion. Vomiting and gastric suction frequently lead to hypokalemia, because potassium is lost when gastric fluid is lost and because potassium is lost through the kidneys in response to metabolic alkalosis. Because relatively large amounts of potassium are contained in intestinal fluids, potassium deficit occurs frequently with diarrhea, which may contain as much potassium as 30 mEq/L. Potassium deficit also occurs from prolonged intestinal suctioning, recent ileostomy, and villous adenoma (a tumor of the intestinal tract characterized by excretion of potassium-rich mucus) (Mount, 2017b).

Alterations in acid–base balance have a significant effect on potassium distribution due to shifts of hydrogen and potassium ions between the cells and the ECF. Respiratory or metabolic alkalosis promotes the transcellular shift of potassium and can have a variable and unpredictable effect on serum potassium. For example, hydrogen ions move out of the cells into the bloodstream in alkalotic states to help correct the high pH, and potassium ions move into the cells to maintain an electrically neutral state (Mount, 2017c) (see later discussion of acid–base balance).

Aldosterone from the adrenal gland acts on the nephron to increase sodium and water reabsorption into the bloodstream. It simultaneously secretes potassium into the renal tubules which in turn is excreted in the urine. In hyperaldosteronism, potassium is constantly secreted into the nephron tubule fluid which leads to loss of potassium into the urine. Hyperaldosteronism causes renal potassium wasting and can lead to severe potassium depletion. Primary hyperaldosteronism is seen in patients with adrenal adenomas (tumors). Secondary hyperaldosteronism occurs in patients with cirrhosis, nephrotic syndrome, heart failure, or malignant hypertension (Dick, Queiroz, Bernardi, et al., 2018).

Insulin promotes the entry of potassium into cells from the bloodstream; therefore, patients with persistent insulin hypersecretion may experience hypokalemia. Patients receiving high carbohydrate parenteral nutrition will have increased secretion of insulin. This will cause the shift of potassium into the cells from the bloodstream, causing hypokalemia. In diabetic ketoacidosis (DKA), potassium moves out of the cell since H^+ ions are high; during this acute phase it seems as though the patient has hyperkalemia. With insulin

treatment of DKA, potassium moves back into the cells, causing hypokalemia (Palmer & Clegg, 2016a).

Patients who are not able to eat a normal diet for a prolonged period are at risk for hypokalemia. This may occur in debilitated older adults and in patients with alcoholism or anorexia nervosa. In addition to poor intake, people with bulimia frequently experience increased potassium loss through self-induced vomiting and overuse of laxatives, diuretics, and enemas. These patients may also be deficient in magnesium. Magnesium depletion also causes renal potassium loss and must be corrected first; otherwise, urine loss of potassium will continue (Mount, 2017d).

Clinical Manifestations

Potassium deficiency can result in widespread derangements in physiologic function. Severe hypokalemia can cause death through cardiac or respiratory arrest. Clinical signs develop when the potassium level decreases to less than 3 mEq/L (3 mmol/L) (Mount, 2017b). Clinical signs and symptoms can be found in Table 10-7. If prolonged, hypokalemia can lead to an inability of the kidneys to concentrate urine, causing dilute urine (resulting in polyuria, nocturia) and excessive thirst. Potassium depletion suppresses the release of insulin and results in glucose intolerance (Palmer & Clegg, 2016a).

Assessment and Diagnostic Findings

In hypokalemia, the serum potassium concentration is less than the lower limit of normal, which is 3.5 mEq/L. Electrocardiographic (ECG) changes can include flat T waves or inverted T waves or both, suggesting ischemia, and depressed ST segments (Fig. 10-8). An elevated U wave is specific to hypokalemia.

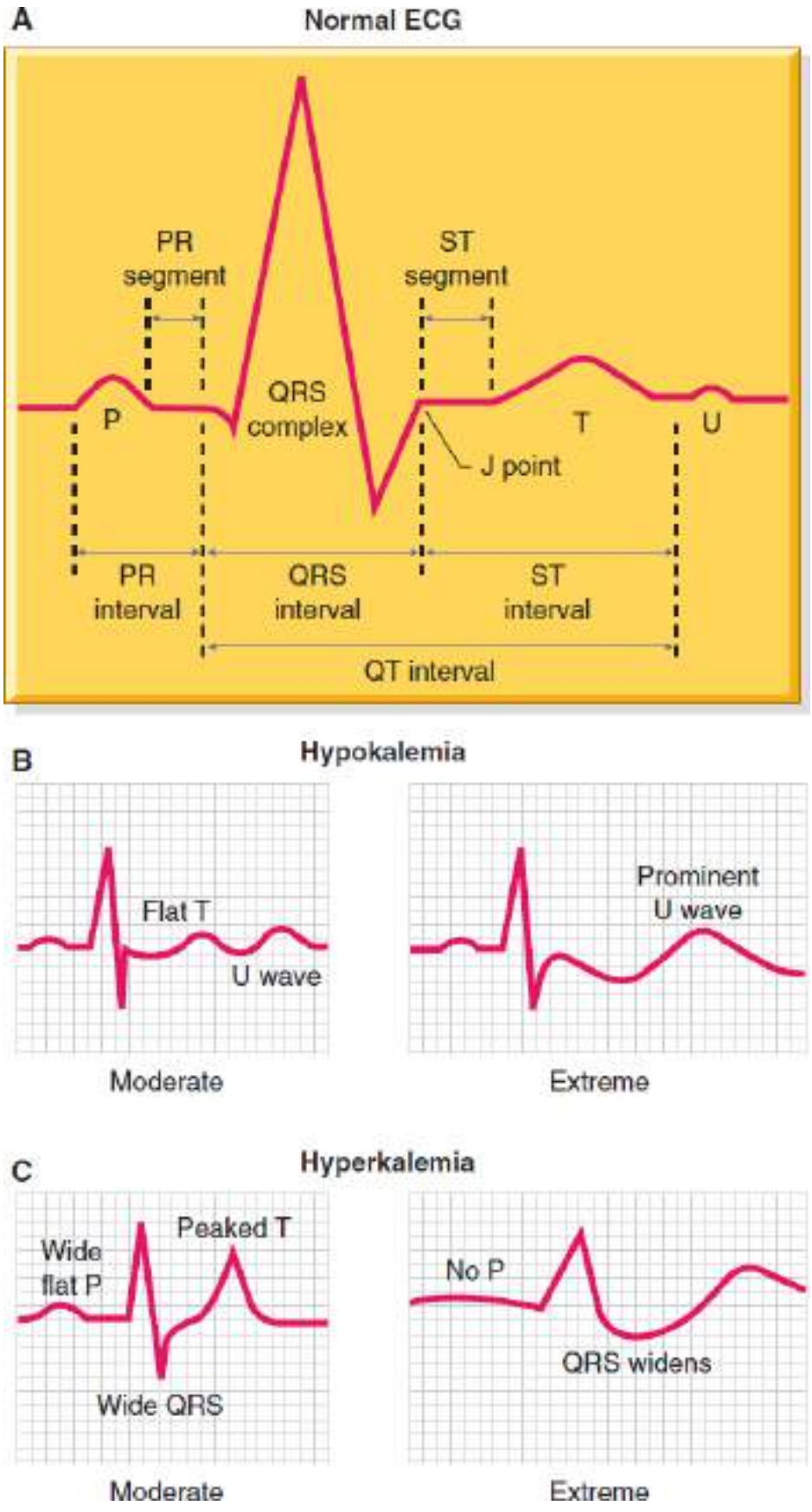

Figure 10-8 • Effect of potassium on the electrocardiogram (ECG). **A.** Normal tracing. **B.** Hypokalemia: serum potassium level below

normal. **Left:** Flattening of the T wave and the appearance of a U wave. **Right:** Further flattening with prominent U wave. **C.** Hyperkalemia: serum potassium level above normal. **Left:** Moderate elevation with wide, flat P wave; wide QRS complex; and peaked T wave. **Right:** ECG changes seen with extreme potassium elevation: widening of QRS complex and absence of P wave.

Quality and Safety Nursing Alert

Hypokalemia increases sensitivity to digitalis, predisposing the patient to digitalis toxicity at lower digitalis levels.

Metabolic alkalosis is commonly associated with hypokalemia. This is discussed further in the section on acid–base disturbances in this chapter.

The source of the potassium loss is usually evident from a careful history. However, if the cause of the loss is unclear, a 24-hour urinary potassium excretion test can be performed to distinguish between renal and extrarenal loss. Urinary potassium excretion exceeding 20 mEq/day with hypokalemia suggests that renal potassium loss is the cause.

Medical Management

If hypokalemia cannot be prevented by conventional measures such as increased intake in the daily diet or by oral potassium supplements for deficiencies, then it is treated cautiously with IV replacement therapy (Mount, 2017b). Potassium loss must be corrected daily; administration of 40 to 60 mEq/day of potassium is adequate in the adult if there are no abnormal losses of potassium.

For patients who are at risk for hypokalemia, a diet containing sufficient potassium should be provided. Dietary intake of potassium in the average adult is 50 to 100 mEq/day. Foods high in potassium include most fruits and vegetables, legumes, whole grains, milk, and meat (Palmer & Clegg, 2016b).

When dietary intake is inadequate for any reason, oral or IV potassium supplements may be prescribed. Many salt substitutes contain 50 to 60 mEq of potassium per teaspoon and may be sufficient to prevent hypokalemia. If oral administration of potassium is not feasible, the IV route is indicated. The IV route is mandatory for patients with severe hypokalemia (e.g., serum level of 2 mEq/L). Although potassium chloride (KCl) is usually used to correct potassium deficits, potassium acetate or potassium phosphate may be prescribed (Mount, 2017e; Vallerand & Sanoski, 2019).

Nursing Management

Because hypokalemia can be life-threatening, the nurse needs to monitor for its early presence in patients at risk. Fatigue, anorexia, muscle weakness, decreased bowel motility, paresthesias, and arrhythmias are signals that warrant assessing the serum potassium concentration. When available, the ECG may provide useful information (Mount, 2017b). For example, patients receiving digitalis who are at risk for potassium deficiency should be monitored closely for signs of digitalis toxicity, because hypokalemia potentiates the action of digitalis.

Preventing Hypokalemia

The nurse helps prevent hypokalemia by encouraging patients at risk to eat foods rich in potassium (when the diet allows). Consumption of foods high in potassium should be encouraged; examples include bananas, melon, citrus fruits, fresh and frozen vegetables (avoid canned vegetables), lean meats, milk, and whole grains. If the hypokalemia is caused by abuse of laxatives or diuretics, patient education may help alleviate the problem. Part of the health history and assessment should be directed at identifying problems that are amenable to prevention through education. Careful monitoring of fluid I&O is necessary, because 40 mEq of potassium is lost for every liter of urine output. The ECG is monitored for changes, and arterial blood gas (ABG) values are checked for elevated bicarbonate and pH levels.

Correcting Hypokalemia

The oral route is ideal to treat mild to moderate hypokalemia because oral potassium supplements are well absorbed. Care should be exercised when administering potassium, particularly in older adults, who have lower lean body mass and total-body potassium levels and therefore lower potassium requirements. In addition, because of the physiologic loss of renal function with advancing years, potassium may be retained more readily in older than in younger people (Cash & Glass, 2018).

Quality and Safety Nursing Alert

Oral potassium supplements can produce small bowel lesions; therefore, the patient must be assessed for and cautioned about abdominal distention, pain, or GI bleeding.

Administering Intravenous Potassium

Potassium should be given only after adequate urine output has been established. A decrease in urine volume to less than 20 mL/h for 2 consecutive hours is an indication to stop the potassium infusion and notify the primary

provider. Potassium is primarily excreted by the kidneys; when oliguria occurs, potassium administration can cause the serum potassium concentration to rise to dangerous levels (Mount, 2017e).

Quality and Safety Nursing Alert

Potassium is never given by IV push or intramuscularly to avoid replacing potassium too quickly. Potassium is extremely irritating to tissues. IV potassium must be given using an infusion pump.

Each health care facility has its own policy for the administration of potassium, which must be consulted. Administration of IV potassium is done with extreme caution using an infusion pump with the patient monitored by continuous ECG. Caution must be used when selecting a premixed solution of IV fluid containing KCl, as the concentrations range from 10 to 40 mEq/100 mL. Renal function should be monitored through BUN and serum creatinine levels and urine output if the patient is receiving potassium replacement. During replacement therapy, the patient should be monitored for signs of worsening hypokalemia as well as hyperkalemia.

Potassium Excess (Hyperkalemia)

Hyperkalemia (serum potassium level greater than 5 mEq/L [5 mmol/L]) seldom occurs in patients with normal renal function. In older adults, there is an increased risk of hyperkalemia due to decreases in renin and aldosterone as well as an increased number of comorbid cardiac conditions. Like hypokalemia, hyperkalemia is often caused by iatrogenic (treatment-induced) causes. Although hyperkalemia is less common than hypokalemia, it is usually more dangerous because cardiac arrest is more frequently associated with high serum potassium levels (Mount, 2017a).

Pathophysiology

Major causes of hyperkalemia are decreased renal excretion of potassium, rapid administration of potassium, and movement of potassium from the ICF compartment to the ECF compartment. Hyperkalemia is commonly seen in patients with untreated kidney injury, particularly those in whom potassium levels increase as a result of infection or excessive intake of potassium in food or medications (Mount, 2017a). Patients with hypoaldosteronism or Addison disease are at risk for hyperkalemia because of a lack of aldosterone. Lack of aldosterone activity at the nephron causes inadequate sodium and water reabsorption into the bloodstream and inadequate excretion of potassium in the

urine. Therefore, deficient adrenal hormones lead to sodium loss and potassium retention (Norris, 2019).

Medications have been identified as a probable contributing factor in more than 60% of hyperkalemic episodes. Medications commonly implicated are KCl, heparin, ACE inhibitors, NSAIDs, beta-blockers, cyclosporine, tacrolimus, and potassium-sparing diuretics (Comerford & Durkin, 2020). Potassium regulation is compromised in acute and chronic kidney disease, with a glomerular filtration rate less than 10% to 20% of normal (Mount, 2017c).

Improper use of potassium supplements predisposes all patients to hyperkalemia, especially if salt substitutes are used. Not all patients receiving potassium-losing diuretics require potassium supplements, and patients receiving potassium-conserving diuretics should not receive supplements.

Quality and Safety Nursing Alert

Potassium supplements are extremely dangerous for patients who have impaired renal function and thus decreased ability to excrete potassium. Even more dangerous is the IV administration of potassium to such patients, because serum levels can rise very quickly. It is possible to exceed the renal tolerance of any patient with rapid IV potassium administration, as well as when large amounts of oral potassium supplements are ingested.

In **acidosis** (low blood pH), potassium moves out of the cells and into the ECF. This occurs as hydrogen ions enter the cells to buffer the pH of the ECF (see later discussion).

An elevated ECF potassium level should be anticipated when extensive tissue trauma has occurred, as in burns, crushing injuries, or severe infections. Similarly, it can occur with lysis of malignant cells after chemotherapy (i.e., tumor lysis syndrome). Any disorder that causes high amounts of cellular lysis or deterioration can cause hyperkalemia (Mount, 2017a).

Pseudohyperkalemia (a false hyperkalemia) has several causes, including the improper collection or transport of a blood sample, a traumatic venipuncture, and use of a tight tourniquet around an exercising extremity while drawing a blood sample, producing hemolysis of the sample before analysis. Other causes include marked leukocytosis (white blood cell count exceeding 200,000/mm^3) and thrombocytosis (platelet count exceeding 1 million/mm^3); drawing blood above a site where potassium is infusing; and familial pseudohyperkalemia, in which potassium leaks out of the RBCs while the blood is awaiting analysis. Lack of awareness of these causes of pseudohyperkalemia can lead to aggressive treatment of a nonexistent

hyperkalemia, resulting in serious lowering of serum potassium levels. Therefore, measurements of grossly elevated levels of potassium in the absence of clinical manifestations (e.g., normal ECG) should be verified by retesting (Mount, 2017a).

Clinical Manifestations

Clinical signs and symptoms can be found in Table 10-7. The most important consequence of hyperkalemia is its effect on the myocardium. Cardiac effects of elevated serum potassium are usually not significant when the level is less than 7 mEq/L (7 mmol/L); however, they are almost always present when the level is 8 mEq/L (8 mmol/L) or greater. As the plasma potassium level rises, disturbances in cardiac conduction occur. The earliest changes, often occurring at a serum potassium level greater than 6 mEq/L (6 mmol/L), are peaked, narrow T waves; ST-segment depression; and a shortened QT interval. If the serum potassium level continues to increase, the PR interval becomes prolonged and is followed by disappearance of the P waves. Finally, there is decomposition and widening of the QRS complex (see Fig. 10-7). Ventricular arrhythmias and cardiac arrest may occur (Mount, 2017a).

Assessment and Diagnostic Findings

Serum potassium levels and ECG changes are crucial to the diagnosis of hyperkalemia, as discussed previously. ABG analysis may reveal either a metabolic or a respiratory acidosis. These are discussed further in the section on acid–base disturbances in this chapter. Correcting the acidosis helps correct the hyperkalemia.

Medical Management

In disorders involving potassium level changes, an ECG should be obtained immediately. Shortened repolarization and peaked T waves are seen initially in hyperkalemia. To verify results, a repeat serum potassium level should be obtained from a vein that is not concomitantly infusing an IV solution containing potassium (Mount, 2017e).

In nonacute situations, restriction of dietary potassium and potassium-containing medications may correct the imbalance. For example, eliminating the use of potassium-containing salt substitutes in a patient who is taking a potassium-conserving diuretic may be all that is needed to deal with mild hyperkalemia.

Administration, either orally or by retention enema, of cation exchange resins (e.g., sodium polystyrene sulfonate) may be necessary. The use of cation exchange resins requires normal bowel function. For instance, cation exchange

resins cannot be used if the patient has a paralytic ileus (i.e., absence of peristalsis in the intestine), because intestinal perforation can occur. Sodium polystyrene sulfonate binds with potassium and then is eliminated in the feces. Other cations in the GI tract can also be depleted which can cause hypomagnesemia and hypocalcemia. Sodium polystyrene sulfonate may also cause sodium retention and fluid overload and should be used with caution in patients with heart failure (Frandsen & Pennington, 2018; Mount, 2017e).

Patiromer sorbitex calcium is another oral agent that is a potassium-removing resin used to treat hyperkalemia. It exchanges calcium for potassium in the lower intestine, thereby increasing fecal excretion of potassium. Side effects include GI intolerance, hypomagnesemia, and edema (Depret, Peacock, Liu, et al., 2019).

Emergency Pharmacologic Therapy

If serum potassium levels are dangerously elevated, it may be necessary to administer IV calcium gluconate. Within minutes after administration, calcium antagonizes the action of hyperkalemia on the heart but does not reduce the serum potassium concentration. Calcium chloride and calcium gluconate are not interchangeable; calcium gluconate contains 4.5 mEq of calcium, and calcium chloride contains 13.6 mEq of calcium. Therefore, caution is required when using calcium preparations to reduce potassium levels (Ashurst, Sergent, & Sergent, 2016).

Monitoring the blood pressure is essential to detect hypotension, which may result from the rapid IV administration of calcium gluconate. The ECG should be continuously monitored during administration; the appearance of bradycardia is an indication to stop the infusion. The myocardial protective effects of calcium last about 30 minutes. Extra caution is required if the patient has received an accelerated dose of a digitalis-based cardiac glycoside to reach a desired serum digitalis level rapidly as parenteral administration of calcium sensitizes the heart to digitalis and may precipitate digitalis toxicity (Ashurst et al., 2016).

IV administration of sodium bicarbonate may be necessary in severe metabolic acidosis to alkalinize the plasma, shift potassium into the cells, and furnish sodium to antagonize the cardiac effects of potassium. Effects of this therapy begin within 30 to 60 minutes and may persist for hours; however, they are temporary. Circulatory overload and hypernatremia can occur when large amounts of hypertonic sodium bicarbonate are given. Bicarbonate therapy should be guided by the bicarbonate concentration or calculated base deficit obtained from blood gas analysis or laboratory measurement (Mount, 2017c).

IV administration of regular insulin and a hypertonic dextrose solution causes a temporary shift of potassium into the cells. Glucose and insulin therapy have an onset of action within 30 minutes and lasts for several hours.

Loop diuretics, such as furosemide, increase excretion of water by inhibiting sodium, potassium, and chloride reabsorption in the ascending loop of Henle and distal renal tubule (Ashurst et al., 2016).

Beta-2 agonists, such as albuterol, are highly effective in decreasing potassium; however, their use is not without risk as they can cause tachycardia and chest discomfort (Depret et al., 2019; Long, Warix, & Koyfman, 2018). Beta-2 agonists, administered intravenously or via nebulizer, move potassium into the cells and may be used in the absence of ischemic cardiac disease. Their use is a stopgap measure that only temporarily protects the patient from hyperkalemia.

If the hyperkalemic condition is not transient, removal of potassium from the body can also be done through peritoneal dialysis, hemodialysis, or other forms of renal replacement therapy.

Nursing Management

Patients at risk for potassium excess (e.g., those with kidney disease) need to be identified and closely monitored for signs of hyperkalemia. The nurse monitors I&O and observes for signs of muscle weakness and arrhythmias. When measuring vital signs, an apical pulse should be taken. The presence of paresthesias and GI symptoms such as nausea and intestinal cramping should be noted. Serum potassium levels, as well as BUN, serum creatinine, serum glucose, and ABG values, should be monitored for patients at risk for developing hyperkalemia.

Preventing Hyperkalemia

Measures should be taken to prevent hyperkalemia in patients at risk, when possible, by encouraging the patient to adhere to the prescribed potassium restriction. Potassium-rich foods to be avoided include many fruits and vegetables, legumes, whole-grain breads, lean meat, milk, eggs, coffee, tea, and cocoa. Conversely, foods with minimal potassium content include butter, margarine, cranberry juice or sauce, ginger ale, gumdrops or jelly beans, hard candy, root beer, sugar, and honey. Labels of cola beverages must be checked carefully because some are high in potassium and some are not (McDonough & Youn, 2017).

Correcting Hyperkalemia

It is possible to exceed the tolerance for potassium if given rapidly by the IV route. Therefore, careful monitoring is necessary when administering potassium solutions. Particular attention is paid to the solution's concentration and rate of administration. IV administration should only be via an infusion pump (Mount, 2017e).

The nurse must caution patients to use salt substitutes sparingly if they are taking other supplementary forms of potassium or potassium-conserving diuretics. In addition, potassium-conserving diuretics, potassium supplements, and salt substitutes should not be given to patients with kidney injury (Mount, 2017e).

Calcium Imbalances

More than 99% of the body's calcium (Ca^{++}) is located in the skeletal system; it is a major component of bones and teeth. About 1% of skeletal calcium is rapidly exchangeable with blood calcium, and the rest is more stable and only slowly exchanged. The small amount of calcium located outside the bone circulates in the serum, partly bound to protein and partly ionized. Calcium plays a major role in transmitting nerve impulses and helps regulate muscle contraction and relaxation, including cardiac muscle. Calcium is instrumental in activating enzymes that stimulate many essential chemical reactions in the body, and it also plays a role in blood coagulation. Because many factors affect calcium regulation, both hypocalcemia and hypercalcemia are relatively common disturbances (Norris, 2019) (Table 10-8).

The normal adult total serum calcium level is 8.8 to 10.4 mg/dL (2.2 to 2.6 mmol/L) (Fischbach & Fischbach, 2018). Calcium exists in plasma in three forms: ionized, bound, and complex. Approximately 50% of the serum calcium exists in a physiologically active ionized form that is important for neuromuscular activity and blood coagulation; this is the only physiologically and clinically significant form. The normal ionized serum calcium level is 4.5 to 5.1 mg/dL (1.1 to 1.3 mmol/L). Less than half of the plasma calcium is bound to serum proteins, primarily albumin. The remainder is combined with nonprotein anions: phosphate, citrate, and carbonate (Hogan & Goldfarb, 2018).

TABLE 10-8 Calcium Imbalances

Imbalance	Contributing Factors	Signs/Symptoms and Laboratory Findings
Calcium deficit (hypocalcemia) Serum calcium <8.8 mg/dL	Hypoparathyroidism (may follow thyroid surgery or radical neck dissection), malabsorption, pancreatitis, alkalosis, vitamin D deficiency, massive subcutaneous infection, generalized peritonitis, massive transfusion of citrated blood, chronic diarrhea, decreased parathyroid hormone, diuretic phase of acute kidney injury, ↑ PO_4, fistulas, burns, alcoholism	Numbness, tingling of fingers, toes, and circumoral region; positive Trousseau sign and Chvostek sign; seizures, carpopedal spasms, hyperactive deep tendon reflexes, irritability, bronchospasm, anxiety, impaired clotting time, ↓ prothrombin, diarrhea, ↓ BP. *ECG:* prolonged QT interval and lengthened ST *Labs indicate:* ↓ Mg^{++}
Calcium excess (hypercalcemia) Serum calcium >10.4 mg/dL	Hyperparathyroidism, malignant neoplastic disease, prolonged immobilization, overuse of calcium supplements, vitamin D excess, oliguric phase of acute kidney injury acidosis, corticosteroid therapy, thiazide diuretic use, increased parathyroid hormone, and digoxin toxicity	Muscular weakness, constipation, anorexia, nausea and vomiting, polyuria and polydipsia, dehydration, hypoactive deep tendon reflexes, lethargy, deep bone pain, pathologic fractures, flank pain, calcium stones, hypertension. *ECG:* shortened ST segment and QT interval, bradycardia, heart blocks

BP, blood pressure; ↓, decreased; ECG, electrocardiogram; ↑, increased.
Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health state* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Calcium is absorbed from foods in the presence of normal gastric acidity and vitamin D. It is excreted primarily in the feces, with the remainder excreted in the urine. The serum calcium level is controlled by PTH and calcitonin. As ionized serum calcium decreases in the bloodstream, the parathyroid glands secrete PTH. This, in turn, increases calcium absorption from the GI tract, increases calcium reabsorption from the renal tubule, and releases calcium from the bone. The resultant increase in calcium ion concentration in the bloodstream then suppresses PTH secretion. When calcium increases excessively, the thyroid gland secretes calcitonin, which inhibits calcium reabsorption from bone and decreases the serum calcium concentration (Norris, 2019).

Calcium Deficit (Hypocalcemia)

Hypocalcemia (serum calcium value lower than 8.8 mg/dL [2.20 mmol/L]) occurs in a variety of clinical situations. A patient may have a total-body calcium deficit (as in osteoporosis) but a normal serum calcium level. Older adults and those with disability have an increased risk of hypocalcemia because immobility, particularly lack of weight-bearing activity, increases bone resorption (Cash & Glass, 2018; Goltzman, 2017).

Pathophysiology

The parathyroid glands are instrumental in regulating blood and body calcium levels. Several factors can cause hypocalcemia, including primary hypoparathyroidism and surgical hypoparathyroidism. Surgical hypoparathyroidism is more common as a result of unintentional trauma or devascularization of the parathyroid glands (Kazaure & Sosa, 2018). Not only is hypocalcemia associated with thyroid and parathyroid surgery, but it can also occur after radical neck dissection and is most likely in the first 24 to 48 hours after surgery. Transient hypocalcemia can occur with massive administration of citrated blood (i.e., massive hemorrhage and shock), because citrate can combine with ionized calcium and temporarily remove it from the circulation (Goltzman, 2017).

Inflammation of the pancreas causes the breakdown of proteins and lipids. It is thought that calcium ions combine with the fatty acids released by lipolysis, forming soaplike compounds. As a result of this process, hypocalcemia occurs and is common in pancreatitis. Hypocalcemia may also be related to excessive secretion of glucagon from the inflamed pancreas, which results in increased secretion of calcitonin from the thyroid gland.

Hypocalcemia is common in patients with acute kidney injury, because these patients frequently have elevated serum phosphate levels. Hyperphosphatemia usually causes a reciprocal drop in the serum calcium level. Other causes of hypocalcemia include inadequate vitamin D consumption, magnesium deficiency, medullary thyroid carcinoma, low serum albumin levels, alkalosis, and alcohol abuse. Medications predisposing to hypocalcemia include aluminum-containing antacids, aminoglycosides, caffeine, cisplatin, corticosteroids, mithramycin, phosphates, isoniazid, loop diuretics, and proton pump inhibitors (Goltzman, 2017).

Clinical Manifestations

Tetany, the most characteristic manifestation of hypocalcemia and hypomagnesemia, refers to the entire symptom complex induced by increased neural excitability. Clinical signs and symptoms are caused by spontaneous discharges of both sensory and motor fibers in peripheral nerves and are outlined in Table 10-8.

Chvostek sign (Fig. 10-9A) consists of twitching of muscles innervated by the facial nerve in response to tapping of the muscle just below the zygomatic arch. Trousseau sign (Fig. 10-9B) can be elicited by inflating a blood pressure cuff on the upper arm to about 20 mm Hg above systolic pressure; within 2 to 5 minutes, carpal spasm will occur as ischemia of the ulnar nerve develops (Goltzman, 2019a).

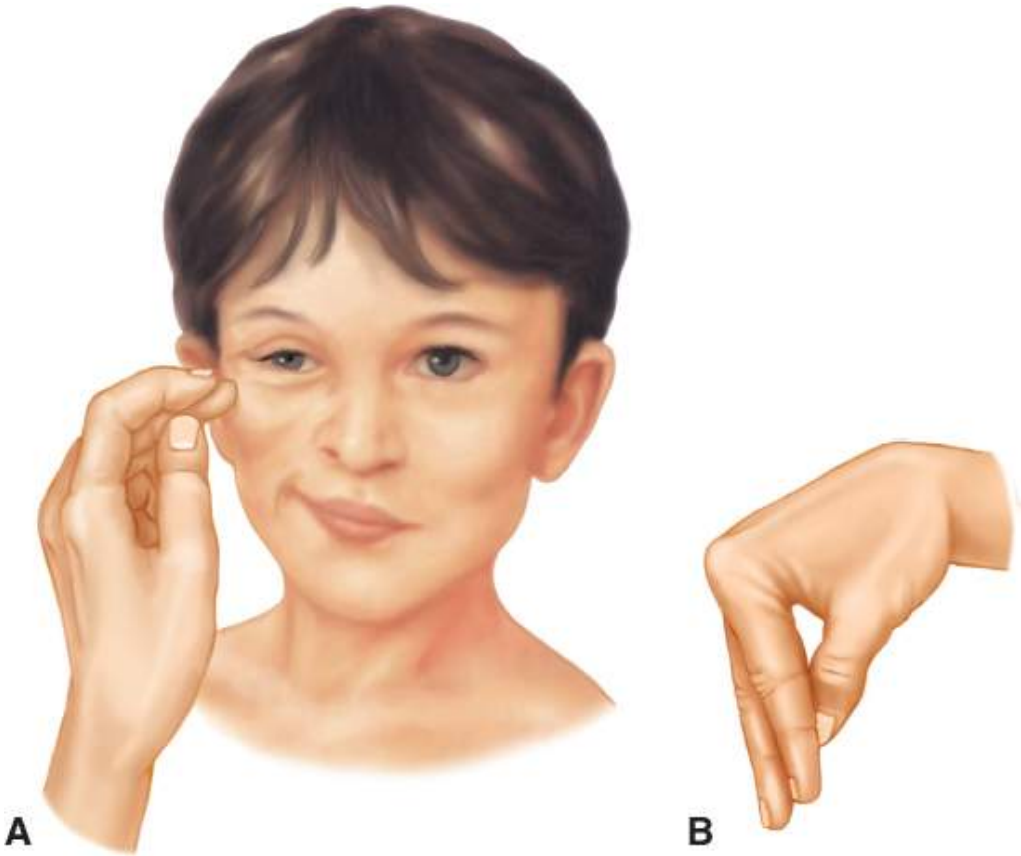

Figure 10-9 • **A.** Chvostek sign: a contraction of the facial muscles elicited in response to light tap over the facial nerve in front of the ear. **B.** Trousseau sign: a carpopedal spasm induced by inflating a blood pressure cuff above systolic blood pressure. Adapted from Bullock, B. A., & Henze, R. J. (2000). *Focus on pathophysiology* (p. 173). Philadelphia, PA: Lippincott Williams & Wilkins.

Hypocalcemia can cause seizures because low calcium levels increase irritability of the central and peripheral nervous systems. Other changes associated with hypocalcemia include mental changes such as depression, impaired memory, confusion, delirium, and hallucinations. A prolonged QT interval is seen on the ECG due to prolongation of the ST segment, and torsades de pointes, a type of ventricular tachycardia, may occur. Respiratory effects with decreasing calcium include dyspnea and laryngospasm. Signs and symptoms of chronic hypocalcemia include hyperactive bowel sounds, dry and brittle hair and nails, and abnormal clotting (Goltzman, 2019a).

Osteoporosis is associated with prolonged low intake of calcium and represents a total-body calcium deficit, even though serum calcium levels are usually normal. This disorder occurs in millions of Americans and is most common in postmenopausal women. It is characterized by loss of bone mass, which causes bones to become porous and brittle and therefore susceptible to fracture (Black & Rosen, 2016) (see Chapter 36 for further discussion of osteoporosis).

Assessment and Diagnostic Findings

When evaluating serum calcium levels, the serum albumin level and the arterial pH must also be considered. Because abnormalities in serum albumin levels may affect interpretation of the serum calcium level, it may be necessary to calculate the corrected serum calcium if the serum albumin level is abnormal. For every decrease in serum albumin of 1 g/dL below 4 g/dL, the total serum calcium level is underestimated by approximately 0.8 mg/dL (Hogan & Goldfarb, 2018). Chart 10-2 displays a quick method that nurses can use to calculate the corrected serum calcium level.

Clinicians often discount a low serum calcium level in the presence of a similarly low serum albumin level. The ionized calcium level is usually normal in patients with reduced total serum calcium levels and concomitant hypoalbuminemia. When the arterial pH increases (alkalosis), more calcium becomes bound to protein. As a result, the ionized portion decreases. Symptoms of hypocalcemia may occur with alkalosis. Acidosis has the opposite effect—that is, less calcium is bound to protein and therefore more exists in the ionized form. However, relatively small changes in serum calcium levels occur in these acid–base abnormalities (Yu & Stubbs, 2019).

Chart 10-2

Calculating Corrected Serum Calcium Level

Abnormalities in serum albumin levels may affect interpretation of the serum calcium level. Below is a method for calculating the corrected serum calcium level if the serum albumin level is abnormal.

Quick Calculation Method

$$\text{Measured total serum } Ca^{++} \text{ level (mg/dL)} + 0.8 \times (4.0 - \text{Measured albumin level [g/dL]}) = \text{Corrected total calcium concentration (mg/dL)}$$

Example Calculation

A patient's reported serum albumin level is 2.5 g/dL; the reported serum calcium level is 10.5 mg/dL. First, the decrease in serum albumin level from normal (i.e., the difference from the normal albumin concentration of 4 g/dL) is calculated: 4 g/dL − 2.5 g/dL = 1.5 g/dL. Next, the following ratio is calculated:

$$0.8 \text{ mg/dL}:1 \text{ g/dL} = X \text{ mg/dL}:1.5 \text{ mg/dL}$$
$$X = 0.8 \times 1.5 \text{ mg/dL}$$
$$X = 1.2 \text{ mg/dL calcium}$$

Finally, 1.2 mg/dL is added to 10.5 mg/dL (the reported serum calcium level) to obtain the corrected total serum calcium level: 1.2 mg/dL + 10.5 mg/dL = 11.7 mg/dL.

Ideally, the ionized level of calcium should be measured in the laboratory. However, in many laboratories, only the total calcium level is reported; therefore, the concentration of the ionized fraction must be estimated by simultaneous measurement of the serum albumin level. Magnesium and phosphorus levels need to be assessed to identify possible causes of decreased calcium (Yu & Stubbs, 2019).

Medical Management

Emergency Pharmacologic Therapy

Acute symptomatic hypocalcemia is life-threatening and requires prompt treatment with IV administration of a calcium salt. Parenteral calcium salts include calcium gluconate and calcium chloride (Duval, Bach, Masson, et al., 2018; Goltzman, 2019b). Although calcium chloride produces a significantly higher ionized calcium level than calcium gluconate does, it is not used as often because it is more irritating and can cause sloughing of tissue if it infiltrates.

IV administration of calcium is particularly dangerous in patients receiving digitalis-derived medications, because calcium ions exert an effect similar to that of digitalis and can cause digitalis toxicity, with adverse cardiac effects. The IV site that delivers calcium must be observed often for any evidence of infiltration because of the risk of extravasation and resultant cellulitis or necrosis. A 0.9% sodium chloride solution should not be used with calcium because it increases renal calcium loss. Solutions containing phosphates or bicarbonate should not be used with calcium because they cause precipitation when calcium is added. The nurse must clarify with the primary provider and pharmacist which calcium salt to administer, because calcium gluconate yields 4.5 mEq of calcium and calcium chloride provides 13.6 mEq of calcium. Calcium replacement can cause orthostatic hypotension; therefore, the patient should remain in bed during IV infusion, and blood pressure is monitored (Duval et al., 2018).

Quality and Safety Nursing Alert

Too rapid IV administration of calcium can cause cardiac arrest, preceded by bradycardia. Therefore, calcium should be diluted in D_5W and given as a slow IV bolus or a slow IV infusion using an infusion pump. A 0.9% sodium chloride solution should not be used when administering calcium.

Nutritional Therapy

Vitamin D therapy may be instituted to increase calcium absorption from the GI tract; otherwise, the amount of calcium absorbed may not satisfy the body's calcium requirement. In addition, aluminum hydroxide, calcium acetate, or calcium carbonate antacids may be prescribed to decrease elevated phosphorus levels before treating hypocalcemia in the patient with chronic kidney disease. Increasing the dietary intake of calcium to at least 1000 to 1500 mg/day in the adult is recommended. Calcium supplements must be given in divided doses of no higher than 500 mg to promote calcium absorption. Calcium-containing foods include milk products; green, leafy vegetables; canned salmon; canned sardines; and fresh oysters. Hypomagnesemia can also cause tetany; if the tetany responds to IV calcium, then a low magnesium level is considered as a possible cause in chronic kidney dysfunction (Goltzman, 2019b; Rosen & Drezner, 2019).

Nursing Management

It is important to assess for hypocalcemia in at-risk patients. Seizure precautions are initiated if hypocalcemia is severe. The status of the airway is

closely monitored because laryngospasm can occur. Safety precautions are taken, as indicated, if confusion is present (Duval et al., 2018).

The nurse must educate the patient with hypocalcemia about foods that are rich in calcium. The nurse must also advise the patient to consider calcium supplements if sufficient calcium is not consumed in the diet. Such supplements should be taken in divided doses with meals. Alcohol and caffeine in high doses inhibit calcium absorption, and moderate cigarette smoking increases urinary calcium excretion. The patient is also cautioned to avoid the overuse of laxatives and antacids that contain phosphorus, because their use decreases calcium absorption (Rosen & Drezner, 2019).

Calcium Excess (Hypercalcemia)

Hypercalcemia (serum calcium value greater than 10.4 mg/dL [2.6 mmol/L]) can affect many organ systems. Symptoms depend on the degree of hypercalcemia and the rate of rise of calcium in the bloodstream. Mild hypercalcemia usually causes no apparent symptoms if the rise in calcium level is chronic over a long period of time. Moderate hypercalcemia can also be well tolerated. Marked symptoms occur when rise in calcium level is acute (Shane, 2019b).

Pathophysiology

The most common causes of hypercalcemia are malignancies and hyperparathyroidism. Malignant tumors can produce hypercalcemia by various mechanisms. The most common malignancies that are associated with hypercalcemia are breast, lung, renal, and multiple myeloma. In hyperparathyroidism, excessive PTH secretion causes increased release of calcium from the bones and increased intestinal and renal absorption of calcium. Calcifications of soft tissue occur when the calcium–phosphorus product (serum calcium × serum phosphorus) exceeds 70 mg/dL. Calcium levels are inversely related to phosphorus levels (Shane, 2019a).

Bone calcium is lost during immobilization, and sometimes this causes elevation of total (and especially ionized) calcium in the bloodstream. However, symptomatic hypercalcemia from immobilization is rare; when it does occur, it is limited to people with high calcium turnover rates (e.g., adolescents during a growth spurt). Most cases of hypercalcemia secondary to immobility occur after severe or multiple fractures or spinal cord injury (Shane, 2019a).

Thiazide diuretics can cause a slight elevation in serum calcium levels because they potentiate the action of PTH on the kidneys, reducing urinary calcium excretion. Vitamin A and D intoxication, as well as chronic lithium use and theophylline toxicity, can cause calcium excess.

Hypercalcemia reduces neuromuscular excitability because it suppresses activity at the myoneural junction. Decreased tone in smooth and striated muscle may cause symptoms such as muscle weakness, incoordination, anorexia, and constipation. Lethal arrhythmias (e.g., ventricular fibrillation) can occur when the serum calcium level is about 18 mg/dL (4.5 mmol/L). Calcium enhances the inotropic effect of digitalis; therefore, hypercalcemia aggravates digitalis toxicity (Shane, 2019a).

Clinical Manifestations

Clinical signs and symptoms can be found in Table 10-8. The symptoms of hypercalcemia are proportional to the degree of elevation of the serum calcium level. The more severe symptoms tend to appear when the serum calcium level climbs rapidly and may be as high as 16 mg/dL (4 mmol/L) or higher. However, some patients become profoundly disturbed with serum calcium levels of only 12 mg/dL (3 mmol/L). These symptoms resolve as serum calcium levels return to normal after treatment (Shane, 2019b).

Hypercalcemic crisis refers to an acute rise in the serum calcium level. Severe thirst and polyuria are often present. Other findings may include muscle weakness, intractable nausea, abdominal cramps, severe constipation, diarrhea, peptic ulcer symptoms, and bone pain. Lethargy, confusion, and coma may also occur. This condition is dangerous and may result in cardiac arrest. Emergency treatment with calcitonin is indicated (Shane & Berenson, 2019) (see later discussion under Pharmacologic Therapy).

Assessment and Diagnostic Findings

In hypercalcemia, the serum calcium level is greater than 10.4 mg/dL (2.6 mmol/L). Cardiovascular changes may include a variety of arrhythmias (e.g., heart blocks) and shortening of the QT interval and ST segment. The PR interval is sometimes prolonged. The double-antibody PTH test may be used to differentiate between primary hyperparathyroidism and malignancy as a cause of hypercalcemia: PTH levels are increased in primary or secondary hyperparathyroidism and suppressed in malignancy. X-rays may reveal bone changes if the patient has hypercalcemia secondary to a malignancy, bone cavitations, or urinary calculi. Urine calcium can be normal or elevated in hyperparathyroidism and hypercalcemia caused by malignancy (Shane, 2019b).

Medical Management

Therapeutic aims include decreasing the serum calcium level and reversing the process causing the hypercalcemia. Treating the underlying cause (e.g.,

chemotherapy for a malignancy, partial parathyroidectomy for hyperparathyroidism) is essential.

Pharmacologic Therapy

To treat hypercalcemia, measures include administering fluids to dilute serum calcium and promote its excretion by the kidneys, mobilizing the patient, and restricting dietary calcium intake. IV administration of 0.9% sodium chloride solution temporarily dilutes the serum calcium level and increases urinary calcium excretion by inhibiting tubular reabsorption of calcium. Administering IV phosphate can cause a reciprocal drop in serum calcium. Furosemide is often used in conjunction with administration of a saline solution; in addition to causing diuresis, furosemide increases calcium excretion. Although often overlooked, fluids and medications that contain calcium and dietary sources of calcium should be halted (Shane & Berenson, 2019).

Calcitonin can be used to lower the serum calcium level and is particularly useful for patients with heart disease or acute kidney injury who cannot tolerate large sodium loads. Calcitonin reduces bone resorption, increases the deposition of calcium and phosphorus in the bones, and increases urinary excretion of calcium and phosphorus. Although several forms are available, calcitonin derived from salmon is commonly used. Skin testing for allergy to salmon calcitonin may be necessary before the hormone is given. Systemic allergic reactions are possible because this hormone is a protein; resistance to the medication may develop later because of antibody formation. Calcitonin is administered by intramuscular injection or intranasal spray rather than subcutaneously, because patients with hypercalcemia have poor perfusion of subcutaneous tissue (Shane & Berenson, 2019).

For patients with cancer, treatment is directed at controlling the condition by surgery, chemotherapy, or radiation therapy. Corticosteroids may be used to decrease bone turnover and tubular reabsorption for patients with sarcoidosis, myelomas, lymphomas, and leukemias; patients with solid tumors are less responsive. Some bisphosphonates (e.g., pamidronate disodium, ibandronate sodium) inhibit osteoclast activity. IV forms of bisphosphonates can cause fever, transient leukopenia, eye inflammation, nephrotic syndrome, and jaw osteonecrosis (Shane & Berenson, 2019).

Mithramycin, a cytotoxic antibiotic, inhibits bone resorption and thus lowers the serum calcium level. This agent must be used cautiously because it has significant side effects, including thrombocytopenia, nephrotoxicity, rebound hypercalcemia when discontinued, and hepatotoxicity. Inorganic phosphate salts can be given orally or by nasogastric tube (in the form of Phospho-Soda or Neutra-Phos), rectally (as retention enemas), or IV. IV phosphate therapy is used with extreme caution in the treatment of hypercalcemia, because it can cause severe calcification in various tissues,

hypotension, tetany, and acute kidney injury (Frandsen & Pennington, 2018; Vallerand & Sanoski, 2019).

Nursing Management

The nurse must monitor for hypercalcemia in at-risk patients. Interventions such as increasing patient mobility and encouraging fluids can help prevent hypercalcemia, or at least minimize its severity. Hospitalized patients at risk should be encouraged to ambulate as soon as possible. Those who are outpatients and receive home care are educated about the importance of frequent ambulation (Daly, 2017).

When encouraging oral fluids, the nurse considers the patient's likes and dislikes. Fluids containing sodium should be given unless contraindicated, because sodium assists with calcium excretion. Patients are encouraged to drink 2.8 to 3.8 L (3 to 4 quarts) of fluid daily (Sterns, 2017b). Adequate fiber in the diet is encouraged to offset the tendency for constipation. Safety precautions are implemented, as necessary, when altered mental status is present. The patient and family are informed that these mental changes are reversible with treatment. Increased calcium increases the effects of digitalis; therefore, the patient on digitalis should be frequently assessed for signs and symptoms of digitalis toxicity. Because ECG changes (premature ventricular contractions, paroxysmal atrial tachycardia, and heart block) can occur, the cardiac rate and rhythm are monitored for any abnormalities (Shane & Berenson, 2019; Vallerand & Sanoski, 2019).

Magnesium Imbalances

Magnesium (Mg^{++}) is an abundant intracellular cation. It acts as an activator for many intracellular enzyme systems and plays a role in both carbohydrate and protein metabolism. The normal serum magnesium level is 1.8 to 2.6 mg/dL (0.74 to 1.07 mmol/L) (Fischbach & Fischbach, 2018). Approximately one third of serum magnesium is bound to protein; the remaining two thirds exist as free cations—the active component (Mg^{++}). Magnesium balance is important in neuromuscular function. Because magnesium acts directly on the myoneural junction, variations in the serum level affect neuromuscular irritability and contractility. For example, an excess of magnesium diminishes the excitability of the muscle cells, whereas a deficit increases neuromuscular irritability and contractility. Magnesium produces its sedative effect at the neuromuscular junction, probably by inhibiting the release of the neurotransmitter acetylcholine. It also increases the stimulus threshold in nerve fibers. Magnesium imbalances are magnesium deficit and magnesium excess (Norris, 2019) (Table 10-9).

Magnesium also affects the cardiovascular system, acting peripherally to produce vasodilation and decreased peripheral resistance. Most magnesium in the body is stored within bone, whereas magnesium ions in the blood are bound to protein, such as albumin, or free as Mg^{++} ions (Yu, 2019a).

TABLE 10-9 Magnesium Imbalances

Imbalance	Contributing Factors	Signs/Symptoms
Magnesium deficit (hypomagnesemia) Serum magnesium <1.8 mg/dL	Chronic alcoholism, hyperparathyroidism, hyperaldosteronism, diuretic phase of acute kidney injury, malabsorptive disorders, diabetic ketoacidosis, refeeding after starvation, parenteral nutrition, chronic laxative use, diarrhea, acute myocardial infarction, heart failure, decreased serum K^+ and Ca^{++} and certain pharmacologic agents (e.g., gentamicin, cisplatin, cyclosporine)	Neuromuscular irritability, positive Trousseau sign and Chvostek sign, insomnia, mood changes, anorexia, vomiting, increased tendon reflexes, and ↑ BP. *ECG:* PVCs, flat or inverted T waves, depressed ST segment, prolonged PR interval, and widened QRS
Magnesium excess (hypermagnesemia) Serum magnesium >2.6 mg/dL	Oliguric phase of acute kidney injury (particularly when magnesium-containing medications are given), adrenal insufficiency, excessive IV magnesium administration, diabetic ketoacidosis, and hypothyroidism	Flushing, hypotension, muscle weakness, drowsiness, hypoactive reflexes, depressed respirations, cardiac arrest and coma, diaphoresis. *ECG:* tachycardia → bradycardia, prolonged PR interval and QRS, peaked T waves

BP, blood pressure; ECG, electrocardiogram; →, followed by; ↑, increased; IV, intravenous; PVCs, premature ventricular contractions.

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health state* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Magnesium Deficit (Hypomagnesemia)

Hypomagnesemia refers to a below-normal serum magnesium concentration and is frequently associated with hypokalemia and hypocalcemia. Magnesium is similar to calcium in two aspects: (1) it is the ionized fraction of magnesium that is primarily involved in neuromuscular activity and other physiologic processes, and (2) magnesium levels should be evaluated in combination with albumin levels. Because about 30% of magnesium is protein bound, principally to albumin, a decreased serum albumin level can reduce the measured total magnesium concentration; however, it does not reduce the ionized plasma magnesium concentration. Magnesium is essential for the

function of the Na^+/K^+ pump, and low Mg^{++} levels have effects on intracellular influxes of K^+ and myocardial ion fluxes (Norris, 2019; Yu, 2019a).

Pathophysiology

An important route of magnesium loss is the GI tract; such loss can occur with nasogastric suction, diarrhea, or fistulas. Because fluid from the lower GI tract has a higher concentration of magnesium (10 to 14 mEq/L) than fluid from the upper tract (1 to 2 mEq/L), losses from diarrhea and intestinal fistulas are more likely to induce magnesium deficit than are those from gastric suction. Although magnesium losses are relatively small in nasogastric suction, hypomagnesemia occurs if losses are prolonged and magnesium is not replaced through IV infusion. Because the distal small bowel is the major site of magnesium absorption, any disruption in small bowel function (e.g., intestinal resection or inflammatory bowel disease) can lead to hypomagnesemia. Hypomagnesemia is a common yet often overlooked imbalance in acutely and critically ill patients. Studies suggest that up to 65% of patients in intensive care are magnesium deficient (Upala, Jaruvongvanich, Wijarnpreecha, et al., 2016). Hypomagnesemia may occur with withdrawal from alcohol and administration of tube feedings or parenteral nutrition (Yu, 2019a).

Chronic alcohol abuse is a major cause of symptomatic hypomagnesemia in the United States. The serum magnesium level should be measured at least every 2 or 3 days in patients undergoing withdrawal from alcohol. The level may be normal on admission but may decrease as a result of metabolic changes, such as the intracellular shift of magnesium associated with IV glucose administration (Yu, 2019a).

During nutritional replacement, the major cellular electrolytes move from the serum to intracellular compartments of newly synthesized cells. Therefore, if the enteral or parenteral feeding formula is deficient in magnesium content, serious hypomagnesemia can occur. Because of this, serum magnesium levels should be measured at regular intervals in patients who are receiving parenteral or enteral feedings, especially those who have undergone a period of starvation (Yu, 2019a).

Other causes of hypomagnesemia include the administration of aminoglycosides, cyclosporine, cisplatin, diuretics, digitalis, proton pump inhibitors, and amphotericin, as well as the rapid administration of citrated blood, especially to patients with renal or hepatic disease. Magnesium deficiency often occurs in DKA, secondary to increased renal excretion during osmotic diuresis and shifting of magnesium into the cells with insulin therapy (Yu, 2019a). A magnesium IV solution can be used to counteract seizures due to preeclampsia or eclampsia, the cardiac arrhythmia torsades de pointes, asthma, and hypertension (Vallerand & Sanoski, 2019).

Clinical Manifestations

Clinical signs and symptoms can be found in Table 10-9. Some clinical manifestations of hypomagnesemia are due directly to the low serum magnesium level; others are due to secondary changes in potassium and calcium metabolism. Symptoms do not usually occur until the serum magnesium level has dropped to less than 1.8 mEq/L (0.75 mmol/L). Chvostek and Trousseau signs (see earlier discussion) occur, in part, because of accompanying hypocalcemia (Norris, 2019).

Hypomagnesemia may be accompanied by marked alterations in psychological status. Apathy, depressed mood, apprehension, and extreme agitation have been noted, as well as ataxia, dizziness, insomnia, and confusion. At times, delirium, auditory or visual hallucinations, and frank psychoses may occur (Yu & Yarlagadda, 2019).

Magnesium deficiency can disturb the ECG by prolonging the QRS, depressing the ST segment, and predisposing to cardiac arrhythmias, such as premature ventricular contractions, supraventricular tachycardia, torsades de pointes, and ventricular fibrillation. Increased susceptibility to digitalis toxicity is associated with low serum magnesium levels. Patients receiving digoxin are also likely to be receiving diuretic therapy, predisposing them to renal loss of magnesium. Concurrent hypokalemia and hypocalcemia must be addressed in addition to hypomagnesemia. These electrolyte disturbances are difficult to correct until magnesium has been replenished. Additionally, hypocalcemia can be worsened by isolated treatment of hypomagnesemia with IV magnesium sulfate because sulfate binds ionized calcium (Yu & Yarlagadda, 2019).

Assessment and Diagnostic Findings

On laboratory analysis, the serum magnesium level is less than 1.8 mg/dL (0.74 mmol/L). Urine magnesium may help identify the cause of magnesium depletion, and levels are measured after a loading dose of magnesium sulfate is given. Additional diagnostic techniques (nuclear magnetic resonance spectroscopy and the ion-selective electrode) are sensitive and direct means of measuring ionized serum magnesium levels (Yu, 2019b).

Medical Management

Mild magnesium deficiency can be corrected by diet alone. Principal dietary sources of magnesium include green leafy vegetables, beans, lentils, white potatoes, wheat bran, dry roasted almonds, and peanut butter (National Institutes of Health [NIH], 2019).

If necessary, magnesium salts can be given orally in an oxide or gluconate form to replace continuous losses but can produce diarrhea. Patients receiving

parenteral nutrition require magnesium in the IV solution to prevent hypomagnesemia

Vital signs must be assessed frequently during magnesium administration to detect changes in cardiac rate or rhythm, hypotension, and respiratory distress. Monitoring urine output is essential before, during, and after magnesium administration as this is how Mg^{++} is excreted; the primary provider is notified if urine volume decreases to less than 100 mL over 4 hours. Calcium gluconate must be readily available to treat hypocalcemic tetany or hypermagnesemia.

Quality and Safety Nursing Alert

Inadvertent overdosage of IV magnesium can result in serious patient harm and death. Whenever a patient is prescribed IV magnesium, a second nurse should independently double check the IV magnesium prescription, including dose calculations, and check infusion pump settings. Milligrams (mg) and grams (g) are not equivalent to milliequivalent (mEq) dosages.

Nursing Management

The nurse should be aware of patients at risk for hypomagnesemia and observe them for its signs and symptoms. Patients receiving digitalis are monitored closely, because a deficit of magnesium can predispose them to digitalis toxicity. If hypomagnesemia is severe, seizure precautions are implemented. Other safety precautions are instituted, as indicated, if confusion is observed. Patients should be screened for dysphagia (difficulty in swallowing), as this may occur in those with magnesium depletion.

Patient education plays a major role in treating magnesium deficit. The patient is educated about sources of magnesium-rich foods, including green vegetables, nuts, legumes, bananas, and oranges.

Magnesium Excess (Hypermagnesemia)

Hypermagnesemia (serum magnesium level higher than 2.6 mg/dL [1.07 mmol/L]) is a rare electrolyte abnormality, because the kidneys efficiently excrete magnesium (Norris, 2019). A serum magnesium level can appear falsely elevated if blood specimens are allowed to hemolyze or are drawn from an extremity with a tourniquet that was applied too tightly.

Pathophysiology

The most common cause of hypermagnesemia is kidney injury (Yu & Gupta, 2019). In fact, most patients with advanced kidney injury have at least a slight elevation in serum magnesium levels. This condition is aggravated when such patients receive magnesium to control seizures.

Hypermagnesemia can occur in patients with untreated DKA when catabolism causes the release of cellular magnesium that cannot be excreted because of profound fluid volume depletion and resulting oliguria. A surplus of magnesium can also result from excessive magnesium given to treat hypertension of pregnancy or to treat hypomagnesemia. Increased serum magnesium levels can also occur in adrenocortical insufficiency, Addison disease, or hypothermia.

Excessive use of magnesium-based antacids or laxatives and medications that decrease GI motility, including opioids and anticholinergics, can also increase serum magnesium levels. Decreased elimination of magnesium or its increased absorption due to intestinal hypomotility from any cause can contribute to hypermagnesemia. Lithium intoxication can also cause an increase in serum magnesium levels. Extensive soft tissue injury or necrosis as with trauma, shock, sepsis, cardiac arrest, or severe burns can also result in hypermagnesemia (Yu & Gupta, 2019).

Clinical Manifestations

Acute elevation of the serum magnesium level depresses the central nervous system as well as the peripheral neuromuscular junction. Clinical signs and symptoms can be found in Table 10-9. The respiratory center is depressed when serum magnesium levels exceed 10 mEq/L (5 mmol/L). Coma, atrioventricular heart block, and cardiac arrest can occur when the serum magnesium level is greatly elevated and not treated. High levels of magnesium also result in platelet clumping and delayed thrombin formation (Yu & Gupta, 2019).

Assessment and Diagnostic Findings

In hypermagnesemia, the serum magnesium level is greater than 2.6 mg/dL (1.07 mmol/L). Increased potassium and calcium are present concurrently. As creatinine clearance decreases to less than 3.0 mL/min, the serum magnesium levels increase. ECG findings may include a prolonged PR interval, tall T waves, a widened QRS, and a prolonged QT interval, as well as an atrioventricular block (Norris, 2019).

Medical Management

Hypermagnesemia can be prevented by avoiding the administration of magnesium to patients with kidney injury and by carefully monitoring seriously ill patients who are receiving magnesium salts. In patients with severe hypermagnesemia, all parenteral and oral magnesium salts are discontinued. In emergencies, such as respiratory depression or defective cardiac conduction, ventilatory support and IV elemental calcium as a magnesium antagonist are indicated. In addition, hemodialysis with a magnesium-free dialysate can reduce the serum magnesium to a safe level within hours. Administration of loop diuretics (e.g., furosemide) and sodium chloride or lactated Ringer's IV solution enhances magnesium excretion in patients with adequate renal function. IV calcium antagonizes the cardiovascular and neuromuscular effects of magnesium (Yu & Gupta, 2019).

Nursing Management

Patients at risk for hypermagnesemia should be monitored closely. If hypermagnesemia is suspected, the nurse should monitor the vital signs, noting hypotension and shallow respirations. The nurse should be aware that arrhythmias, bradycardia, and heart block can occur. The nurse also observes for decreased deep tendon reflexes (DTRs), muscle weakness, and changes in the level of consciousness. Medications that contain magnesium are not given to patients with compromised renal function, and patients with kidney injury are cautioned to check with their primary providers before taking OTC supplements. Administration of fluids and diuretics are often used in treatment, and monitoring of I&O is important. Hemodialysis may be necessary in severe hypermagnesemia, particularly if cardiovascular or neurologic manifestations are present. Hemodialysis is also necessary in patients with severe hypermagnesemia and kidney injury (Yu & Gupta, 2019).

Phosphorus Imbalances

Phosphorus (HPO_4^-) is a critical constituent of all body tissues and is plentiful in the average diet of people living in developed countries. Intake of phosphorus usually exceeds body requirements and the kidney excretes the excess. Phosphorus is essential to the function of muscle and RBCs; the formation of adenosine triphosphate (ATP) and of 2,3-diphosphoglycerate, which facilitates the release of oxygen from hemoglobin; and the maintenance of acid–base balance, as well as the nervous system and the intermediary metabolism of carbohydrate, protein, and fat. It is a major component of the cell structure, phospholipids, nucleotides, and nucleic acids (DNA and RNA). It provides structural support to bones and teeth. Phosphorus is the primary anion of the ICF and requires active transport mechanisms to maintain its

presence inside the cells. Most intracellular phosphorus is bound to proteins and lipids. About 85% of phosphorus is located in bones and teeth, 14% in soft tissue, and less than 1% in the ECF (Norris, 2019).

TABLE 10-10 Phosphorus Imbalances

Imbalance	Contributing Factors	Signs/Symptoms
Phosphorus deficit (hypophosphatemia) Serum phosphorus <2.7 mg/dL	Refeeding after starvation, alcohol withdrawal, diabetic ketoacidosis, respiratory and metabolic alkalosis, ↓ magnesium, ↓ potassium, hyperparathyroidism, vomiting, diarrhea, hyperventilation, vitamin D deficiency associated with malabsorptive disorders, burns, acid–base disorders, parenteral nutrition, and diuretic and antacid use	Paresthesias, muscle weakness, bone pain and tenderness, chest pain, confusion, cardiomyopathy, respiratory failure, seizures, tissue hypoxia, and increased susceptibility to infection, nystagmus
Phosphorus excess (hyperphosphatemia) Serum phosphorus >4.5 mg/dL	Acute kidney injury and chronic kidney disease, excessive intake of phosphorus, vitamin D excess, respiratory and metabolic acidosis, hypoparathyroidism, volume depletion, leukemia/lymphoma treated with cytotoxic agents, increased tissue breakdown, rhabdomyolysis	Tetany, tachycardia, anorexia, nausea and vomiting, muscle weakness, signs and symptoms of hypocalcemia; hyperactive reflexes; soft tissue calcifications in lungs, heart, kidneys, and cornea

↓, decreased.

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health state* (10th ed.). Philadelphia, PA: Wolters Kluwer.

The normal serum phosphorus level is 2.7 to 4.5 mg/dL (0.87 to 1.45 mmol/L) in adults (Fischbach & Fischbach, 2018). Phosphorus homeostasis is maintained through absorption and secretion in the GI tract, filtration and absorption in the kidneys, and shifts into and out of bone. PTH and vitamin D assist in phosphate homeostasis by varying phosphate reabsorption in the proximal tubule of the kidney. PTH allows the shift of phosphate from bone to plasma. Phosphorus deficit and phosphorus excess are less common electrolyte imbalances (Table 10-10).

Phosphorus Deficit (Hypophosphatemia)

Hypophosphatemia is indicated by a value below 2.7 mg/dL (0.87 mmol/L). Although it often indicates phosphorus deficiency, hypophosphatemia may

occur under a variety of circumstances in which total-body phosphorus stores are normal. Phosphorus deficiency can also occur as an abnormally low content of phosphorus in lean tissues without evidence of low phosphate in the bloodstream. Hypophosphatemia can be due to lack of sufficient intake, excess excretion (renal phosphate wasting), shift of phosphorus from extracellular to intracellular spaces, or by decreased intestinal absorption of phosphorus (Yu & Stubbs, 2019).

Pathophysiology

Hypophosphatemia rarely occurs due to inadequate intake, as there are many dietary sources of phosphate (e.g., meats, dairy products, beans). However, phosphate can become depleted in GI malabsorption disorders such as chronic diarrhea, Crohn's disease, or celiac disease. Hypophosphatemia can also occur in anorexia, bulimia, and alcoholism. Vitamin D deficit can cause low phosphate levels in the bloodstream. Vitamin D regulates intestinal absorption of calcium and phosphate ion; therefore, a deficiency of vitamin D can cause both decreased calcium and phosphorus levels. These deficiencies can lead to osteomalacia (softened and brittle bones) in the adult (Norris, 2019).

Hypophosphatemia can occur if there is high intake of antacids—particularly those containing calcium, magnesium, or aluminum. Excess phosphorus binding by antacids may decrease the phosphorus available from the diet to an amount lower than required to maintain serum phosphorus balance. The degree of hypophosphatemia depends on the amount of phosphorus in the diet compared to the dose of antacid (Yu & Stubbs, 2019).

Hypophosphatemia can also occur during the administration of calories to patients who have had severe protein–calorie malnutrition. This syndrome can be induced in any person with severe malnutrition (e.g., patients with anorexia nervosa or alcoholism, older patients who are debilitated and unable to eat). Feeding a patient who is nutritionally deprived stimulates a large insulin release that can cause shift of phosphate from the extracellular to the intracellular compartment. Also, marked hypophosphatemia can develop in patients who are malnourished who receive parenteral nutrition that does not contain sufficient phosphorus (Aubry, Friedli, Schetz, et al., 2018).

Other causes of hypophosphatemia include heatstroke, prolonged intense hyperventilation, alcohol withdrawal, DKA, respiratory alkalosis, hepatic encephalopathy, and major thermal burns. Hyperparathyroidism can also cause increased urinary losses of phosphorus leading to hypophosphatemia. Loss of phosphorus through the kidneys also occurs with acute volume expansion, osmotic diuresis, the use of carbonic anhydrase inhibitors (acetazolamide), and some malignancies.

Respiratory alkalosis can cause a decrease in phosphorus in the bloodstream because of an intracellular shift of phosphorus. Respiratory alkalosis,

commonly caused by extreme hyperventilation, can reduce serum phosphate concentrations to very low levels and is a common cause of marked hypophosphatemia in patients who are hospitalized.

Some genetic disorders, such as Fanconi syndrome and X-linked hypophosphatemic rickets, cause renal phosphate wasting. Acquired oncogenic osteomalacia, a paraneoplastic syndrome that occurs with some types of cancer, can also cause low phosphate levels. Hypophosphatemia is also a frequent complication of renal transplantation (Yu & Stubbs, 2019).

Clinical Manifestations

Most of the signs and symptoms of phosphorus deficiency result from a deficiency of ATP, 2,3-diphosphoglycerate, or both (Yu & Stubbs, 2019). ATP deficiency impairs cellular energy resources; diphosphoglycerate deficiency impairs oxygen delivery to tissues, resulting in generalized weakness and neurologic manifestations. Clinical signs and symptoms can be found in Table 10-10.

Muscle damage may develop as the ATP level in the muscle tissue declines. Clinical manifestations are muscle weakness, which may be subtle or profound and may affect any muscle group; muscle pain; and at times acute rhabdomyolysis (breakdown of skeletal muscle). Weakness of the diaphragm and intercostal muscles may greatly impair ventilation. Bone pain, altered mental status, seizures, focal neurologic signs, and heart failure can occur with severe hypophosphatemia (Yu & Stubbs, 2019).

Assessment and Diagnostic Findings

On laboratory analysis, the serum phosphorus level is less than 2.7 mg/dL (0.87 mmol/L). When reviewing laboratory results, the nurse should keep in mind that glucose or insulin administration causes a decrease in the serum phosphorus level. Acute hypophosphatemia can occur during the treatment of DKA due to high doses of insulin. Elevated PTH levels that occur as a result of hyperparathyroidism can lower blood levels of phosphate. A 24-hour urine collection for phosphorus can be done if renal-phosphate wasting is suspected. Fanconi syndrome causes loss of glucose, amino acids, uric acid, and phosphate in the urine. X-rays and bone density studies may show skeletal changes of reduced bone mineralization caused by osteomalacia or rickets. A technetium (Tc99m) sestamibi scan of the neck can be done to check for hyperparathyroidism. CT scan, MRI, or indium-111 octreotide scan may show oncogenic osteomalacia (decreased bone density due to cancer) (Sharma & Castro, 2019).

Medical Management

Prevention of hypophosphatemia is the goal. In patients at risk for hypophosphatemia, serum phosphate levels should be closely monitored and correction initiated before deficits become severe. Adequate amounts of phosphorus should be added to parenteral solutions, and attention should be paid to the phosphorus levels in enteral feeding solutions.

Medical management of hypophosphatemia depends on the etiology, and treatment of the cause is essential. Severe hypophosphatemia is dangerous and requires prompt attention. Oral phosphate supplements are usually adequate for mild hypophosphatemia. Sources of phosphorus include dairy foods, meats, and beans. Oral supplements may be sufficient to treat renal-wasting disorders, malabsorption, or oncogenic osteomalacia until an exact etiology is found. Vitamin D may also be necessary to enhance absorption of phosphorus and calcium.

Aggressive IV phosphorus correction is usually limited to the patient whose serum phosphorus levels decrease to less than 1 mg/dL (0.3 mmol/L). Possible effects of IV administration of phosphorus include tetany from hypocalcemia and calcifications in tissues (blood vessels, heart, lung, kidney, eyes) from hyperphosphatemia.

Recently a monoclonal antibody-type drug, burosumab, has been approved for patients with renal phosphate wasting disorders and hypophosphatemic rickets. This drug has been found to normalize phosphate levels, improve bone mineralization, and heal fractures in rickets (Perwad & Portale, 2019).

If hyperparathyroidism is caused by parathyroid tumor, surgery may be necessary. A parathyroid tumor, termed an adenoma, can cause hyperparathyroidism with resulting demineralization of bone (osteomalacia). Patients with hyperparathyroidism can also be given calcimimetic medications, such as cinacalcet, which activate the calcium receptor in the gland and decrease PTH secretion (Wang & Yuan, 2019).

Patients with oncogenic osteomalacia should be treated for the cancer causing this syndrome. If malabsorption is the cause of hypophosphatemia, treatment of the GI disorder is necessary. Because patients with osteomalacia are at high risk for fracture, fall precautions should be observed. If hypophosphatemia is caused by an eating disorder, the patient should obtain behavioral counseling and nutritional therapy.

Nursing Management

The nurse should identify patients at risk for hypophosphatemia and monitor them. Because patients who are malnourished and receiving parenteral nutrition are at risk when calories are introduced too aggressively, preventive measures involve gradually introducing the solution to avoid rapid shifts of phosphorus into the cells. Vitamin D and calcium levels should also be monitored as phosphate levels are influenced by these levels. Vitamin D

supplementation may be needed to enhance calcium and phosphate absorption (Aubry et al., 2018).

In patients requiring correction of phosphorus losses, the nurse frequently monitors serum phosphorus levels and documents and reports early signs of hypophosphatemia (apprehension, confusion, change in level of consciousness). If the patient experiences mild hypophosphatemia, foods such as milk and milk products, organ meats, beans, nuts, fish, poultry, and whole grains should be encouraged. With moderate hypophosphatemia, supplements such as Neutra-Phos capsules, K-Phos, and Fleet Phospho-Soda may be prescribed (Vallerand & Sanoski, 2019; Yu & Stubbs, 2019).

For patients with severe hypophosphatemia, IV preparations of phosphorus are available as sodium or potassium phosphate. The rate of phosphorus administration should not exceed 3 mmol/h, and the site should be carefully monitored because tissue sloughing and necrosis can occur with infiltration. Serum calcium and phosphate blood levels should be monitored every 6 hours with IV therapy.

Phosphorus Excess (Hyperphosphatemia)

Hyperphosphatemia is a serum phosphorus level that exceeds 4.5 mg/dL (1.45 mmol/L). Abnormally high levels of phosphate in the bloodstream can arise from excessive intake of phosphorus, decreased excretion of phosphorus, or a disorder that shifts intracellular phosphate into the extracellular space.

Pathophysiology

Various conditions can lead to hyperphosphatemia; however, the most common is kidney injury, which diminishes urinary phosphate excretion (Stubbs & Yu, 2019). When renal insufficiency progresses to 40% to 50% of renal function, hyperphosphatemia can occur. Other causes include increased intake or a shift of phosphate from the intracellular to extracellular space. Conditions such as excessive vitamin D intake, administration of total parenteral nutrition, chemotherapy for neoplastic disease, hypoparathyroidism, pseudohypoparathyroidism, metabolic or respiratory acidosis, DKA, acute hemolysis, high phosphate intake, profound muscle necrosis, and increased phosphorus absorption may also lead to this phosphorus imbalance. Hypoparathyroidism causes hyperphosphatemia by failure of the kidneys to inhibit renal reabsorption of phosphate. The kidneys reabsorb excessive phosphate into the bloodstream. Pseudohypoparathyroidism is a disorder caused by end-organ resistance to PTH. Excessive use of phosphate-containing laxatives or enemas can also lead to hyperphosphatemia. False elevation of phosphate in the bloodstream can occur with elevated protein or bilirubin levels, dyslipidemia, or hemolysis. The primary complication of increased

phosphorus is metastatic calcification in the organs, soft tissues, joints, and arteries. Arterial calcification is a risk factor for myocardial infarction, stroke, and peripheral arterial disease (Norris, 2019; Stubbs & Yu, 2019).

Clinical Manifestations

Clinical signs and symptoms can be found in Table 10-10. Most symptoms result from decreased calcium levels and soft tissue calcifications. The most important short-term consequence is tetany (severe muscle cramping). Because of the reciprocal relationship between phosphorus and calcium, a high serum phosphorus level tends to cause a low serum calcium concentration. Hypocalcemia causes neuromuscular irritability and muscle spasms (Bove-Fenderson & Mannstadt, 2018).

The major long-term consequence is soft tissue calcification, which occurs mainly in patients with a reduced glomerular filtration rate. High serum levels of inorganic phosphorus promote precipitation of calcium phosphate in nonosseous sites, which can decrease urine output, impair vision, and produce palpitations. Skin and soft tissue deposits of calcium can cause pruritus (Marcucci, Cianferotti, & Brandi, 2018).

Assessment and Diagnostic Findings

On laboratory analysis, the serum phosphorus level exceeds 4.5 mg/dL (1.5 mmol/L). The serum calcium level is useful also for diagnosing the primary disorder and assessing the effects of treatments. X-rays may show skeletal changes with abnormal bone development. PTH levels are decreased in hypoparathyroidism. BUN and creatinine levels are used to assess renal function (Marcucci et al., 2018).

Medical Management

Phosphate intake should be reduced and phosphate binders can be given with meals to reduce hyperphosphatemia. When possible, treatment is directed at the underlying disorder. For example, hyperphosphatemia may be related to volume depletion or respiratory or metabolic acidosis. Correction of these disorders may normalize the blood level of phosphate.

Calcium carbonate or calcium citrate are phosphate binders that can be used to lower blood phosphate levels. However, careful monitoring of calcium is essential as hypercalcemia can result. Phosphate binding resins that do not contain calcium include sevelamer and lanthanum. Sucroferric oxyhydroxide can also be used particularly in patients who require iron supplementation. Forced diuresis with a loop diuretic or saline diuresis can be used in patients

with normal renal function. Hemodialysis can also lower phosphorus (Carfagna, Del Vecchio, Pontoriero, et al., 2018).

Nursing Management

The nurse monitors patients at risk for hyperphosphatemia. If a low phosphorus diet is prescribed, the patient is instructed to avoid phosphorus-rich foods, such as hard cheeses, cream, nuts, meats, whole-grain cereals, dried fruits, dried vegetables, kidneys, sardines, and dairy foods (Shimada, Shutto-Uchita, & Yamabe, 2019). When appropriate, the nurse instructs the patient to avoid phosphate-containing laxatives and enemas. When administering phosphate binders, calcium levels should be monitored as well. During diuresis the nurse monitors urine output. The nurse also educates the patient about recognizing the signs of hypocalcemia, such as muscle cramping (Goltzman, 2019a).

Chloride Imbalances

Chloride (Cl^-) is the major anion of the ECF compartment. It maintains cellular integrity by providing water balance and maintains acid–base balance. Sodium and chloride make up the electrolytes that exert osmotic pressure. Chloride is also contained in gastric and pancreatic juices, sweat, bile, and saliva. Chloride is produced in the stomach, where it combines with hydrogen to form hydrochloric acid. Chloride control depends on the intake of chloride and the excretion and reabsorption of its ions in the kidneys. A small amount of chloride is lost in the feces (Norris, 2019).

The normal serum chloride level is 97 to 107 mEq/L (97 to 107 mmol/L). Inside the cell, the chloride level is 4 mEq/L. The serum level of chloride reflects a change in dilution or concentration of the ECF and does so in direct proportion to the sodium concentration. Serum osmolality parallels chloride levels as well. Aldosterone secretion increases sodium reabsorption, thereby increasing chloride reabsorption (Hall, 2016).

The choroid plexus, which secretes cerebrospinal fluid in the brain, depends on sodium and chloride to attract water to form the fluid portion of the cerebrospinal fluid.

Bicarbonate has an inverse relationship with chloride. As chloride moves from plasma into the RBCs (called the *chloride shift*), bicarbonate moves back into the plasma. Hydrogen ions are formed, which then help release oxygen from hemoglobin (Emmett & Szerlip, 2017a). When the level of one of these three electrolytes (sodium, bicarbonate, or chloride) is disturbed, the other two are also affected. Chloride assists in maintaining acid–base balance and works as a buffer in the exchange of oxygen and CO_2 in RBCs (Fischbach &

Fischbach, 2018). Chloride is primarily obtained from the diet as table salt. The chloride imbalances are chloride deficit and chloride excess (Table 10-11).

Chloride Deficit (Hypochloremia)

Hypochloremia is a serum chloride level below 97 mEq/L (97 mmol/L).

Pathophysiology

Hypochloremia can occur with GI tube drainage, gastric suctioning, gastric surgery, and severe vomiting and diarrhea. Administration of chloride-deficient IV solutions, low sodium intake, decreased serum sodium levels, DKA, chronic respiratory acidosis, massive blood transfusions, diuretic therapy, excessive sweating, burns, SIADH, and fever may cause hypochloremia. Administration of aldosterone, ACTH, corticosteroids, bicarbonate, excess diuretics, or laxatives decreases serum chloride levels as well. As chloride decreases (usually because of volume depletion), sodium and bicarbonate ions are retained by the kidney to balance the loss. Bicarbonate accumulates in the ECF, which raises the pH and can lead to hypochloremic metabolic alkalosis (Emmett & Szerlip, 2017a).

Clinical Manifestations

The signs and symptoms of hypochloremia are outlined in Table 10-11. The signs and symptoms of hyponatremia, hypokalemia, and metabolic alkalosis may also be present. Metabolic alkalosis is a disorder that results in a high pH and a high serum bicarbonate level as a result of excess alkali intake or loss of hydrogen ions. With compensation, the partial pressure of CO_2 in arterial blood ($PaCO_2$) increases to 50 mm Hg. Hyperexcitability of muscles, tetany, hyperactive DTRs, weakness, twitching, and muscle cramps may result. Hypokalemia can cause hypochloremia, resulting in cardiac arrhythmias. In addition, because low chloride levels parallel low sodium levels, a water excess may occur. Hyponatremia can cause seizures and coma (Squiers, 2017).

TABLE 10-11 Chloride Imbalances

Imbalance	Contributing Factors	Signs/Symptoms and Laboratory Findings
Chloride deficit (hypochloremia) Serum chloride <96 mEq/L	Addison disease, reduced chloride intake or absorption, untreated diabetic ketoacidosis, chronic respiratory acidosis, excessive sweating, vomiting, gastric suction, diarrhea, sodium and potassium deficiency, metabolic alkalosis; loop, osmotic, or thiazide diuretic use; overuse of bicarbonate, rapid removal of ascitic fluid with a high sodium content, IV fluids that lack chloride (dextrose and water), draining fistulas and ileostomies, heart failure, cystic fibrosis	Agitation, irritability, tremors, muscle cramps, hyperactive deep tendon reflexes, hypertonicity, tetany, slow shallow respirations, seizures, arrhythmias, coma *Labs indicate:* ↓ serum chloride, ↓ serum sodium, ↑ pH, ↑ serum bicarbonate, ↑ total carbon dioxide content, ↓ urine chloride level, ↓ serum potassium
Chloride excess (hyperchloremia) Serum chloride >108 mEq/L	Excessive sodium chloride infusions with water loss, head injury (sodium retention), hypernatremia, kidney injury, corticosteroid use, dehydration, severe diarrhea (loss of bicarbonate), respiratory alkalosis, administration of diuretics, overdose of salicylates, sodium polystyrene sulfonate, acetazolamide, phenylbutazone and ammonium chloride use, hyperparathyroidism, metabolic acidosis	Tachypnea, lethargy, weakness, deep rapid respirations, decline in cognitive status, ↓ cardiac output, dyspnea, tachycardia, pitting edema, arrhythmias, coma *Labs indicate:* ↑ serum chloride, ↑ serum potassium and sodium, ↓ serum pH, ↓ serum bicarbonate, normal anion gap, ↑ urinary chloride level

↓, decreased; ↑, increased; IV, intravenous.

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health state* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Assessment and Diagnostic Findings

In addition to the chloride level, sodium and potassium levels are also evaluated, because these electrolytes are lost along with chloride. ABG analysis identifies the acid–base imbalance, which is usually metabolic alkalosis. The urine chloride level, which is also measured, decreases in hypochloremia.

Medical Management

Treatment involves correcting the cause of hypochloremia and the contributing electrolyte and acid–base imbalances. Normal saline (0.9% sodium chloride) or half-strength saline (0.45% sodium chloride) solution is given by IV to replace the chloride. If the patient is receiving a diuretic (loop, osmotic, or thiazide), it may be discontinued or another diuretic prescribed (Squiers, 2017).

Ammonium chloride, an acidifying IV agent, may be prescribed to treat metabolic alkalosis; the dosage depends on the patient's weight and serum chloride level. This agent is metabolized by the liver, and its effects last for about 3 days. Its use should be avoided in patients with impaired liver or renal function (Emmett & Szerlip, 2017b).

Nursing Management

The nurse monitors the patient's I&O, ABG values, and serum electrolyte levels. Changes in the patient's level of consciousness and muscle strength and movement are reported to the primary provider promptly. Vital signs are monitored, and respiratory assessment is carried out frequently. The nurse provides and educates the patient about foods with high chloride content, which include tomato juice, bananas, dates, eggs, cheese, milk, salty broth, canned vegetables, and processed meats. A person who drinks free water (water without electrolytes) or bottled water and excretes large amounts of chloride needs instruction to avoid drinking this kind of water (Squiers, 2017).

Chloride Excess (Hyperchloremia)

Hyperchloremia exists when the serum level of chloride exceeds 107 mEq/L (107 mmol/L). Hypernatremia, bicarbonate loss, and metabolic acidosis can occur with high chloride levels.

Pathophysiology

High serum chloride levels are almost exclusively a result of iatrogenically induced hyperchloremic metabolic acidosis, stemming from excessive

administration of chloride relative to sodium, most commonly as 0.9% normal saline solution, 0.45% normal saline solution, or lactated Ringer's solution. This condition can also be caused by the loss of bicarbonate ions via the kidney or the GI tract with a corresponding increase in chloride ions. Chloride ions in the form of acidifying salts accumulate, and acidosis occurs with a decrease in bicarbonate ions. Head trauma, increased perspiration, excess adrenocortical hormone production, and decreased glomerular filtration can lead to a high serum chloride level (Squiers, 2017).

Clinical Manifestations

The signs and symptoms of hyperchloremia are the same as those of metabolic acidosis: hypervolemia and hypernatremia. Tachypnea, weakness, lethargy, deep and rapid respirations, diminished cognitive ability, and hypertension occur. If untreated, hyperchloremia can lead to a decrease in cardiac output, arrhythmias, and coma. A high chloride level is accompanied by a high sodium level and fluid retention (Squiers, 2017).

Assessment and Diagnostic Findings

The serum chloride level is 108 mEq/L (108 mmol/L) or greater, the serum sodium level is greater than 145 mEq/L (145 mmol/L), the serum pH is less than 7.35, and the serum bicarbonate level is less than 22 mEq/L (22 mmol/L). Urine chloride levels are elevated.

Medical Management

Correcting the underlying cause of hyperchloremia and restoring electrolyte, fluid, and acid–base balance are essential. Hypotonic IV solutions may be given to restore balance. Lactated Ringer's solution may be prescribed to convert lactate to bicarbonate in the liver, which increases the bicarbonate level and corrects the acidosis. IV sodium bicarbonate may be given to increase bicarbonate levels, which leads to the renal excretion of chloride ions because bicarbonate and chloride compete for combination with sodium. Diuretics may be given to eliminate chloride as well. Sodium, chloride, and fluids are restricted (Squiers, 2017).

Nursing Management

Monitoring vital signs, ABG values, and I&O is important to assess the patient's status and the effectiveness of treatment. Assessment findings related to respiratory, neurologic, and cardiac systems are documented, and changes are discussed with the primary provider. The nurse educates the patient about

the diet that should be followed to manage hyperchloremia and maintain adequate hydration.

Acid–Base Disturbances

Acid–base disturbances are commonly encountered in clinical practice, especially in critical-care units. Identification of the specific acid–base imbalance is important in ascertaining the underlying cause of the disorder and determining appropriate treatment.

Plasma pH is an indicator of hydrogen ion (H^+) concentration and measures the acidity or alkalinity of the blood. Homeostatic mechanisms keep pH within a normal range (7.35 to 7.45). These mechanisms consist of buffer systems, the kidneys, and the lungs. The H^+ concentration is extremely important: The greater the concentration, the more acidic the solution and the lower the pH. The lower the H^+ concentration, the more alkaline the solution and the higher the pH (Larkin & Zimmanck, 2015; Norris, 2019).

Buffer systems prevent major changes in the pH of body fluids by removing or releasing H^+; they can act quickly to prevent excessive changes in H^+ concentration. Hydrogen ions are buffered by both intracellular and extracellular buffers. The body's major extracellular buffer system is the bicarbonate–carbonic acid buffer system, which is assessed when ABGs are measured. Normally, there are 20 parts of bicarbonate (HCO_3^-) to 1 part of carbonic acid (H_2CO_3). If this ratio is altered, the pH will change. It is the ratio of HCO_3^- to H_2CO_3 that is important in maintaining pH, not absolute values (Larkin & Zimmanck, 2015; Norris, 2019).

CO_2 is a potential acid; when dissolved in water, it becomes carbonic acid ($CO_2 + H_2O = H_2CO_3$). Therefore, when CO_2 is increased, the carbonic acid content is also increased. When the CO_2 level decreases, carbonic acid decreases. If either bicarbonate or carbonic acid is increased or decreased so that the 20:1 ratio is no longer maintained, acid–base imbalance results (Larkin & Zimmanck, 2015; Theodore, 2019).

Less important buffer systems in the ECF include the inorganic phosphates and the plasma proteins. Intracellular buffers include proteins, organic and inorganic phosphates, and, in RBCs, hemoglobin (Norris, 2019).

The kidneys regulate the bicarbonate level in the ECF; they can regenerate bicarbonate ions as well as reabsorb them from the renal tubular cells. In respiratory acidosis and most cases of metabolic acidosis, the kidneys excrete hydrogen ions and conserve bicarbonate ions to help restore balance. In respiratory and metabolic alkalosis, the kidneys retain hydrogen ions and excrete bicarbonate ions to help restore balance. The kidneys cannot

compensate for the metabolic acidosis created by kidney injury. Renal compensation for imbalances is relatively slow (a matter of hours or days) (Larkin & Zimmanck, 2015; Norris, 2019).

The lungs, under the control of the medulla, control the CO_2 and thus the carbonic acid content of the ECF. They do so by adjusting ventilation in response to the amount of CO_2 in the arterial blood. A rise in the partial pressure of CO_2 in arterial blood (designated $PaCO_2$) is a powerful stimulant to respiration. Of course, the partial pressure of oxygen in arterial blood (designated PaO_2) also influences respiration. However, its effect is not as marked as that produced by the $PaCO_2$ (Theodore, 2019).

In metabolic acidosis, the lungs compensate by raising respiratory rate, causing greater elimination of CO_2 (to reduce the acid load). In metabolic alkalosis, the lungs compensate by decreasing respiratory rate, causing CO_2 to be retained (to increase the acid load).

In order to understand acid–base imbalances, it is important to comprehend the chemical reaction that occurs in the bloodstream to maintain homeostasis. The bicarbonate buffer system is demonstrated by the following chemical equation:

$$CO_2 + H_2O \longleftrightarrow H_2CO_3 \longleftrightarrow H^+ \text{ and } HCO_3^-$$

TABLE 10-12 Normal Values for Arterial and Mixed Venous Bloods

Parameter	Arterial Blood	Mixed Venous Blood
pH	7.35–7.45	7.32–7.42
PCO_2	35–45 mm Hg	38–52 mm Hg
PO_2[a]	>80 mm Hg	24–48 mm Hg
HCO_3^-	22–26 mEq/L	19–25 mEq/L
Base excess/deficit	±2 mEq/L	±5 mEq/L
Oxygen saturation (SaO_2%)	>94%	65–75%

[a]At altitudes of 3000 feet and higher; age dependent.

Adapted from Fischbach, F., & Fischbach, M. (2018). *A manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

In this chemical equation, carbon dioxide (CO_2) and water form carbonic acid (H_2CO_3) which dissociates into H^+ and HCO_3^-. It is also important to recognize that the major organs that control acid–base balance are the lungs, in control of CO_2, and the kidneys, which can excrete or reabsorb the ions needed to balance the pH. ABGs are laboratory tests that can provide values of blood pH, $PaCO_2$, PaO_2, and HCO_3^-. ABGs are used to diagnose acid–base imbalances of the bloodstream. The saturation of Hgb with oxygen can also be

measured by pulse oximetry and designated as SaO_2. Normal range of SaO_2 is 95% to 100% (Theodore, 2019) (Table 10-12).

If the lungs slow down breathing rate, a condition termed hypoventilation, CO_2 will increase. Hypoventilation increases CO_2 retention. Normal $PaCO_2$ range is 35 to 45 mm Hg. Hypoventilation can increase the $PaCO_2$ greater than 45 mm Hg. Increased CO_2 will move the chemical equation to the right, which produces more H^+ ions and an acidotic bloodstream. The normal pH of the bloodstream is 7.35 to 7.45. An acidotic bloodstream has a pH less than 7.35 (Larkin & Zimmanck, 2015; Norris, 2019).

If the lungs increase breathing rate, a condition called hyperventilation, CO_2 is lost via the lungs. If CO_2 decreases it moves the equation to the left, pulling H^+ out of the bloodstream and creating an alkalotic bloodstream. An alkalotic bloodstream has a pH greater than 7.45 (Larkin & Zimmanck, 2015; Norris, 2019).

If H^+ ions increase in the bloodstream due to lactic acid accumulation, DKA, toxicity, or other source, it will push the equation to the left and increase CO_2 to be eliminated by the lungs. The lungs will increase breathing rate to rid the body of CO_2 in attempt to compensate for the high acid (Larkin & Zimmanck, 2015; Theodore, 2019).

If H^+ ions decrease in the bloodstream, it will pull the equation to the right using up some CO_2 to create more H^+. The lungs will slow breathing rate in an attempt to compensate by accumulating CO_2, which will produce H^+ (Larkin & Zimmanck, 2015; Theodore, 2019).

Acute and Chronic Metabolic Acidosis (Base Bicarbonate Deficit)

Metabolic acidosis is a common clinical disturbance characterized by a low pH due to an increased H^+ concentration and a low plasma bicarbonate concentration. Metabolic acidosis can occur by a gain of hydrogen ions or a loss of bicarbonate ions in the bloodstream. It can be divided clinically into two forms, according to the values of the serum anion gap: high anion gap metabolic acidosis and normal anion gap metabolic acidosis. The anion gap refers to the difference between the sum of all measured positively charged electrolytes (cations) and the sum of all negatively charged electrolytes (anions) in blood. Because the sum of measured cations is typically greater than the sum of measured anions in the bloodstream, there normally exists a disparity with predominance of cations; this is referred to as the anion gap. The anion gap reflects unmeasured anions (phosphates, sulfates, and proteins) in plasma that replace bicarbonate in metabolic acidosis. Measuring the anion

gap is necessary when analyzing conditions of metabolic acidosis as it can help determine the cause of the acidosis (Emmett & Szerlip, 2018).

The anion gap can be calculated by either of the following equations:

$$\text{Anion gap} = Na^+ + K^+ - (Cl^- + HCO_3^-)$$
$$\text{Anion gap} = Na^+ - (Cl^- + HCO_3^-)$$

Potassium is often omitted from the equation because of its low level in the plasma; therefore, the second equation is used more often than the first (Theodore, 2019).

The normal value for an anion gap is 8 to 12 mEq/L (8 to 12 mmol/L) without potassium in the equation. If potassium is included in the equation, the normal value for the anion gap is 12 to 16 mEq/L (12 to 16 mmol/L). The unmeasured anions in the serum normally account for less than 16 mEq/L of the anion production. Metabolic acidotic conditions can be differentiated according to the anion gap; there is either a normal anion gap or high anion gap. A person diagnosed with metabolic acidosis is determined to have normal anion gap metabolic acidosis if the anion gap is within this normal range (8 to 12 mEq/L). An anion gap greater than 16 mEq (16 mmol/L) suggests excessive accumulation of unmeasured anions and would indicate high anion gap metabolic acidosis. An anion gap occurs because not all electrolytes are measured. More anions are left unmeasured than cations (Emmett & Szerlip, 2018).

Pathophysiology

Normal anion gap metabolic acidosis results from the direct loss of bicarbonate, as in diarrhea, lower intestinal fistulas, ureterostomies, use of diuretics, early renal insufficiency, excessive administration of chloride, and the administration of parenteral nutrition without bicarbonate or bicarbonate-producing solutes (e.g., lactate) (Emmett & Szerlip, 2018).

High anion gap metabolic acidosis occurs when there is an excessive accumulation of acids. High anion gap occurs in lactic acidosis, salicylate poisoning (acetylsalicylic acid), renal failure, methanol, ethylene or propylene glycol toxicity, DKA, and ketoacidosis that occurs with starvation. The high amount of hydrogen ions due to the acids present are neutralized and buffered by HCO_3^- causing the bicarbonate concentration to fall and become exhausted. Other anions in the bloodstream are called upon to neutralize the high acid in the blood. In all of these instances, abnormally high levels of anions are used to neutralize the H^+, which increases the anion gap above normal limits (high anion gap) (Emmett & Szerlip, 2019).

Concept Mastery Alert

Metabolic acidosis is characterized by a low pH and low plasma bicarbonate concentration. Nurses need to remember that an anion gap is calculated primarily to identify the cause (pathology) of metabolic acidosis.

	Reduced or Negative Anion Gap	Normal Anion Gap	High Anion Gap
Anion gap without potassium	<8	8–12 mEq/L	>12
Anion gap with potassium	<12	12–16 mEq/L	>16
Clinical significance	Hypoproteinemia	Normal anion gap metabolic acidosis	High anion gap metabolic acidosis

Clinical Manifestations

Signs and symptoms of metabolic acidosis vary with the severity of the acidosis but include headache, confusion, drowsiness, increased respiratory rate and depth, nausea, and vomiting. Peripheral vasodilation and decreased cardiac output occur when the pH drops to less than 7. Additional physical assessment findings include decreased blood pressure, cold and clammy skin, arrhythmias, and shock. Chronic metabolic acidosis is primarily caused by chronic kidney disease because dysfunctional kidneys do not excrete acid (Emmett & Szerlip, 2018; Kovesdy, 2018).

Assessment and Diagnostic Findings

ABG measurements are used in the diagnosis of acid–base imbalances such as metabolic acidosis. Expected ABG changes include a low bicarbonate level (less than 22 mEq/L) and a low blood pH (less than 7.35). The cardinal feature of metabolic acidosis is a decrease in the serum bicarbonate level. In conditions of acidosis there is elevated H^+ and the sodium–potassium cellular pump brings H^+ into the cells in place of K^+. Therefore, high K^+ accumulates in the bloodstream in metabolic acidosis as a result of the shift of potassium out of the cells (Theodore, 2019). Later, when the acidosis is corrected and pH normalized, the cellular pump causes potassium to move back into the cells and hypokalemia may occur. Blood levels of potassium need to be closely monitored. ECG monitoring is recommended as changes of potassium in the bloodstream can cause arrhythmias (Palmer & Clegg, 2016a).

In metabolic acidosis, the lungs compensate for the high H^+ through hyperventilation to decrease the CO_2 level, which in turn reduces H^+ (see

carbonic acid equation). Calculation of the anion gap is helpful in determining the cause of metabolic acidosis. There are certain conditions that cause high anion gap metabolic acidosis and others that cause normal anion gap metabolic acidosis (Table 10-13).

TABLE 10-13 Summary of Single Acid–Base Disturbances and Their Compensatory Responses

Acid–Base Imbalance	Primary Disturbance	Respiratory Compensation and Predicted Response[a]	Renal Compensation and Predicted Response[a,b]
Metabolic acidosis	↓ pH and HCO_3^- HCO_3^- <22 mEq/L	↑ ventilation and ↓ PCO_2 *1 mEq/L ↓ HCO_3^- → 1–1.2 mm Hg ↓ PCO_2*	↑ H^+ excretion and ↑ HCO_3^- reabsorption if no renal disease
Metabolic alkalosis	↑ pH and HCO_3^- HCO_3^- >26 mEq/L	↓ ventilation and ↑ PCO_2 *1 mEq/L ↑ HCO_3^- → 0.7 mm Hg ↑ PCO_2*	↓ H^+ excretion and ↓ HCO_3^- reabsorption if no renal disease
Respiratory acidosis	↓ pH and ↑ PCO_2 PCO_2 >45 mm Hg	None	↑ H^+ excretion and ↑ HCO_3^- reabsorption *Acute: 1 mm Hg ↑ PCO_2 → 0.1 mEq/L ↑ HCO_3^-* *Chronic: 1 mm Hg ↑ PCO_2 → 0.3 mEq/L ↑ HCO_3^-*
Respiratory alkalosis	↑ pH and ↓ PCO_2 PCO_2 <35 mm Hg	None	↓ H^+ excretion and ↓ HCO_3^- reabsorption *Acute: 1 mm Hg ↓ PCO_2 → 0.2 mEq/L ↓ HCO_3^-* *Chronic: 1 mm Hg ↓ PCO_2 → 0.4 mEq/L ↓ HCO_3^-*

Note: Predicted compensatory responses are in *italics.*

[a]If blood values are the same as predicted compensatory values, a single acid–base disorder is present; if values are different, a mixed acid–base disorder is present.

[b]Acute renal compensation refers to duration of minutes to several hours; chronic renal compensation refers to a duration of several days.

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Medical Management

Treatment is directed at correcting the metabolic imbalance. If the problem results from excessive intake of chloride, treatment is aimed at eliminating the source of the chloride. When necessary, bicarbonate is given; however, the administration of sodium bicarbonate during cardiac arrest can result in

paradoxical intracellular acidosis. Hyperkalemia may occur with acidosis and hypokalemia with reversal of the acidosis and subsequent movement of potassium back into the cells. Therefore, the serum potassium level is monitored closely, and hypokalemia is corrected as acidosis is reversed (Mount, 2017c).

In chronic metabolic acidosis, low serum calcium levels are treated before the chronic metabolic acidosis is treated to avoid tetany resulting from an increase in pH and a decrease in ionized calcium. Alkalizing agents may be given. Treatment modalities may also include hemodialysis or peritoneal dialysis (Goltzman, 2019b).

Acute and Chronic Metabolic Alkalosis (Base Bicarbonate Excess)

Metabolic alkalosis is a clinical disturbance characterized by a high pH (decreased H^+ concentration) and a high plasma bicarbonate concentration. It is caused by a gain of bicarbonate or a loss of H^+ (Emmett & Szerlip, 2017a; Norris, 2019).

Pathophysiology

A common cause of metabolic alkalosis is severe vomiting or gastric suction that causes loss of stomach HCl (hydrogen and chloride ions). The disorder also occurs in pyloric stenosis, in which only gastric fluid is lost. Gastric fluid has an acid pH (usually 1 to 3), and loss of this highly acidic fluid pulls H^+ ions from the bloodstream to replenish the gastric acid. As a result, the bloodstream loses H^+ ions and becomes alkalotic. Other situations predisposing to metabolic alkalosis include those associated with loss of potassium, such as diuretic therapy that promotes excretion of potassium (e.g., thiazides, furosemide), and ACTH secretion (as in hyperaldosteronism and Cushing's syndrome) (Emmett & Szerlip, 2017a; Norris, 2019).

Hypokalemia produces alkalosis in two ways: (1) when the bloodstream is low in K^+, the nephrons reabsorb K^+ into the bloodstream and secrete H^+ into the tubule fluid which is excreted in the urine and (2) when the bloodstream is low in K^+, intracellular potassium moves out of the cells into the ECF, and as potassium ions leave the cells, hydrogen ions must enter to maintain electroneutrality (Mount, 2017c). Excessive alkali ingestion from antacids containing bicarbonate or from the use of sodium bicarbonate during cardiopulmonary resuscitation can also cause metabolic alkalosis (Emmett & Szerlip, 2017b).

Chronic metabolic alkalosis can occur with long-term diuretic therapy (thiazides or furosemide), villous adenoma in the GI tract, external drainage of gastric fluids, significant potassium depletion, cystic fibrosis, and the chronic ingestion of milk and calcium carbonate (Emmett & Szerlip, 2017b).

Clinical Manifestations

In alkalosis, H^+ ions are decreased in the bloodstream, leaving negatively charged proteins attracting other positive ions. Calcium (Ca^{++}) ions bind to these proteins. As calcium ions bind to proteins in the bloodstream, free Ca^{++} ions decrease in the bloodstream and hypocalcemia develops. Alkalosis is primarily manifested by symptoms related to hypocalcemia, such as tingling of the fingers and toes, dizziness, and tetany (cramping muscles). Because it is the ionized fraction of calcium that is diminished in metabolic alkalosis, neuromuscular symptoms due to hypocalcemia are often the predominant symptoms (Emmett & Szerlip, 2017c).

In metabolic alkalosis, the lungs attempt to compensate by slowing respiratory rate, which increases CO_2 retention, and in turn increases H^+ content of the blood (see carbonic acid equation). If the kidneys are functional, there is increased renal excretion of HCO_3^- and conservation of H^+ in an attempt to reduce the alkalinity of the bloodstream. As the pH of blood increases in metabolic alkalosis, H^+ ions are reabsorbed into the bloodstream to neutralize the blood. As the nephrons increase H^+ ion reabsorption, they excrete K^+, and hypokalemia develops (Larkin & Zimmanck, 2015). In hypokalemia a prominent U wave often develops on the ECG and ventricular rhythm disturbances, such as PVCs, may occur. Hypokalemia also can lead to decreased GI motility and paralytic ileus (Emmett & Szerlip, 2017c).

Assessment and Diagnostic Findings

In metabolic alkalosis, evaluation of ABGs reveals a pH greater than 7.45 and a serum bicarbonate concentration greater than 26 mEq/L (see Table 10-12 for normal values of ABGs). The $PaCO_2$ increases as the lungs attempt to compensate for the excess bicarbonate by retaining CO_2. This hypoventilation is more pronounced in patients who are semiconscious, unconscious, or debilitated than in patients who are alert. Because of hypoventilation the patient may develop hypoxemia (Emmett & Szerlip, 2017c).

Urine chloride levels may help identify the cause of metabolic alkalosis if the patient's history provides inadequate information. Metabolic alkalosis is the setting in which urine chloride concentration may be a more accurate estimate of fluid volume than the urine sodium concentration. Urine chloride concentrations can help to determine the source of the metabolic alkalosis. Urine chloride concentrations can be used to differentiate between vomiting, diuretic therapy, and excessive

adrenocorticosteroid secretion as the cause of the metabolic alkalosis. In patients with vomiting or cystic fibrosis, those receiving nutritional repletion, and those receiving diuretic therapy, hypovolemia and hypochloremia produce urine chloride concentrations lower than 25 mEq/L. Signs of hypovolemia are not present, and the urine chloride concentration exceeds 40 mEq/L in patients with mineralocorticoid excess or alkali loading; these patients usually have expanded fluid volume (Emmett & Palmer, 2019).

Medical Management

Treatment of both acute and chronic metabolic alkalosis is aimed at correcting the underlying acid–base disorder. Because volume depletion is commonly present with GI losses of H^+, the patient's I&O must be monitored carefully.

Treatment includes restoring normal fluid volume by administering normal saline because continued volume depletion perpetuates the alkalosis. In patients with hypokalemia, potassium is given as KCl to replace both K^+ and Cl^- losses. Proton pump inhibitors (e.g., omeprazole) are recommended to reduce the production of gastric hydrogen chloride (HCl). This decreased HCl will in turn decrease the loss of HCl with gastric suction in metabolic alkalosis. Carbonic anhydrase inhibitors (e.g., acetazolamide) are useful in treating metabolic alkalosis in patients who cannot tolerate rapid volume expansion (e.g., patients with heart failure). Carbonic anhydrase inhibitors act at the nephron to enhance bicarbonate excretion (Mehta & Emmett, 2018).

Acute and Chronic Respiratory Acidosis (Carbonic Acid Excess)

Respiratory acidosis is a clinical disorder in which the pH is less than 7.35 and the $PaCO_2$ is greater than 45 mm Hg. It may be either acute or chronic.

Pathophysiology

Respiratory acidosis is due to inadequate excretion of CO_2 with inadequate ventilation, resulting in elevated plasma CO_2 concentrations

and, consequently, increased levels of carbonic acid. In addition to an elevated $PaCO_2$, inadequate ventilation usually causes a decrease in PaO_2. Acute respiratory acidosis occurs in emergency situations, such as acute pulmonary edema, aspiration of a foreign object, atelectasis, pneumothorax, and overdose of sedatives, as well as in nonemergent situations, such as sleep apnea associated with severe obesity, severe pneumonia, and acute respiratory distress syndrome. Respiratory acidosis commonly occurs in patients with severe chronic obstructive pulmonary disease (COPD) when patients acutely decompensate due to respiratory infection or heart failure. Respiratory acidosis can also occur in diseases that impair respiratory muscle function and cause hypoventilation. These disorders include severe scoliosis, muscular dystrophy, multiple sclerosis, myasthenia gravis, and Guillain-Barré syndrome (Feller-Kopman & Schwartzstein, 2017).

Clinical Manifestations

Clinical signs in acute and chronic respiratory acidosis vary. Acute respiratory acidosis can occur due to sudden hypercapnia (elevated $PaCO_2$) that will increase pulse, blood pressure, and respiratory rate. The patient may complain of confusion, disorientation, or may exhibit diminished level of consciousness. An elevated $PaCO_2$, greater than 60 mm Hg causes reflexive cerebrovascular vasodilation and increased cerebral blood flow. Ventricular fibrillation may be the first sign of respiratory acidosis in anesthetized patients (Feller-Kopman & Schwartzstein, 2017).

If respiratory acidosis is severe, intracranial pressure may increase, resulting in papilledema and dilated conjunctival blood vessels. Acidosis can cause hyperkalemia as the hydrogen ion concentration overwhelms the compensatory mechanisms. Acidosis causes H^+ ion to move into the cells, causing a shift of potassium out of the cell. The bloodstream then gains increased potassium ions (i.e., hyperkalemia) (Mount, 2017c).

Chronic respiratory acidosis occurs with pulmonary diseases such as COPD, including emphysema and chronic bronchitis; obstructive sleep apnea; and obesity. As long as the $PaCO_2$ does not exceed the body's ability to compensate, the patient will be asymptomatic. However, if the $PaCO_2$ increases rapidly, reflexive cerebral vasodilation will increase intracranial pressure, and cyanosis and tachypnea will develop. Patients with slowly progressive COPD gradually accumulate CO_2 over a

prolonged period of time (months to years) and the body becomes used to high CO_2 levels. Patients with long-term COPD may not develop symptoms of hypercapnia because compensatory renal changes have had time to occur (Feller-Kopman & Schwartzstein, 2017).

Quality and Safety Nursing Alert

If the $PaCO_2$ is chronically greater than 50 mm Hg, the respiratory center becomes relatively insensitive to CO_2 as a respiratory stimulant, leaving hypoxemia as the major drive for respiration. Patients with long-term COPD breathe independently based on a hypoxic drive. High oxygen concentration administration can remove the stimulus of hypoxemia. The patient can lose the independent stimulus to breathe and incur respiratory failure. Therefore, oxygen is given with extreme caution in patients with long-term COPD.

Assessment and Diagnostic Findings

In respiratory acidosis, ABG analysis reveals a pH less than 7.35, a $PaCO_2$ greater than 45 mm Hg, and variation in the bicarbonate level, depending on the duration of the acute respiratory acidosis. When compensation occurs over a prolonged period and renal retention of bicarbonate has fully occurred, the bicarbonate neutralizes the acidosis. Arterial pH is within the lower limits of normal (e.g., pH 7.35). Depending on the cause of respiratory acidosis, other diagnostic measures include monitoring of serum electrolyte levels, chest x-ray for determining respiratory infection or other disease, and a drug screen if an overdose is suspected. ECG monitoring is recommended to identify any cardiac involvement as a result of COPD (Feller-Kopman & Schwartzstein, 2017).

Medical Management

Treatment is directed at improving ventilation in acute and chronic respiratory acidosis. Exact measures vary according to the cause of inadequate ventilation. Pharmacologic agents are commonly used. For example, bronchodilators help reduce bronchial spasm and increase ventilation, antibiotics are used for respiratory infections, and

thrombolytics or anticoagulants are used for pulmonary emboli (Stoller, 2019).

Pulmonary physiotherapy and nebulizer treatment can be used to clear the respiratory tract of mucus and purulent drainage. Adequate hydration (2 to 3 L/day) is indicated to keep the mucous membranes moist and decrease viscosity of mucous, thereby facilitating removal of secretions. Low concentration of supplemental oxygen is given as necessary (Aboussouan, 2018).

Mechanical ventilation, used appropriately, may be necessary to improve pulmonary ventilation. $PaCO_2$ should be reduced slowly and gradually using a mechanical ventilator. Mechanical ventilation can cause too rapid ventilatory loss of CO_2, which pulls H^+ out of the bloodstream too rapidly. If there is a rapid loss of H^+ the bloodstream becomes too alkalotic. The kidneys are unable to eliminate bicarbonate quickly enough to prevent alkalosis and seizures (Feller-Kopman & Schwartzstein, 2017).

Acute and Chronic Respiratory Alkalosis (Carbonic Acid Deficit)

Respiratory alkalosis is a clinical condition in which the arterial pH is greater than 7.45 and the $PaCO_2$ is less than 35 mm Hg. As with respiratory acidosis, acute and chronic conditions can cause this acid–base disturbance.

Pathophysiology

Respiratory alkalosis is caused by hyperventilation, which causes excessive loss or "blowing off" of CO_2 and, hence, there is a decrease in the plasma carbonic acid concentration (see carbonic acid equation). Causes include extreme anxiety such as panic disorder, hypoxemia, salicylate intoxication, gram-negative sepsis, and inappropriate ventilator settings.

Chronic respiratory alkalosis results from chronic hypocapnia which leads to decreased serum H^+ ion, resulting in alkalosis. Chronic hepatic insufficiency and cerebral tumors can cause chronic hyperventilation that leads to chronic respiratory alkalosis (Schwartzstein, Richards, Edlow, et al., 2018).

Clinical Manifestations

Clinical signs of respiratory alkalosis consist of lightheadedness and inability to concentrate due to cerebral artery vasoconstriction and decreased cerebral blood flow, numbness and tingling from decreased calcium ionization in the bloodstream, tinnitus, and sometimes loss of consciousness. Cardiac effects of respiratory alkalosis include tachycardia and ventricular and atrial arrhythmias (Schwartzstein et al., 2018).

Assessment and Diagnostic Findings

Analysis of ABGs assists in the diagnosis of both acute and chronic respiratory alkalosis. In the acute state, the pH is elevated above normal (greater than 7.45) as a result of a low $PaCO_2$ and a normal bicarbonate level. The kidneys take days to compensate for acid–base imbalances. Therefore, the kidneys cannot alter the bicarbonate level in the bloodstream quickly enough and medical intervention is necessary (Norris, 2019).

In the compensated state of chronic respiratory alkalosis, the kidneys have had sufficient time to lower the bicarbonate level to a near-normal level. Evaluation of serum electrolytes is indicated to identify any decrease in potassium, as hydrogen is pulled out of the cells in exchange for potassium. A decreased calcium level may occur as severe alkalosis inhibits calcium ionization, resulting in carpopedal spasms and tetany. A decreased phosphate level can occur due to alkalosis because there is increased uptake of phosphate by the cells. A toxicology screen should be performed to rule out salicylate intoxication due to aspirin poisoning (Schwartzstein et al., 2018).

Medical Management

Treatment depends on the exact underlying cause of respiratory alkalosis. If the cause is anxiety, the patient is instructed to breathe more slowly to allow CO_2 to accumulate or to breathe into a closed system (such as a paper bag or CO_2 rebreather mask). An antianxiety agent may be required to relieve hyperventilation in very anxious patients. Treatment of other causes of respiratory alkalosis is directed at correcting the underlying problem.

Mixed Acid–Base Disorders

Patients can simultaneously experience two or more independent acid–base disorders. A normal pH in the presence of changes in the $PaCO_2$ and plasma HCO_3^- concentration immediately suggests a mixed disorder. An example of a mixed disorder is the simultaneous occurrence of metabolic acidosis due to lactic acid accumulation and respiratory acidosis due to hypoventilation. Both of these disorders result in excessive acid accumulation in the bloodstream due to respiratory failure and cardiac arrest (Emmett & Palmer, 2018b).

Compensation

Generally, the pulmonary and renal systems compensate for each other to return the pH to normal. In a single acid–base disorder, the system not causing the problem tries to compensate by returning the ratio of bicarbonate to carbonic acid to the normal 20:1. The lungs compensate for metabolic disturbances by changing CO_2 excretion; hypoventilation accumulates CO_2, hyperventilation causes loss of CO_2. The kidneys compensate for respiratory disturbances by altering bicarbonate reabsorption and H^+ secretion (Norris, 2019; Theodore, 2019).

In respiratory acidosis, excess hydrogen in the blood is excreted in the urine in exchange for bicarbonate ions which are conserved. In respiratory alkalosis, the renal excretion of bicarbonate increases, and hydrogen ions are retained. In metabolic acidosis, the lungs compensate by increasing the ventilation rate and the kidneys retain bicarbonate. In metabolic alkalosis, the respiratory system compensates by decreasing ventilation to conserve CO_2 and increase the $PaCO_2$, which in turn increases carbonic acid. Because the lungs respond to acid–base disorders within minutes, compensation for metabolic imbalances occurs faster than renal compensation for respiratory imbalances (Norris, 2019; Theodore, 2019).

Table 10-13 summarizes compensation effects.

Blood Gas Analysis

Blood gas analysis is often used to identify the specific acid–base disturbance and the degree of compensation that has occurred. The analysis is usually based on an arterial blood sample; however, if an arterial sample cannot be obtained, a mixed venous sample may be used

(Theodore, 2019). Results of ABG analysis provide information about alveolar ventilation, oxygenation, and acid–base balance. It is necessary to evaluate the concentrations of serum electrolytes (e.g., sodium, potassium, chloride) along with ABG data because electrolytes are commonly affected by acid–base imbalances. The health history, physical examination, previous blood gas results, and serum electrolytes should always be part of the assessment used to determine the cause of the acid–base disorder (Larkin & Zimmanck, 2015). Responding to isolated sets of blood gas results without these data can lead to serious errors in interpretation. Treatment of the underlying condition usually corrects acid–base disorders (Chart 10-3).

PARENTERAL FLUID THERAPY

When patients cannot take oral fluid or oral feedings, their status is termed NPO (*nil per os*), meaning nothing by mouth. In patients who are NPO, **parenteral fluid therapy,** also termed IV fluid therapy, is used to administer fluids. IV fluid therapy can be initiated to replace fluids in various clinical settings such as hospitals, outpatient diagnostic and surgical settings, clinics, and home health care. IV fluids can also be used to administer medications and provide nutrients.

Purpose

The choice of an IV solution depends on the purpose of its administration. Generally, IV fluids are given to achieve one or more of the following goals:

- To provide water, electrolytes, and nutrients to meet daily requirements
- To replace water and correct electrolyte deficits
- To administer medications and blood products

IV solutions contain dextrose and/or electrolytes mixed in various proportions with water. Pure, electrolyte-free water can never be given by IV because it rapidly enters RBCs and causes them to rupture (Sterns, 2017b).

Types of Intravenous Solutions

IV solutions are categorized as isotonic, hypotonic, or hypertonic, according to whether their total osmolality is the same as, less than, or greater than that of blood, respectively (see earlier discussion of osmolality and tonicity). Electrolyte solutions are considered isotonic if the total electrolyte content (anions + cations) is between 250 and 375 mEq/L, hypotonic if the total electrolyte content is less than 250 mEq/L, and hypertonic if the total electrolyte content is greater than 375 mEq/L. The nurse must also consider a solution's osmolality, keeping in mind that the osmolality of plasma is approximately 300 mOsm/L (300 mmol/L). For example, a 10% dextrose solution has an osmolality of approximately 505 mOsm/L, which is greater than the osmolality of the bloodstream (Emmett & Palmer, 2018a).

Isotonic Fluids

Fluids that are classified as isotonic have a total osmolality close to that of the ECF and do not cause cells to shrink or swell. When isotonic fluids are administered they expand the ECF volume. One liter of isotonic fluid expands the ECF by 1 L; however, isotonic solution expands the plasma component of ECF by only 0.25 L. An isotonic solution is a crystalloid solution (water containing soluble mineral salts). Plasma is a colloidal solution. A colloidal solution is a mixture of fluid containing insoluble large particles, such as proteins. Colloidal solutions exert oncotic pressure; crystalloids do not exert oncotic pressure (Siparsky, 2019; Sterns, 2018a).

Quality and Safety Nursing Alert

It is important for the nurse to recognize that in blood loss, 3 L of isotonic fluid (crystalloid solution) is needed to replace 1 L of blood (colloidal solution).

Because isotonic fluids expand the water volume in the intravascular space, patients with heart failure or hypertension who receive isotonic solutions should be carefully monitored for signs of fluid overload (Siparsky, 2019).

Chart 10-3 ASSESSMENT

Assessing Arterial Blood Gases

The following steps are recommended to evaluate arterial blood gas values. They are based on the assumption that the average values are:

pH = 7.35–7.45

$PaCO_2$ = 35–45 mm Hg

HCO_3^- = 24 to 27 mEq/L

1. *First, note the pH.* It can be high, low, or normal, as follows:

   A normal pH may indicate perfectly normal blood gases, *or* it may indicate a *compensated* imbalance. A compensated imbalance is one in which the body has been able to correct the pH by either respiratory or metabolic changes (depending on the primary problem). For example, a patient with primary metabolic acidosis starts out with a low bicarbonate level but a normal CO_2 level. Soon afterward, the lungs try to compensate for the imbalance by exhaling large amounts of CO_2 (hyperventilation). As another example, a patient with primary respiratory acidosis starts out with a high CO_2 level; soon afterward, the kidneys attempt to compensate by retaining bicarbonate. If the compensatory mechanism is able to restore the bicarbonate to carbonic acid ratio back to 20:1, full compensation (and thus normal pH) will be achieved.

   pH > 7.45 (alkalosis)

   pH < 7.35 (acidosis)

   pH = 7.4 (normal)

2. The next step is to determine the primary cause of the disturbance. This is done by evaluating the $PaCO_2$ and HCO_3^- in relation to the pH.

   Example: pH > 7.45 (alkalosis)

   a. If the $PaCO_2$ is less than 35 mm Hg, the primary disturbance is respiratory alkalosis. (This situation occurs when a patient hyperventilates and "blows off" too much CO_2. Recall that CO_2 dissolved in water becomes carbonic acid, the acid side of the "carbonic acid–bicarbonate buffer system.")

   b. If the HCO_3^- is greater than 27 mEq/L, the primary disturbance is metabolic alkalosis. (This situation occurs when the body gains too much bicarbonate, an alkaline substance. Bicarbonate is the basic or alkaline side of the "carbonic acid–bicarbonate buffer system.")

   Example: pH < 7.35 (acidosis)

   c. If the $PaCO_2$ is greater than 40 mm Hg, the primary disturbance is respiratory acidosis. (This situation occurs when a patient

hypoventilates and thus retains too much CO_2, an acidic substance.)

d. If the HCO_3^- is less than 24 mEq/L, the primary disturbance is metabolic acidosis. (This situation occurs when the body's bicarbonate level drops, either because of direct bicarbonate loss or because of gains of acids such as lactic acid or ketones.)

3. The next step involves determining if compensation has begun. This is done by looking at the value other than the primary disorder. If it is moving in the same direction as the primary value, compensation is under way. Consider the following gases:

The first set (1) indicates acute respiratory acidosis without compensation (the $PaCO_2$ is high, the HCO_3^- is normal). The second set (2) indicates chronic respiratory acidosis. Note that compensation has taken place—that is, the HCO_3^- has elevated to an appropriate level to balance the high $PaCO_2$ and produce a normal pH.

	pH	$PaCO_2$	HCO_3^-
(1)	7.2	60 mm Hg	24 mEq/L
(2)	7.4	60 mm Hg	37 mEq/L

4. Two distinct acid–base disturbances may occur simultaneously. These can be identified when the pH does not explain one of the changes. When the $PaCO_2$ is ↑ and the HCO_3 is ↓, respiratory acidosis and metabolic acidosis coexist. When the $PaCO_2$ is ↓ and the HCO_3 is ↑, respiratory alkalosis and metabolic alkalosis coexist.

Example: Metabolic and respiratory acidosis

a. pH 7.2 decreased pH (indicates acidosis)

b. $PaCO_2$ 52 increased pH (indicates respiratory acidosis)

c. HCO_3 13 decreased HCO_3 (indicates metabolic acidosis)

5. If metabolic acidosis exists, then calculate the anion gap (AG) to determine the cause of the metabolic acidosis (AG vs. non-AG):

$AG = Na - (Cl^- + HCO_3^-)$

Normal AG = 10−14 mmol/L

6. Evaluate the patient to determine if the clinical signs and symptoms are compatible with the acid–base analysis.

Adapted from Fischbach, F., & Fischbach, M. (2018). *A manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

D_5W

A solution of D_5W is unique in that it may be both isotonic and hypotonic (Hoorn, 2017). Once given, the glucose is rapidly metabolized, and this initially isotonic solution (same osmolality as serum) then disperses as a hypotonic fluid—one third extracellular and two thirds intracellular. It is essential to consider this action of D_5W, especially if the patient is at risk for increased intracranial pressure. During fluid resuscitation, this solution should not be used because hyperglycemia can result. Therefore, D_5W is used mainly to supply water and to correct an increased serum osmolality. About 1 L of D_5W provides less than 170 kcal and is a minor source of the body's daily caloric requirements (Hoorn, 2017).

Normal Saline Solution

Normal saline (0.9% sodium chloride) solution contains water, sodium, and chloride. Because the osmolality is entirely contributed by electrolytes, the solution remains within the ECF and expands the intravascular volume. For this reason, normal saline solution is often used to correct an extracellular volume deficit but is not identical to ECF. It is used with administration of blood transfusions and to replace large sodium losses, such as in burn injuries. It should not be used in heart failure, pulmonary edema, renal impairment, or sodium retention. Normal saline does not supply calories (Hoorn, 2017).

Other Isotonic Solutions

Several other solutions contain ions in addition to sodium and chloride and are somewhat similar to the ECF in composition. Lactated Ringer's solution contains potassium and calcium in addition to sodium chloride. It is used to correct dehydration, blood loss, and sodium depletion and to replace GI losses.

Hypotonic Fluids

One purpose of hypotonic solution is to replace fluid, because it is hypotonic compared with plasma. Another purpose of hypotonic solution is to provide free water. At times, hypotonic sodium solutions are used to treat hypernatremia and other hyperosmolar conditions. Half-strength saline (0.45% sodium chloride) solution is frequently used.

Hypertonic Fluids

Hypertonic fluids include 3% NaCl and IV mannitol. If a patient is sodium depleted, a hypertonic sodium IV solution might be used. If a patient is experiencing acute cerebral edema, IV mannitol is often used. Hypertonic solutions pull water from the interstitial and intracellular compartments into the bloodstream. These solutions draw water out of intracellular compartments causing cellular dehydration (Hoorn, 2017). Normal saline and lactated Ringer's solution are considered isotonic solutions. When 5% dextrose (D_5W) is added to normal saline solution or lactated Ringer's solution, the total osmolality exceeds that of the ECF. With the added dextrose, these are then considered hypertonic solutions. However, the dextrose is quickly metabolized, and after the dextrose is depleted, only the isotonic solution remains. Therefore, any effect on the intracellular compartment is temporary. Similarly, with hypotonic electrolyte solutions containing 5% dextrose, once the dextrose is metabolized, these solutions disperse as hypotonic fluids. However, higher concentrations of dextrose, such as 50% dextrose ($D_{50}W$) in water, are strongly hypertonic. Hypertonic solutions should be administered into central veins so that they can be diluted by large amounts of rapid blood flow (Hoorn, 2017).

Saline solutions are also available in osmolar concentrations greater than that of the ECF. These solutions draw water from the ICF to the ECF and cause cells to shrink. If given rapidly or in large quantity, they may cause an extracellular volume excess and precipitate circulatory overload and dehydration. As a result, these solutions must be given cautiously and usually only when the serum osmolality has decreased to dangerously low levels. Hypertonic solutions exert an osmotic pressure greater than that of the ECF (Hoorn, 2017).

Other Intravenous Therapies

When the patient is unable to tolerate food, nutritional requirements are often met using the IV route. Solutions may include high concentrations of glucose (such as 50% dextrose in water), protein, or fat to meet nutritional requirements (see Chapter 41). The IV route may also be used to administer colloids, plasma expanders, and blood products (Hoorn, 2017). Examples of blood products include whole blood, packed RBCs, fresh-frozen plasma, albumin, and cryoprecipitate (these are discussed in more detail in Chapter 28).

Many medications are also delivered by the IV route, either by continuous infusion or by intermittent bolus directly into the vein. Because IV medications enter the circulation rapidly, administration by this route is potentially hazardous. All medications can produce adverse reactions; however, medications given by the IV route can cause these reactions quickly after administration, because the medications are delivered directly into the bloodstream. Administration rates and recommended dilutions for individual medications are available in specialized texts pertaining to IV medications and in manufacturers' package inserts; these should be consulted to ensure safe IV administration of medications (Institute for Safe Medication Practices [ISMP], 2019).

Quality and Safety Nursing Alert

The nurse must assess the patient for a history of allergic reactions to medications. Although obtaining drug allergy information is important when administering any medication, it is especially critical with IV administration, because the medication is delivered directly into the bloodstream. This can trigger an immediate hypersensitivity reaction.

Nursing Management of the Patient Receiving Intravenous Therapy

In many settings, the ability to perform venipuncture to gain access to the venous system for administering fluids and medication is an expected nursing skill. This responsibility includes selecting the appropriate venipuncture site and type of cannula and being proficient in the technique of vein entry. The nurse should demonstrate competency in and knowledge of IV catheter placement according to the Nurse Practice Act applicable in their state and should follow the rules and regulations, organizational policies and procedures, and practice guidelines of that state's board of nursing (Gorski, Hadaway, Hagle, et al., 2016).

Managing Systemic Complications

Fluid Overload

Overloading the circulatory system with excessive IV fluids causes increased blood pressure and central venous pressure. Signs and symptoms of fluid overload include moist crackles on auscultation of the lungs, cough, restlessness, distended neck veins, edema, weight gain, dyspnea, and rapid, shallow respirations. Possible causes include rapid infusion of an IV solution or hepatic, cardiac, or renal disease. The risk of fluid overload and subsequent pulmonary edema is especially increased in older patients with cardiac disease; this is referred to as circulatory overload. Its treatment includes decreasing the IV rate, monitoring vital signs frequently, assessing breath sounds, and placing the patient in a high Fowler position. The primary provider is contacted immediately. This complication can be avoided by using an infusion pump and by carefully monitoring all infusions. Complications of circulatory overload include heart failure and pulmonary edema (Connelly, 2018).

Air Embolism

The risk of air embolism is rare but ever-present. It is most often associated with cannulation of central veins and directly related to the size of the embolus and the rate of entry. Air entering into central veins gets to the right ventricle, where it lodges against the pulmonary valve and blocks the flow of blood from the ventricle into the pulmonary arteries. Manifestations of air embolism include palpitations, dyspnea, continued coughing, jugular venous distention, wheezing, and cyanosis; hypotension; weak, rapid pulse; altered mental status; and chest, shoulder, and low back pain. Treatment calls for immediately clamping the cannula and replacing a leaking or open infusion system, placing the patient on the left side in the Trendelenburg position, assessing vital signs and breath sounds, and administering oxygen. Air embolism can be prevented by using locking adapters on all lines, filling all tubing completely with solution, and using an air detection alarm on an IV infusion pump. Complications of air embolism include shock and death. The amount of air necessary to induce death in humans is not known; however, the rate of entry is probably as important as the actual volume of air (Malik, Claus, Illman, et al., 2017).

Infection

Pyogenic substances in either the infusion solution or the IV administration set can cause bloodstream infections. Signs and symptoms include an abrupt temperature elevation shortly after the infusion is started, backache, headache, increased pulse and respiratory rate, nausea and vomiting, diarrhea, chills and shaking, and general malaise. Additional symptoms include erythema, edema, and induration or drainage at the insertion site. In sepsis, vascular collapse and septic shock may occur (Connelly, 2018). (See Chapter 11 for a discussion of septic shock.)

Infection ranges in severity from local involvement of the insertion site to systemic dissemination of organisms through the bloodstream, as in sepsis. Measures to prevent infection are essential at the time the IV line is inserted and throughout the entire infusion (Hugill, 2017).

Managing Local Complications

Local complications of IV therapy include phlebitis, infiltration and extravasation, thrombophlebitis, hematoma, and clotting of the needle (Simin, Milutinović, Turkulov, et al., 2019). Chart 10-4 provides a Nursing Research Profile about complications of peripheral IVs.

Phlebitis

Phlebitis, or inflammation of a vein, can be categorized as chemical, mechanical, or bacterial; however, two or more of these types of irritation often occur simultaneously. Chemical phlebitis can be caused by an irritating medication or solution (increased pH or high osmolality of a solution), rapid infusion rates, and medication incompatibilities. Mechanical phlebitis results from long periods of cannulation, catheters in flexed areas, catheter gauges larger than the vein lumen, and poorly secured catheters. Bacterial phlebitis can develop from poor hand hygiene, lack of aseptic technique, failure to check all equipment before use, and failure to recognize early signs and symptoms of phlebitis. Other factors include poor venipuncture technique, catheter in place for a prolonged period, and failure to adequately secure the catheter (Hugill, 2017). Phlebitis is characterized by a reddened, warm area around the insertion site or along the path of the vein, pain or tenderness at the site or along the vein, and swelling. The incidence of phlebitis increases with the length of time the IV line is in place, the composition of the fluid or medication infused (especially its pH and tonicity), catheter material, emergency insertions, the size and site of the cannula inserted,

ineffective filtration, inadequate anchoring of the line, and the introduction of microorganisms at the time of insertion (Mihala, Ray-Barruel, Chopra, et al., 2018).

Chart 10-4 **NURSING RESEARCH PROFILE**

Complication Rates of Peripheral IVs

Simin, D., Milutinović, D., Turkulov, V., et al. (2019). Incidence, severity and risk factors of peripheral intravenous cannula-induced complications: An observational prospective study. *Journal of Clinical Nursing, 28*(9–10), 1585–1599.

Purpose

The incidence and severity of complications of peripheral IV insertion is not known. The purpose of this study was to determine the incidence, severity, and risk factors of peripheral IV cannula-induced complications in hospitalized adult patients.

Design

This was an observational prospective study. Observations were made of 1428 IV insertions among 368 adult patients hospitalized in a tertiary medical center.

Findings

Phlebitis was the most common complication, with a rate of 44%, followed by infiltration with a rate of 16%, while the incidence of occlusion and catheter dislodgement were 7.6% and 5.6%, respectively. The risk factors for phlebitis were identified as the presence of a comorbidity (i.e., diabetes), a current infection, and an indwelling urinary catheter. The frequency of infiltration increased with the age of the patient, the number of attempts at the IV insertion in the same anatomic site, and the number of medications and IV solutions administered per day.

Nursing Implications

Medical-surgical nurses assess for all complications following IV insertion but should be particularly alert for phlebitis, which is the most common. This study provides evidence that older patients are at higher risk of infiltration and that attempting multiple IV sticks in the same anatomic site may lead to higher complication rates. The nurse should also be aware that patients who have comorbidities (such as diabetes) and those who are receiving multiple medications and IV solutions are at higher risk for IV complications.

Chart 10-5 ASSESSMENT

Assessing for Phlebitis

Grade	Clinical Criteria
0	No clinical symptoms
1	Erythema at access site with or without pain
2	Pain at access site Erythema, edema, or both
3	Pain at access site Erythema, edema, or both Streak formation Palpable venous cord
4	Pain at access site with erythema Streak formation Palpable venous cord (longer than 1 inch) Purulent drainage

Adapted from Gorski, L. A., Hadaway, L., Hagle, M., et al. (2016). Infusion therapy standards of practice. *Journal of Infusion Nursing, 39*(1 Suppl), S1–S159.

The Infusion Nurses Society (INS) has identified specific standards for assessing phlebitis (Gorski et al., 2016); these appear in Chart 10-5. Phlebitis is graded according to the most severe presenting indication.

Treatment consists of discontinuing the IV line and restarting it in another site, and applying a warm, moist compress to the affected site (INS, 2016). Phlebitis can be prevented by using aseptic technique during insertion, using the appropriate-size cannula or needle for the vein, considering the composition of fluids and medications when selecting a site, observing the site hourly for any complications, anchoring the cannula or needle well, and changing the IV site according to agency policy and procedures (Mihala et al., 2018).

Infiltration and Extravasation

Infiltration is the unintentional administration of a nonvesicant solution or medication into surrounding tissue. This can occur when the IV cannula dislodges or perforates the wall of the vein. Infiltration is characterized by edema around the insertion site, leakage of IV fluid from the insertion site, discomfort and coolness in the area of infiltration, and a significant decrease in the flow rate. When the solution is particularly irritating, sloughing of tissue may result. Close monitoring

of the insertion site is necessary to detect infiltration before it becomes severe (Nickel, 2019; Simin et al., 2019).

Infiltration is usually easily recognized if the insertion area is larger than the same site of the opposite extremity but is not always so obvious. A common misconception is that a backflow of blood into the tubing proves that the catheter is properly placed within the vein. However, if the catheter tip has pierced the wall of the vessel, IV fluid will seep into tissues and flow into the vein. Although blood return occurs, infiltration may have occurred as well. A more reliable means of confirming infiltration is to apply a tourniquet above (or proximal to) the infusion site and tighten it enough to restrict venous flow. If the infusion continues to drip despite the venous obstruction, infiltration is present.

As soon as the nurse detects infiltration, the infusion should be stopped, the IV catheter removed, and a sterile dressing applied to the site after careful inspection to determine the extent of infiltration. The infiltration of any amount of blood product, irritant, or vesicant is considered the most severe (Brooks, 2018; Odom, Lowe, & Yates, 2018).

The IV infusion should be started in a new site or proximal to the infiltration site if the same extremity must be used again. A warm compress may be applied to the site if small volumes of noncaustic solutions have infiltrated over a long period, or if the solution was isotonic with a normal pH; the affected extremity should be elevated to promote the absorption of fluid. If the infiltration is recent and the solution was hypertonic or had an increased pH, a cold compress may be applied to the area (Gorski et al., 2016; Odom et al., 2018).

Infiltration can be detected and treated early by inspecting the site every hour for redness, pain, edema, blood return, coolness at the site, and IV fluid leaking from the IV site. Using the appropriate size and type of cannula for the vein prevents this complication. The use of electronic infusion devices (EIDs) does not cause an infiltration or extravasation; however, these devices will exacerbate the problem until the infusion is turned off. The Infusion Nursing Standards of Practice state that a standardized infiltration scale should be used to document the infiltration (Brooks, 2018; Gorski et al., 2016) (Chart 10-6).

Extravasation is similar to infiltration, with an inadvertent administration of vesicant or irritant solution or medication into the surrounding tissue. Medications such as vasopressors, potassium and calcium preparations, and chemotherapeutic agents can cause pain, burning, and redness at the site. Blistering, inflammation, and necrosis of tissues can occur. Older patients, comatose or anesthetized patients,

patients with diabetes, and patients with peripheral vascular or cardiovascular disease are at greater risk for extravasation; other risk factors include high pressure infusion pumps, palpable cording of vein, and fluid leakage from the insertion site. The extent of tissue damage is determined by the concentration of the medication, the quantity that extravasated, the location of the infusion site, the tissue response, and the duration of the process of extravasation (Gorski et al., 2016; Odom et al., 2018).

Chart 10-6 **ASSESSMENT**

Assessing for Infiltration

Grade	Clinical Criteria
0	No clinical symptoms
1	Skin blanched, edema less than 1 inch in any direction, cool to touch, with or without pain
2	Skin blanched, edema 1 to 6 inches in any direction, cool to touch, with or without pain
3	Skin blanched, translucent, gross edema greater than 6 inches in any direction, cool to touch, mild to moderate pain, possible numbness
4	Skin blanched, translucent, skin tight, leaking, skin discolored, bruised, swollen, gross edema greater than 6 inches in any direction, deep pitting tissue edema, circulatory impairment, moderate to severe pain, infiltration of any amount of blood products, irritant, or vesicant

Adapted from Gorski, L. A., Hadaway, L., Hagle, M., et al. (2016). Infusion therapy standards of practice. *Journal of Infusion Nursing, 39*(1 Suppl), S1–S159.

When extravasation occurs, the infusion must be stopped and the provider notified promptly. The agency's protocol to treat extravasation is initiated; the protocol may specify specific treatments, including antidotes specific to the medication that extravasated, and may indicate whether the IV line should remain in place or be removed before treatment. The protocol often specifies infiltration of the infusion site with an antidote prescribed after assessment by the provider, removal of the cannula, and application of warm compresses to sites of extravasation from alkaloids or cold compresses to sites of extravasation

from alkylating and antibiotic vesicants. The affected extremity should not be used for further cannula placement. Thorough neurovascular assessments of the affected extremity must be performed frequently (Gorski et al., 2016).

Reviewing the institution's IV policy and procedures and incompatibility charts and checking with the pharmacist before administering any IV medication, whether peripherally or centrally, are recommended to determine incompatibilities and vesicant potential to prevent extravasation. Careful, frequent monitoring of the IV site, avoiding insertion of IV devices in areas of flexion, securing the IV line, and using the smallest catheter possible that accommodates the vein help minimize the incidence and severity of this complication. In addition, when vesicant medication is given by IV push, it should be given through a side port of an infusing IV solution to dilute the medication and decrease the severity of tissue damage if extravasation occurs. Extravasation is rated as grade 4 on the infiltration scale. Complications of an extravasation may include blister formation, skin sloughing and tissue necrosis, functional or sensory loss in the injured area, and disfigurement or loss of limb (Gorski et al., 2016; Nickel, 2019).

Thrombophlebitis

Thrombophlebitis refers to the presence of a clot plus inflammation in the vein. It is evidenced by localized pain, redness, warmth, and swelling around the insertion site or along the path of the vein, immobility of the extremity because of discomfort and swelling, sluggish flow rate, fever, malaise, and leukocytosis (Brooks, 2018).

Treatment includes discontinuing the IV infusion; applying a cold compress first to decrease the flow of blood, followed by a warm compress; elevating the extremity; and restarting the line in the opposite extremity. If the patient has signs and symptoms of thrombophlebitis, the IV line should not be flushed (although flushing may be indicated in the absence of phlebitis to ensure cannula patency and to prevent mixing of incompatible medications and solutions). The catheter should be cultured after the skin around the catheter is cleaned with alcohol. If purulent drainage exists, the site is cultured before the skin is cleaned (Brooks, 2018; Hugill, 2017).

Thrombophlebitis can be prevented by avoiding trauma to the vein at the time the IV line is inserted, observing the site every hour, and checking medication additives for compatibility (Gorski et al., 2016).

Hematoma

Hematoma results when blood leaks into tissues surrounding the IV insertion site. Leakage can result if the vein wall is perforated during venipuncture, the needle slips out of the vein, a cannula is too large for the vessel, or insufficient pressure is applied to the site after removal of the needle or cannula. The signs of a hematoma include ecchymosis, immediate swelling at the site, and leakage of blood at the insertion site.

Treatment includes removing the needle or cannula and applying light pressure with a sterile, dry dressing; applying ice for 24 hours to the site to avoid extension of the hematoma; elevating the extremity to maximize venous return, if tolerated; assessing the extremity for any circulatory, neurologic, or motor dysfunction; and restarting the line in the other extremity if indicated. A hematoma can be prevented by carefully inserting the needle and by frequently monitoring patients who have a bleeding disorder, are taking anticoagulant medication, or have advanced liver disease (Nickel, 2019).

Clotting and Obstruction

Blood clots may form in the IV line as a result of kinked IV tubing, a very slow infusion rate, an empty IV bag, or failure to flush the IV line after intermittent medication or solution administrations. The signs are decreased flow rate and blood backflow into the IV tubing (Brooks, 2018).

If blood clots in the IV line, the infusion must be discontinued and restarted in another site with a new cannula and administration set. The tubing should not be irrigated or milked. Neither the infusion rate nor the solution container should be raised, and the clot should not be aspirated from the tubing. Clotting of the needle or cannula may be prevented by not allowing the IV solution bag to run dry, taping the tubing to prevent kinking and maintain patency, maintaining an adequate flow rate, and flushing the line after intermittent medication or other solution administration. In some cases, a specially trained nurse or primary provider may inject a thrombolytic agent into the catheter to clear an occlusion resulting from fibrin or clotted blood (Brooks, 2018; Gorski et al., 2016).

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

At times, IV therapy must be given in the home setting, in which case much of the daily management rests with the patient and family. Education becomes essential to ensure that the patient and family can manage the IV fluid and infusion correctly and avoid complications. Written instructions as well as demonstration and return demonstration help reinforce the key points for all of these functions (Payne, 2019).

Continuing and Transitional Care

Home infusion therapies cover a wide range of treatments, including antibiotic, analgesic, and antineoplastic medications; blood or blood component therapy; and parenteral nutrition. When direct nursing care is necessary, arrangements are made to have an infusion nurse visit the home and administer the IV therapy as prescribed. In addition to implementing and monitoring the IV therapy, the nurse carries out a comprehensive assessment of the patient's condition and continues to educate the patient and family about the skills involved in overseeing the IV therapy setup. Any dietary changes that may be necessary because of fluid or electrolyte imbalances are explained or reinforced during such sessions (Payne, 2019).

Periodic laboratory testing may be necessary to assess the effects of IV therapy and the patient's progress. Blood specimens may be obtained by a laboratory near the patient's home, or a home visit may be arranged to obtain blood specimens for analysis (Payne, 2019).

The nurse collaborates with the case manager in assessing the patient, family, and home environment; developing a plan of care in accordance with the patient's treatment plan and level of ability; and arranging for appropriate referral and follow-up if necessary. Any necessary equipment may be provided by the agency or purchased by the patient, depending on the terms of the home care arrangements. Appropriate documentation is necessary to assist in obtaining third-party payment for the service provided.

CRITICAL THINKING EXERCISES

1 ebp A 34-year-old woman comes to the walk-in clinic where you work. She is going to run her first marathon and asks about using salt tablets to compensate for loss of sodium through sweat. What is the best evidence for the use of salt tablets in performance athletes? What is the strength of the evidence base guiding your recommendation?

2 ipe An 82-year-old man with hypovolemia has been admitted to the medical unit where you work. What nursing and interprofessional assessments are indicated during your initial interactions with him? What other interprofessional services might you try to engage?

3 pq A 55-year-old woman is sent to the emergency department by her primary provider. The patient has a history of congestive heart failure. The primary provider has requested laboratory tests. Blood gas results are as follows: pH 7.46; HCO_3^- 26; $PaCO_2$ 40 mm Hg. Blood chemistry results are as follows: potassium 4.5 mEq/L; sodium 140 mEq/L; glucose 110 mg/dL. Vital signs: BP 140/92, HR 90 bpm, RR 18 bpm. What is your priority for this patient? Give your rationale. What further diagnostic testing is indicated?

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*Asterisk indicates nursing research.

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Resources

Infusion Nurses Society (INS), www.ins1.org

11 Shock, Sepsis, and Multiple Organ Dysfunction Syndrome

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the pathophysiology, clinical manifestations, and collaborative management of progressive stages of various types of shock, of sepsis, and of multiple organ dysfunction syndrome.
2. Compare and contrast the pathophysiology, clinical manifestations, and collaborative management of shock states in hypovolemic, cardiogenic, and distributive shock.
3. Identify medical and nursing management priorities in treating patients across the continuum of shock.
4. Describe medical and nursing management priorities in the treatment and prevention of sepsis and septic shock.
5. Discuss the role of nurses in providing psychosocial support to patients experiencing shock, sepsis, and multiple organ dysfunction syndrome, and their families.
6. Discuss the role of nurses in providing transitional care to patients and their families after having been managed in a critical-care unit for shock, sepsis, or multiple organ dysfunction syndrome.

NURSING CONCEPTS

Cellular Regulation
Fluids and Electrolytes
Infection
Medical Emergencies
Perfusion

GLOSSARY

anaphylactic shock: distributive shock state resulting from a severe allergic reaction producing an acute systemic vasodilation and relative hypovolemia

cardiogenic shock: shock state resulting from impairment or failure of the myocardium

colloids: intravenous solutions that contain molecules that are too large to pass through capillary membranes

crystalloids: intravenous electrolyte solutions that move freely between the intravascular compartment and interstitial spaces

cytokines: messenger substances that may be released by a cell to create an action at that site or may be carried by the bloodstream to a distant site before being activated; (*synonyms*: biochemical mediators, inflammatory mediators)

distributive shock: shock state resulting from displacement of intravascular volume creating a relative hypovolemia and inadequate delivery of oxygen to the cells

hypovolemic shock: shock state resulting from decreased intravascular volume due to fluid loss

multiple organ dysfunction syndrome: presence of altered function of two or more organs in an acutely ill patient such that interventions are necessary to support continued organ function

neurogenic shock: shock state resulting from loss of sympathetic tone causing relative hypovolemia

sepsis: life-threatening organ dysfunction caused by a dysregulated host response to infection

septic shock: a subset of sepsis in which underlying circulatory and cellular metabolic abnormalities are profound enough to substantially increase mortality

shock: life-threatening physiologic condition in which there is inadequate blood flow to tissues and cells of the body

systemic inflammatory response syndrome: a syndrome resulting from a clinical insult that initiates an inflammatory response that is systemic, rather than localized to the site of the insult; a type of cytokine release syndrome also referred to as cytokine storm

Shock is a life-threatening condition that results from inadequate tissue perfusion. Many conditions may cause shock; irrespective of the cause, tissue hypoperfusion prevents adequate oxygen delivery to cells, leading to cell dysfunction and death. The progression of shock is neither linear nor predictable, and shock states, especially septic shock (the most life-threatening form of sepsis), comprise an area of ongoing clinical research. Nurses caring

for patients with shock and those at risk for shock must understand the underlying mechanisms of the various shock states (i.e., hypovolemic, cardiogenic, obstructive [see Chapter 25], and distributive shock [i.e., septic, neurogenic, anaphylactic]) and recognize the subtle as well as more obvious signs of each of these states. If shock is not effectively treated, **multiple organ dysfunction syndrome (MODS)** which is the presence of altered function of two or more organs in an acutely ill patient such that interventions are necessary to support continued organ function may ensue, often resulting in patient death. MODS may be a complication of any form of shock but is most commonly seen in patients with sepsis. Rapid assessment with early recognition and response to shock states and sepsis is essential to the patient's recovery.

Overview of Shock

Shock can best be defined as a clinical syndrome that results from inadequate tissue perfusion, creating an imbalance between the delivery of oxygen and nutrients needed to support cellular function (Kislitsina, Rich, Wilcox, et al., 2019; Massaro, 2018). Adequate blood flow to the tissues and cells requires an effective cardiac pump, adequate vasculature or circulatory system, and sufficient blood volume. If one of these components is impaired, perfusion to the tissues is threatened or compromised. Without treatment, inadequate blood flow to the cells results in poor delivery of oxygen and nutrients, cellular hypoxia, and cell death that progresses to organ dysfunction and eventually death.

Shock affects all body systems. It may develop rapidly or slowly, depending on the underlying cause. During shock, the body struggles to survive, calling on all its homeostatic mechanisms to restore blood flow. Any insult to the body can create a cascade of events resulting in poor tissue perfusion. Therefore, any patient with any disease state may be at risk for developing shock. The primary underlying pathophysiologic process and underlying disorder are used to classify the shock state (e.g., hypovolemic shock, cardiogenic shock, obstructive shock [see Chapter 25], distributive shock [i.e., septic, neurogenic, anaphylactic]; all discussed later in the chapter).

Regardless of the initial cause of shock, certain physiologic responses are common to all types of shock. These physiologic responses include hypoperfusion of tissues, hypermetabolism, and activation of the inflammatory response. The body responds to shock states by activating the sympathetic nervous system and mounting a hypermetabolic and inflammatory response. Failure of compensatory mechanisms to effectively restore physiologic balance is the final pathway of all shock states and results in end-organ dysfunction and death (Massaro, 2018; Seymour & Angus, 2018).

Nursing care of patients with shock requires ongoing systematic assessment. Many of the interventions required in caring for patients with shock call for close collaboration with other members of the health care team and rapid implementation of prescribed therapies. Nurses are in key positions to identify early signs of shock and anticipate rapid therapy.

Normal Cellular Function

Energy metabolism occurs within the cell, where nutrients are chemically broken down and stored in the form of adenosine triphosphate (ATP). Cells use this stored energy to perform necessary functions, such as active transport, muscle contraction, and biochemical synthesis, as well as specialized cellular functions, such as the conduction of electrical impulses. ATP can be synthesized aerobically (in the presence of oxygen) or anaerobically (in the absence of oxygen). Aerobic metabolism yields far greater amounts of ATP per mole of glucose than does anaerobic metabolism; therefore, it is a more efficient and effective means of producing energy. In addition, anaerobic metabolism results in the accumulation of the toxic end product lactic acid, which must be removed from the cell and transported to the liver for conversion into glucose and glycogen.

Pathophysiology

The pathophysiology of shock involves cellular changes, vascular responses, and changes in blood pressure.

Cellular Changes

In shock, the cells lack an adequate blood supply and are deprived of oxygen and nutrients; therefore, they must produce energy through anaerobic metabolism. This results in low-energy yields from nutrients and an acidotic intracellular environment. Because of these changes, normal cell function ceases (Fig. 11-1). The cell swells and the cell membrane becomes more permeable, allowing electrolytes and fluids to seep out of and into the cell. The sodium–potassium pump becomes impaired; cell structures, primarily the mitochondria, are damaged, and death of the cell results.

Glucose is the primary substrate required for the production of cellular energy in the form of ATP. In stress states, catecholamines, cortisol, glucagon, and inflammatory **cytokines** (i.e., biochemical or inflammatory mediators) are released, causing hyperglycemia and insulin resistance to mobilize glucose for cellular metabolism. Activation of these substances promotes gluconeogenesis, which is the formation of glucose from noncarbohydrate sources such as proteins and fats. Glycogen that has been stored in the liver is converted to

glucose through glycogenolysis to meet metabolic needs, increasing the blood glucose concentration (i.e., hyperglycemia).

Continued activation of the stress response by shock states causes a depletion of glycogen stores, resulting in increased proteolysis and eventual organ failure (Massaro, 2018). The deficit of nutrients and oxygen for normal cellular metabolism causes a buildup of metabolic end products in the cells and interstitial spaces. The clotting cascade, also associated with the inflammatory process, becomes activated, which compounds this pathologic cycle. With significant cell injury or death caused by shock, the clotting cascade is overproductive, resulting in small clots lodging in microcirculation, further hampering cellular perfusion (Seymour & Angus, 2018). This upregulation of the clotting cascade further compromises microcirculation of tissues, exacerbating cellular hypoperfusion (Seymour & Angus, 2018). Cellular metabolism is impaired, and a self-perpetuating negative situation (i.e., a positive feedback loop) is initiated.

Vascular Responses

Local regulatory mechanisms, referred to as autoregulation, stimulate vasodilation or vasoconstriction in response to biochemical mediators released by the cell, communicating the need for oxygen and nutrients (Kislitsina et al., 2019). A cytokine is a substance released by a cell or immune cells such as macrophages; the substance triggers an action at a cell site or travels in the bloodstream to a distant site, where it triggers action. Researchers are learning more every day about the physiologic actions of numerous proinflammatory and anti-inflammatory biochemical mediators that are responsible for the complex clinical presentation of shock states (Honore, Hoste, Molnár, et al., 2019).

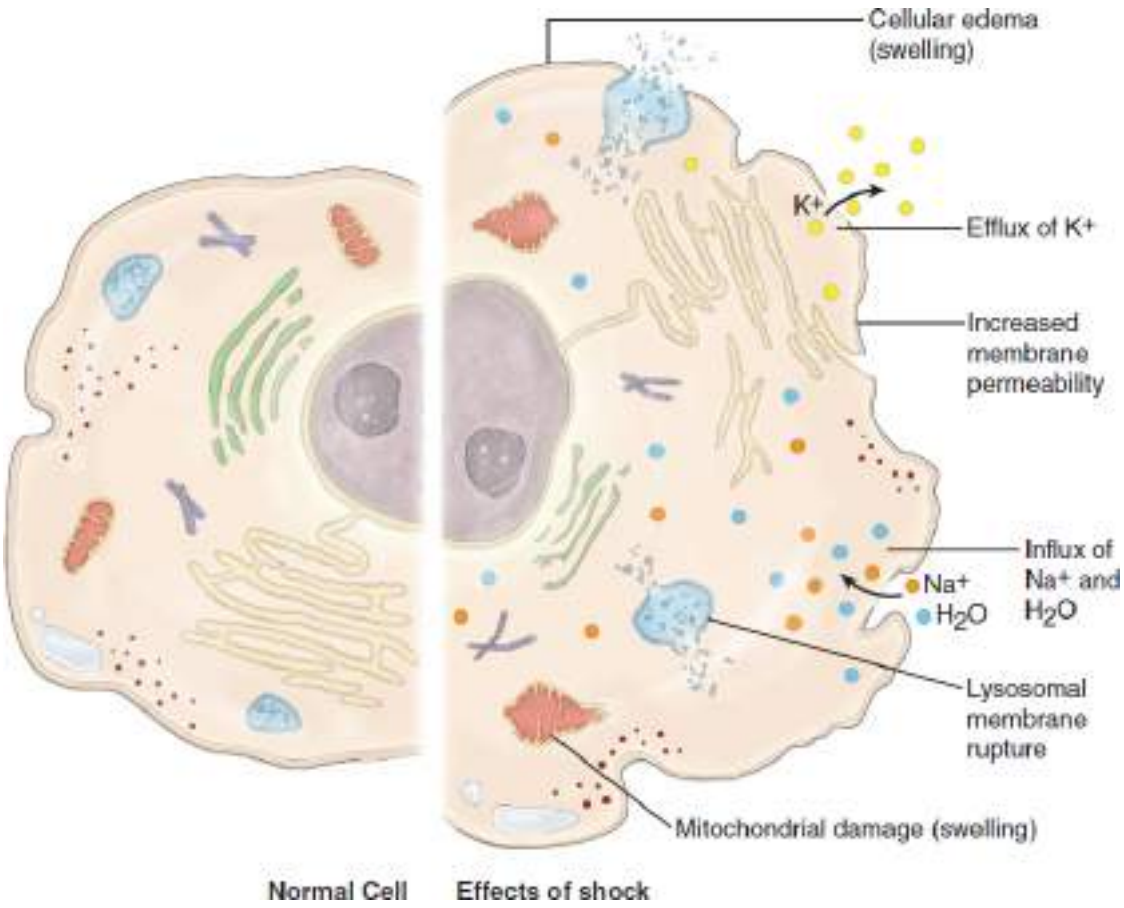

Figure 11-1 • Cellular effects of shock. The cell swells and the cell membrane becomes more permeable; fluids and electrolytes seep from and into the cell. Mitochondria and lysosomes are damaged and the cell dies.

Blood Pressure Regulation

Three major components of the circulatory system—blood volume, the cardiac pump, and the vasculature—must respond effectively to complex neural, chemical, and hormonal feedback systems to maintain an adequate blood pressure (BP) and perfuse body tissues. BP is regulated through a complex interaction of neural, chemical, and hormonal feedback systems affecting both cardiac output and peripheral resistance. This relationship is expressed in the following equation:

Mean arterial BP = Cardiac output × Peripheral resistance

Cardiac output is a product of the stroke volume (the amount of blood ejected from the left ventricle during systole) and heart rate. Peripheral resistance is primarily determined by the diameter of the arterioles.

Tissue perfusion and organ perfusion depend on mean arterial pressure (MAP), or the average pressure at which blood moves through the vasculature. MAP must exceed 65 mm Hg for cells to receive the oxygen and nutrients needed to metabolize energy in amounts sufficient to sustain life (Hallisey &

Greenwood, 2019). True MAP can be calculated only by complex methods; however, most digital BP machines provide a MAP reading to guide clinical decisions.

BP is regulated by baroreceptors (pressure receptors) located in the carotid sinus and aortic arch. These pressure receptors are responsible for monitoring the circulatory volume and regulating neural and endocrine activities (see Chapter 27 for further description). When BP drops, catecholamines (e.g., epinephrine, norepinephrine) are released from the adrenal medulla. These increase heart rate and cause vasoconstriction, restoring BP. Chemoreceptors, also located in the aortic arch and carotid arteries, regulate BP and respiratory rate using much the same mechanism in response to changes in oxygen and carbon dioxide (CO_2) concentrations in the blood. These primary regulatory mechanisms can respond to changes in BP on a moment-to-moment basis.

The kidneys regulate BP by releasing renin, an enzyme needed for the eventual conversion of angiotensin I to angiotensin II, a potent vasoconstrictor. This stimulation of the renin–angiotensin mechanism and the resulting vasoconstriction indirectly lead to the release of aldosterone from the adrenal cortex, which promotes the retention of sodium and water (i.e., hypernatremia). Hypernatremia then stimulates the release of antidiuretic hormone (ADH) by the pituitary gland. ADH causes the kidneys to retain water further in an effort to raise blood volume and BP. These secondary regulatory mechanisms may take hours or days to respond to changes in BP. The relationship between the initiation of shock and the responsiveness of primary and secondary regulatory mechanisms that compensate for deficits in blood volume, the pumping effectiveness of the heart, or vascular tone, which may result because of the shock state, is noted in Figure 11-2.

Stages of Shock

Shock progresses along a continuum and can be identified as early or late, depending on the signs and symptoms and the overall severity of organ dysfunction. A convenient way to understand the physiologic responses and subsequent clinical signs and symptoms of shock is to divide the continuum into separate stages: compensatory (stage 1), progressive (stage 2), and irreversible (stage 3). The earlier that interventions are initiated along this continuum, the greater the patient's chance of survival. Current research and evidence-based practice focuses on assessing patients at greatest risk for shock and implementing early and aggressive interventions to reverse tissue hypoxia (Zhang, Hong, Smischney, et al., 2017). Current evidence suggests that the window of opportunity that increases the likelihood of patient survival occurs when aggressive therapy begins within 3 hours of identifying a shock state,

especially septic shock (Rhodes, Evans, Alhazzani, et al., 2017; Singer, Deutschman, Seymour, et al., 2016).

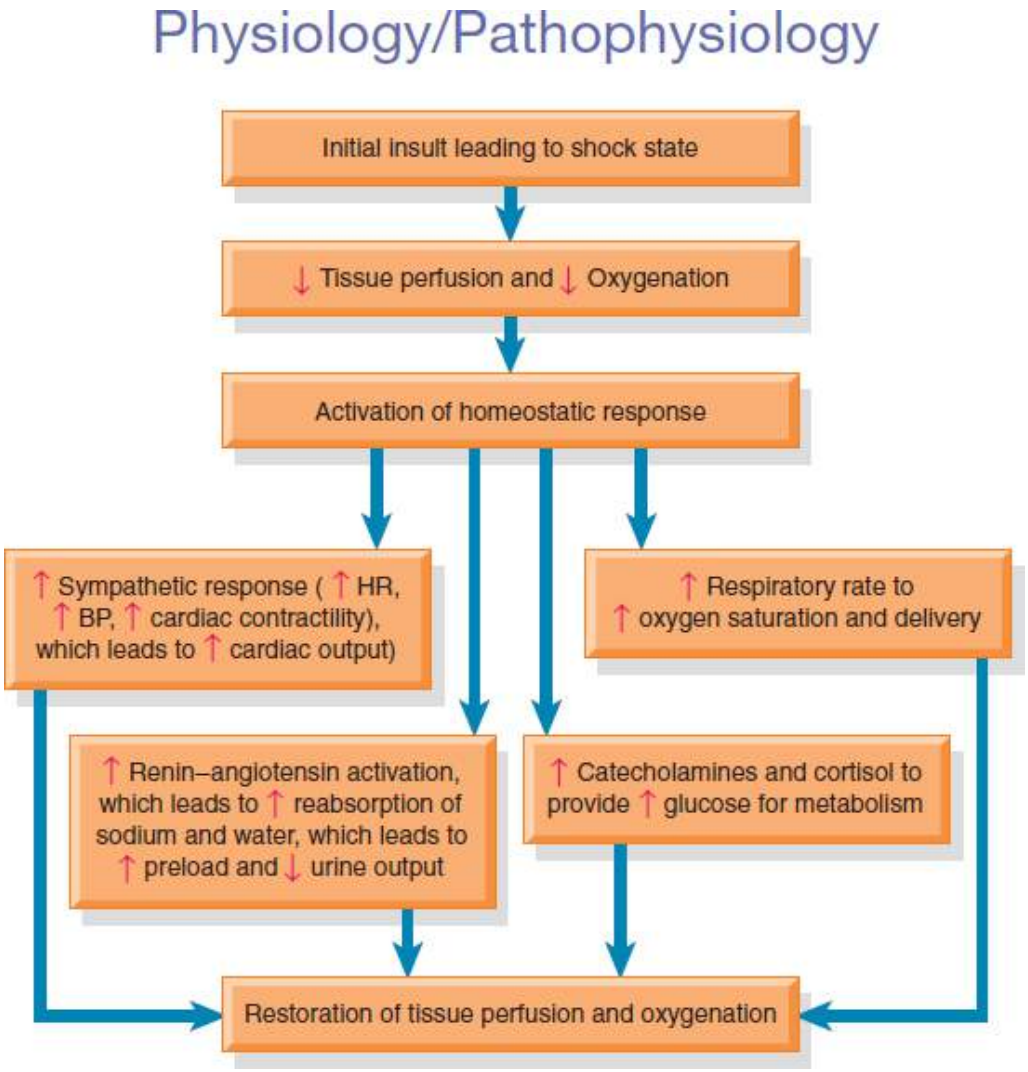

Figure 11-2 • Pathophysiologic sequence of regulatory mechanisms in shock.

Compensatory Stage

In the compensatory stage of shock, the BP remains within normal limits. Vasoconstriction, increased heart rate, and increased contractility of the heart contribute to maintaining adequate cardiac output. This results from stimulation of the sympathetic nervous system and subsequent release of catecholamines (e.g., epinephrine, norepinephrine). Patients display the often-described "fight-or-flight" response. The body shunts blood from organs such as the skin, kidneys, and gastrointestinal (GI) tract to the brain, heart, and lungs to ensure adequate blood supply to these vital organs. As a result, the skin may be cool and pale, bowel sounds are hypoactive, and urine output decreases in response to the release of aldosterone and ADH.

Clinical Manifestations

Despite a normal BP, the patient shows numerous clinical signs indicating inadequate organ perfusion (Table 11-1). The result of inadequate perfusion is anaerobic metabolism and a buildup of lactic acid, producing metabolic acidosis. The respiratory rate increases in response to the need to increase oxygen to the cells and in compensation for metabolic acidosis. This rapid respiratory rate facilitates removal of excess CO_2 but raises the blood pH and often causes a compensatory respiratory alkalosis. The patient may experience a change in effect, feel anxious, or be confused. If treatment begins in this stage of shock, the prognosis for the patient is better than in later stages.

TABLE 11-1 Clinical Findings in Stages of Shock

Finding	Stage: Compensatory	Progressive	Irreversible
Blood pressure	Normal	Systolic ≤100 mm Hg; MAP ≤65 mm Hg Requires fluids resuscitation to support blood pressure	Requires mechanical or pharmacologic support
Heart rate	>100 bpm	>150 bpm	Erratic
Respiratory status	≥22 breaths/min $PaCO_2$ <32 mm Hg	Rapid, shallow respirations; crackles PaO_2 <80 mm Hg $PaCO_2$ >45 mm Hg	Requires intubation and mechanical ventilation and oxygenation
Skin	Cold, clammy Capillary refill ≤3.5 s	Mottling, petechiae Capillary refill ≥3.5 s	Jaundice
Urinary output	Decreased	<0.5 mL/kg/h	Anuric; requires dialysis
Mentation	Confusion and/or agitation	Lethargy	Unconscious
Acid–base balance	Respiratory alkalosis	Metabolic acidosis	Profound acidosis

MAP, mean arterial pressure; $PaCO_2$, partial pressure of arterial carbon dioxide; PaO_2, partial pressure of arterial oxygen.

Adapted from Bridges, E. (2017). Assessing patients during septic shock resuscitation. *American Journal of Nursing*, *117*(10), 34–40; Makic, M. B. F., & Bridges, E. (2018). Managing sepsis and septic shock: Current guidelines and definitions. *American Journal of Nursing*, *118*(2), 34–39; Rhodes, A., Evans, L., Alhazzani, W., et al. (2017). Surviving Sepsis Campaign. (2017). Retrieved on 11/27/20 at: www.sccm.org/getattachment/SurvivingSepsisCampaign/Guidelines/Adult-Patients/SSC-Guidelines-FAQ.pdf?lang=en-US; Simmons, J., & Ventetuolo, C. E. (2017). Cardiopulmonary monitoring of shock. *Current Opinion*, *23*(3), 223–231.

Medical Management

Medical treatment is directed toward identifying the cause of the shock, correcting the underlying disorder so that shock does not progress, and supporting those physiologic processes that thus far have responded successfully to the threat. Because compensation cannot be maintained indefinitely, measures such as fluid replacement, supplemental oxygen, and

medication therapy must be initiated to maintain an adequate BP and reestablish and maintain adequate tissue perfusion (Makic & Bridges, 2018; Rhodes et al., 2017).

Nursing Management

Early intervention along the continuum of shock is the key to improving the patient's prognosis (Makic & Bridges, 2018; Rhodes et al., 2017). The nurse must systematically assess the patient at risk for shock, recognizing subtle clinical signs of the compensatory stage before the patient's BP drops. Early interventions include identifying the cause of shock, administering intravenous (IV) fluids and oxygen, and obtaining necessary laboratory tests to rule out and treat metabolic imbalances or infection. Special considerations related to recognizing early signs of shock in the older adult patient are discussed in Chart 11-1.

Monitoring Tissue Perfusion

In assessing tissue perfusion, the nurse observes for subtle changes in level of consciousness, vital signs (including pulse pressure), urinary output, skin (including assessment of capillary refill and signs of mottling), respiratory rate, and laboratory values (e.g., base deficit, lactic acid levels). In the compensatory stage of shock, serum sodium and blood glucose levels are elevated in response to the release of aldosterone and catecholamines. If infection is suspected, blood cultures should be obtained prior to administration of prescribed antibiotics; both of these interventions should be given priority in the care of the patient (Bridges, 2017; Levy, Evans, & Rhodes, 2018).

The nurse should monitor the patient's hemodynamic status and promptly report deviations to the primary provider, assist in identifying and treating the underlying disorder by continuous in-depth assessment of the patient, administer prescribed fluids and medications, and promote patient safety. Vital signs are key indicators of hemodynamic status, and BP is an indirect measure of tissue hypoxia. The nurse should report a systolic BP of 100 mm Hg or lower, or a drop in systolic BP of 40 mm Hg from baseline, or a MAP of 65 mm Hg or less (Hallisey & Greenwood, 2019; Rhodes et al., 2017). If the patient is concurrently diagnosed with an infection or if an infection is suspected, the nurse should promptly notify the primary provider if the patient exhibits any two of the three following signs (Singer et al., 2016) (see later discussion of Septic Shock):

- Respiratory rate greater than or equal to 22 breaths/min
- Altered mentation

- Systolic BP less than or equal to 100 mm Hg

Pulse pressure correlates well with stroke volume. Pulse pressure is calculated by subtracting the diastolic measurement from the systolic measurement; the difference is the pulse pressure. Normally, the pulse pressure is 30 to 40 mm Hg. Narrowing or decreased pulse pressure is an earlier indicator of shock than a drop in systolic BP (Simmons & Ventetuolo, 2017). Decreased or narrowing pulse pressure, an early indication of decreased stroke volume, is illustrated in the following example:

Chart 11-1

Recognizing Shock in Older Adults

The physiologic changes associated with aging, coupled with pathologic and chronic disease states, place older adults at increased risk for developing a state of shock and possibly multiple organ dysfunction syndrome. Older adults can recover from shock if it is detected and treated early with aggressive and supportive therapies. Nurses play an essential role in assessing and interpreting subtle changes in older adults' responses to illness.

- Medications such as beta-blocking agents (e.g., metoprolol) used to treat hypertension may mask tachycardia, a primary compensatory mechanism to increase cardiac output, during hypovolemic states.
- The aging immune system may not mount a truly febrile response (temperature greater than 38.3°C [101°F]); however, a lack of a febrile response (temperature less than 37°C [98.6°F]) or an increasing trend in body temperature should be addressed. The patient may also report increased fatigue and malaise in the absence of a febrile response.
- The heart does not function well in hypoxemic states, and the aging heart may respond to decreased myocardial oxygenation with arrhythmias that may be misinterpreted as a normal part of the aging process.
- There is a progressive decline in respiratory muscle strength, maximal ventilation, and response to hypoxia. Older adults have a decreased respiratory reserve and decompensate more quickly.
- Changes in mentation may be inappropriately misinterpreted as dementia. Older adults with a sudden change in mentation should be aggressively assessed for acute delirium (hypo- and hyperdelirium states) and treated for the presence of infection and organ hypoperfusion.

Adapted from Rhodes, A., Evans, L., Alhazzani, W., et al. (2017). Surviving Sepsis Campaign: International guidelines for management of sepsis and septic shock: 2016. *Critical Care Medicine, 45*(3), 486–552; Rowe, T. A., & McKoy, J. M. (2017). Sepsis in older adults. *Infectious Disease Clinics of North America, 31*(4), 731–742.

Systolic BP − Diastolic BP = Pulse pressure

Normal pulse pressure:

120 mm Hg − 80 mm Hg = 40 mm Hg

Narrowing of pulse pressure:

90 mm Hg − 70 mm Hg = 20 mm Hg

Elevation of the diastolic BP with release of catecholamines and attempts to increase venous return through vasoconstriction is an early compensatory mechanism in response to decreased stroke volume, BP, and overall cardiac output.

Quality and Safety Nursing Alert

By the time BP drops, damage has already been occurring at the cellular and tissue levels. Therefore, the patient at risk for shock must be assessed and monitored closely before the BP falls.

Continuous central venous oximetry ($Sc\bar{v}O_2$) monitoring may be used to evaluate mixed venous blood oxygen saturation and severity of tissue hypoperfusion states. A central catheter is introduced into the superior vena cava (SVC), and a sensor on the catheter measures the oxygen saturation of the blood in the SVC as blood returns to the heart and pulmonary system for reoxygenation. A normal $Sc\bar{v}O_2$ value is 70% (Zhang et al., 2017). Body tissues use approximately 25% of the oxygen delivered to them during normal metabolism. During stressful events, such as shock, more oxygen is consumed and the $Sc\bar{v}O_2$ saturation is lower, indicating that the tissues are consuming more oxygen.

Interventions focus on decreasing tissue oxygen requirements and increasing perfusion to deliver more oxygen to the tissues. For instance, sedating agents may be given to lower metabolic demands, or the patient's pain may be treated with opioid, nonopioid, or sedating agents (e.g., propofol, dexmedetomidine, acetaminophen) to decrease metabolic demands for oxygen. Supplemental oxygen and mechanical ventilation may be required to increase the delivery of oxygen in the blood. Administration of IV fluids and medications supports BP and cardiac output, and the transfusion of packed red blood cells enhances oxygen transport. Monitoring tissue oxygen consumption with $Sc\bar{v}O_2$ is an invasive measure to more accurately assess tissue oxygenation in the compensatory stage of shock before changes in vital signs detect altered tissue perfusion (Rhodes et al., 2017; Zhang et al., 2017).

In the patient who has an arterial line present, arterial pulse waveform analysis or pulse contour may be used to determine the patient's stroke volume and responsiveness to IV fluid replacement to meet tissue perfusion needs (Simmons & Ventetuolo, 2017). More commonly, passive leg raising (PLR) is used to determine which patients will or will not respond to IV fluid bolus challenges. PLR involves raising the patient's legs to a 30- to 45-degree angle to increase venous return and thus cardiac output (Fig. 11-3). If the blood pressure improves with PLR, the patient will respond to additional fluids. If the blood pressure does not improve, giving more IV fluids will not improve

the patient's condition and can precipitate fluid overload (Laher, Watermeyer, Buchanan, et al., 2017; Pickett, Bridges, Kritek, et al., 2018). If the patient is mechanically ventilated, functional hemodynamic monitoring will be used to assess fluid volume needs and the patient's response to IV fluid administration (i.e., preload, cardiac output, and blood pressure). An improvement in preload, cardiac output, and blood pressure indicates a favorable response. Functional hemodynamic monitoring has replaced static measures obtained from central venous pressure (CVP) or pulmonary artery (PA) monitoring. Functional hemodynamic monitoring assesses real-time dynamic changes between the patient's breathing patterns and circulating blood volume. Assessing functional hemodynamic parameters requires the patient to be mechanically ventilated and have an invasive arterial catheter placed and connected to monitoring devices that measure fluid volume (Bridges, 2013; Hallisey & Greenwood, 2019; Simmons & Ventetuolo, 2017).

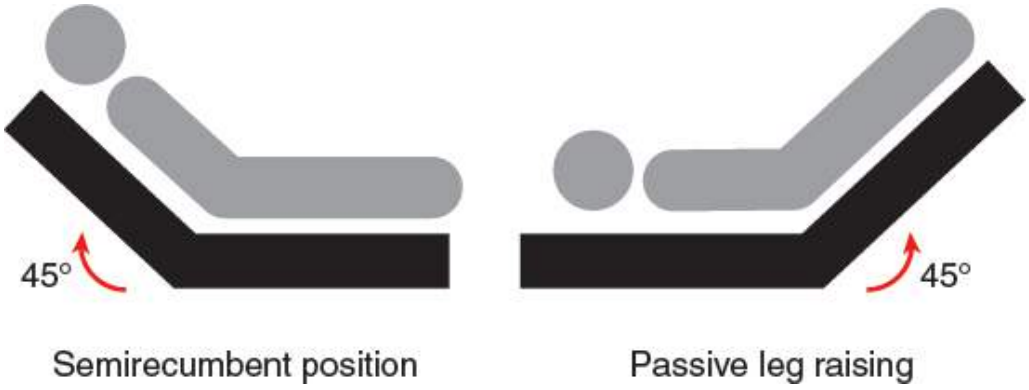

Figure 11-3 • Passive leg raise.

Although treatments are prescribed and initiated by the primary provider, the nurse usually implements them, operates and troubleshoots equipment used in treatment, monitors the patient's status during treatment, and evaluates the immediate effects of treatment. In addition, the nurse assesses the response of the family to the crisis and its treatment.

Reducing Anxiety

Patients and their families often become anxious and apprehensive when they face a major threat to health and well-being and are the focus of attention of many health care providers. Providing brief explanations about the diagnostic and treatment procedures, supporting the patient during these procedures, and providing information about their outcomes are usually effective in reducing stress and anxiety and thus promoting the patient's physical and mental well-being. Speaking in a calm, reassuring voice and using gentle touch also help ease the patient's concerns. These actions may provide comfort for patients who are critically ill and frightened (Reaza-Alarcón & Rodríguez-Martín,

2019). Evidence suggests that family members have certain needs during a health-related crisis, which include that health care professionals provide honest, consistent, and thorough communication; are present with the patient to facilitate physical and emotional support; demonstrate caring behaviors, see the patient frequently, and know the daily, short-term, and long-term plan of care for the patient (Reaza-Alarcón & Rodríguez-Martín, 2019; Wong, Redley, Digby, et al., 2019).

The nurse should advocate for family members to be present during procedures and routine patient care activities. The presence of family provides an important connection and support for the patient during a time of crisis. Clinical practice guidelines suggest that sharing decision making with the patient and the family enhances communication with the health care team, reduces patient anxiety, and improves overall satisfaction with care (Davidson, Aslakson, Long, et al., 2017).

Clarifying Advance Directives

Because shock can progress rapidly and its course may be unpredictable, it is important for the nurse to ask patients on admission if they have advance directives, including durable power of attorney for health care or living wills, or if they have had conversations with anyone about their health care wishes. When appropriate, the patient and family (with patient permission) should be approached regarding preferences for resuscitation and Physician Orders for Life-Sustaining Treatment (POLST) (see Chapter 13). The POLST helps ensure that the patient's wishes are honored if their condition deteriorates rapidly and they lose the ability to speak for themselves (Turner & Hylton, 2019).

Promoting Safety

The nurse must be vigilant for potential threats to the patient's safety, because a high anxiety level and changes in mental status may impair judgment. Patients who were previously cooperative and followed instructions may now disrupt IV lines and catheters, increasing the risk for potential complications. Close monitoring, frequent reorientation, hourly rounding, and implementing interventions to prevent falls (e.g., bed alarms) are essential.

Progressive Stage

In the second stage of shock, the mechanisms that regulate BP can no longer compensate, and the MAP falls below normal limits. Patients are clinically hypotensive; this is defined as a systolic BP of 100 mm Hg or lower, or a decrease in systolic BP of 40 mm Hg from baseline. The patient shows signs of declining mental status (Rhodes et al., 2017; Singer et al., 2016).

Pathophysiology

Although all organ systems suffer from hypoperfusion at this stage, several events perpetuate the shock syndrome. First, the overworked heart becomes dysfunctional, the body's inability to meet increased oxygen requirements produces ischemia, and biochemical mediators cause myocardial depression (Massaro, 2018). This leads to failure of the heart, even if the underlying cause of the shock is not of cardiac origin. Second, the autoregulatory function of the microcirculation fails in response to the numerous biochemical mediators released by the cells, resulting in increased capillary permeability, with areas of arteriolar and venous constriction further compromising cellular perfusion (Massaro, 2018). At this stage, the prognosis worsens. The relaxation of precapillary sphincters causes fluid to leak from the capillaries, creating interstitial edema and decreased return to the heart. In addition, the inflammatory response is activated, and proinflammatory and anti-inflammatory mediators are released, which activate the coagulation system in an effort to reestablish homeostasis (Seymour & Angus, 2018). The body mobilizes energy stores and increases oxygen consumption to meet the increased metabolic needs of the underperfused tissues and cells. Anaerobic metabolism ensues, resulting in a buildup of lactic acid and disruption of normal cell function.

Even if the underlying cause of the shock is reversed, the sequence of compensatory responses to the decrease in tissue perfusion perpetuates the shock state, and a vicious cycle ensues. The cellular reactions that occur during the progressive stage of shock are an active area of clinical research. It is believed that the body's response to shock or lack of response in this stage of shock may be the primary factor determining the patient's survival. Early recognition of shock signs and symptoms is essential to improving morbidity and mortality.

Clinical Manifestations

Chances of survival depend on the patient's general health before the shock state as well as the amount of time it takes to restore tissue perfusion. As shock progresses, organ systems decompensate (see Table 11-1).

Respiratory Effects

The lungs, which become compromised early in shock, are affected at this stage. Subsequent decompensation of the lungs increases the likelihood that mechanical ventilation will be needed. Respirations are rapid and shallow. Crackles are heard over the lung fields. Decreased pulmonary blood flow causes arterial oxygen levels to decrease and CO_2 levels to increase. Hypoxemia and biochemical mediators cause an intense inflammatory

response and pulmonary vasoconstriction, perpetuating pulmonary capillary hypoperfusion and hypoxemia. The hypoperfused alveoli stop producing surfactant and subsequently collapse. Pulmonary capillaries begin to leak, causing pulmonary edema, diffusion abnormalities (shunting), and additional alveolar collapse. This condition is called *acute lung injury* (ALI); as ALI continues, interstitial inflammation and fibrosis are common consequences, leading to acute respiratory distress syndrome (ARDS) (Mitchell & Seckel, 2018). Further explanation of ALI and ARDS, as well as their nursing management, can be found in Chapter 19.

Cardiovascular Effects

A lack of adequate blood supply leads to arrhythmias and ischemia. The heart rate is rapid, sometimes exceeding 150 bpm. The patient may complain of chest pain and even suffer a myocardial infarction (MI). Levels of cardiac biomarkers (e.g., cardiac troponin I [cTn-I]) increase. In addition, myocardial depression and ventricular dilation may further impair the heart's ability to pump enough blood to the tissues to meet increasing oxygen requirements.

Neurologic Effects

As blood flow to the brain becomes impaired, mental status deteriorates. Changes in mental status occur with decreased cerebral perfusion and hypoxia. Initially, the patient may exhibit subtle changes in behavior, become agitated, confused, or demonstrate signs of delirium. (See Chapter 61 for more information about delirium.) Subsequently, lethargy increases, and the patient begins to lose consciousness.

Renal Effects

When the MAP falls below 65 mm Hg (Hallisey & Greenwood, 2019), the glomerular filtration rate of the kidneys cannot be maintained, and significant changes in renal function occur. Acute kidney injury (AKI) is characterized by an increase in blood urea nitrogen (BUN) and serum creatinine levels, fluid and electrolyte shifts, acid–base imbalances, and a loss of the renal–hormonal regulation of BP. Urinary output usually decreases to less than 0.5 mL/kg/h (or less than 30 mL/h) but may vary depending on the phase of AKI. (See Chapter 48 for further information about AKI.)

Hepatic Effects

Decreased blood flow to the liver impairs the ability of liver cells to perform metabolic and phagocytic functions. Consequently, the patient is less able to metabolize medications and metabolic waste products, such as ammonia and lactic acid. Metabolic activities of the liver, including gluconeogenesis and glycogenolysis, are impaired. The patient becomes more susceptible to

infection as the liver fails to filter bacteria from the blood. Liver enzymes (aspartate aminotransferase, alanine aminotransferase, lactate dehydrogenase) and bilirubin levels are elevated, and the patient develops jaundice.

Gastrointestinal Effects

GI ischemia can cause stress ulcers in the stomach, putting the patient at risk for GI bleeding. In the small intestine, the mucosa can become necrotic and slough off, causing bloody diarrhea. Beyond the local effects of impaired perfusion, GI ischemia leads to bacterial translocation and organ dysfunction, in which bacterial toxins enter the bloodstream through the lymphatic system. In addition to causing infection, bacterial toxins can cause cardiac depression, vasodilation, increased capillary permeability, and an intense inflammatory response with activation of additional biochemical mediators. The net result is interference with healthy cellular functioning and the ability to metabolize nutrients (Rhodes et al., 2017).

Hematologic Effects

The combination of hypotension, sluggish blood flow, metabolic acidosis, coagulation system imbalance, and generalized hypoxemia can interfere with normal hemostatic mechanisms. In shock states, the inflammatory cytokines activate the clotting cascade, causing deposition of microthrombi in multiple areas of the body and consumption of clotting factors. The alterations of the hematologic system, including imbalance of the clotting cascade, are linked to the overactivation of the inflammatory response (Massaro, 2018; Seymour & Angus, 2018). Disseminated intravascular coagulation (DIC) may occur either as a cause or as a complication of shock. In this condition, widespread clotting and bleeding occur simultaneously. Ecchymoses (bruises) and petechiae (bleeding) may appear in the skin. Coagulation times (e.g., prothrombin time, activated partial thromboplastin time) are prolonged. Clotting factors and platelets are consumed and require replacement therapy to achieve hemostasis. (Further discussion of DIC appears in Chapter 29.)

Medical Management

Specific medical management in the progressive stage of shock depends on the type of shock, its underlying cause, and the degree of decompensation in the organ systems. Medical management specific to each type of shock is discussed later in this chapter. Although medical management in the progressive stage differs by type of shock, some medical interventions are common to all types. These include the use of appropriate IV fluids and medications to restore tissue perfusion by the following methods:

- Supporting the respiratory system
- Optimizing intravascular volume
- Supporting the pumping action of the heart
- Improving the competence of the vascular system

Other aspects of management may include early enteral nutritional support, targeted hyperglycemic control with IV insulin and use of antacids, histamine-2 (H_2) blockers, or antipeptic medications to reduce the risk of GI ulceration and bleeding.

Tight glycemic control (i.e., maintaining serum glucose close to the normal parameters of 80 to 100 mg/dL) is not recommended in patients who are critically ill because this therapy has been found to result in adverse patient outcomes (Griesdale, DeSouza, VanDam, et al., 2009). Current evidence suggests that maintaining serum glucose less than 180 mg/dL with insulin therapy and close monitoring is indicated in the management of the patient who is critically ill (American Diabetes Association, 2019; Rhodes et al., 2017).

Quality and Safety Nursing Alert

Glycemic control is linked to outcomes in the patient in shock. Although tight glycemic control is not indicated, evidence shows that maintaining serum glucose less than 180 mg/dL is linked to best outcomes.

Nursing Management

Nursing care of patients in the progressive stage of shock requires expertise in assessing and understanding shock and the significance of changes in assessment data. Early interventions are essential to the survival of patients; therefore, suspecting that a patient may be in shock and reporting subtle changes in assessment are imperative. Patients in the progressive stage of shock are cared for in the intensive care setting to facilitate close monitoring (hemodynamic monitoring, electrocardiographic [ECG] monitoring, arterial blood gases, serum electrolyte levels, physical and mental status changes); rapid and frequent administration of various prescribed medications and fluids; and possibly interventions with supportive technologies, such as mechanical ventilation, dialysis (e.g., continuous renal replacement therapy), and intra-aortic balloon pump (IABP).

Working closely with other members of the health care team, the nurse carefully documents treatments, medications, and fluids that are given; the

time, dosage or volume, and patient responses are recorded. In addition, the nurse coordinates care, including the scheduling of diagnostic procedures that may occur at the bedside, and communication among health care personnel, family members, and the patient.

Preventing Complications

The nurse monitors the patient for early signs of complications to help reduce potential risks to the patient. Monitoring includes evaluating blood levels of medications, observing invasive vascular lines and catheters for signs of infection, and checking neurovascular status if arterial lines are inserted, especially in the lower extremities. Simultaneously, the nurse promotes the patient's safety and comfort by ensuring that all procedures, including invasive procedures and arterial and venous punctures, are carried out using correct aseptic techniques and that venous and arterial puncture and infusion sites are maintained with the goal of preventing infection. Nursing interventions that reduce the incidence of ventilator-associated pneumonia (VAP) must also be implemented. These include frequent oral care with a toothbrush, aseptic suction technique, turning, elevating the head of the bed at least 30 degrees to prevent aspiration, and implementing daily interruption of sedation as prescribed to evaluate patient readiness for extubation (Mitchell, Russo, Cheng, et al., 2019). See Chart 19-6 for an overview of the evidence-based ("bundled") interventions aimed at preventing VAP. Positioning and repositioning of the patient to promote comfort and maintain skin integrity are essential.

The nurse must also be vigilant in assessing for acute delirium, characterized by an acute change in mental status, inattention, disorganized thinking, and altered level of consciousness. Delirium is potentially preventable (Devlin, Skrobik, Gelians, et al., 2018; Makic, 2018). Patients who are critically ill and have delirium have longer mechanical ventilation support needs, experience higher functional decline, and have higher rates of morbidity and mortality than those without delirium. Furthermore, they are at a higher risk of developing postintensive care syndrome (PICS), which manifests as new or worsening impairments in the patient's physical, cognitive, or mental status after a critical illness has resolved and that persists beyond the acute hospitalization (Devlin et al., 2018). Delirium should be assessed at a minimum each shift using a standardized delirium assessment tool, such as the Confusion Assessment Method (CAM)-ICU (Critical Illness, Brain Dysfunction, and Survivorship (CIBS) Center, 2020). The CAM-ICU is a modified version of the CAM, specifically designed for use in patients who are critically ill (see Chapter 8, Chart 8-7 for discussion of the CAM). Nursing interventions that can prevent delirium include engaging the patient in frequent reorientation activities (e.g., to date, time, place), assessing and treating pain, promoting sleep, providing early mobilization activities, and limiting sedation,

especially sedation with benzodiazepines (e.g., lorazepam) (Devlin et al., 2018; Makic, 2018).

Promoting Rest and Comfort

Efforts are made to minimize the cardiac workload by reducing the patient's physical activity and treating pain and anxiety. Because promoting patient rest and comfort is a priority, the nurse performs essential nursing activities in blocks of time, allowing the patient to have periods of uninterrupted sleep, which may prevent acute delirium, as noted previously (Devlin et al., 2018). To conserve the patient's energy, the nurse should protect the patient from temperature extremes (e.g., excessive warmth or cold, shivering), which can increase the metabolic rate and oxygen consumption and thus the cardiac workload.

Supporting Family Members

Because patients in shock receive intense attention by the health care team, families may be overwhelmed and frightened. Family members may be reluctant to ask questions or seek information for fear that they will be in the way or will interfere with the attention given to the patient. The nurse should make sure that the family is comfortably situated and kept informed about the patient's status. Often, families need encouragement from the health care team to get some rest; family members are more likely to take this advice if they feel that the patient is being well cared for and that they will be notified of any significant changes in the patient's status. A visit from the hospital chaplain may be comforting and provides some attention to the family while the nurse concentrates on the patient. Ensuring patient- and family-centered care is central to the delivery of high-quality care. This helps meet the emotional well-being as well as the physiologic needs of the patient and the family (Wong et al., 2019).

Irreversible Stage

The irreversible (or refractory) stage of shock represents the point along the shock continuum at which organ damage is so severe that the patient does not respond to treatment and cannot survive. Despite treatment, BP remains low. Renal and liver dysfunction, compounded by the release of biochemical mediators, creates an acute metabolic acidosis. Anaerobic metabolism contributes to a worsening lactic acidosis. Reserves of ATP are almost totally depleted, and mechanisms for storing new supplies of energy have been destroyed. Respiratory system dysfunction prevents adequate oxygenation and ventilation despite mechanical ventilatory support, and the cardiovascular system is ineffective in maintaining an adequate MAP for tissue perfusion.

Multiple organ dysfunction progressing to complete organ failure has occurred, and death is imminent. Multiple organ dysfunction can occur as a progression along the shock continuum or as a syndrome unto itself and is described in more detail later in this chapter.

Medical Management

Medical management during the irreversible stage of shock is similar to interventions and treatments used in the progressive stage. Although the patient may have progressed to the irreversible stage, the judgment that the shock is irreversible can only be made after the patient has failed to respond to treatment. Strategies that may be experimental (e.g., investigational medications, such as immunomodulation therapy) may be tried to reduce or reverse the severity of shock.

Nursing Management

As in the progressive stage of shock, the nurse focuses on carrying out prescribed treatments, monitoring the patient, preventing complications, protecting the patient from injury, and providing comfort. Offering brief explanations to the patient about what is happening is essential even if there is no certainty that the patient hears or understands what is being said. Simple comfort measures, including reassuring touches, should continue to be provided despite the patient's nonresponsiveness to verbal stimuli (Wong et al., 2019).

As it becomes obvious that the patient is unlikely to survive, the family needs to be informed about the prognosis and likely outcome. Opportunities should be provided throughout the patient's care for the family to see, touch, and talk to the patient. Close friends or spiritual or religious advisors may be of comfort to the family members in dealing with the inevitable death of their loved one.

During this stage of shock, the family may misinterpret the actions of the health care team. They have been told that nothing has been effective in reversing the shock and that the patient's survival is very unlikely, yet they find primary providers and nurses continuing to work feverishly on the patient. Distraught, grieving families may interpret this as a chance for recovery when none exists, and family members may become angry when the patient dies. Conferences with all members of the health care team and the family promote better understanding by the family of the patient's prognosis and the purpose for management interventions. Engaging palliative care specialists can be beneficial in developing a plan of care that maximizes comfort and effective

symptom management as well as assisting the family with difficult decisions (Ivany & Aitken, 2019). During these conferences, it is essential to explain that the equipment and treatments being provided are intended for patient comfort and do not suggest that the patient will recover. Family members should be encouraged to express their views of life-support measures. In some cases, ethics committees may be consulted to assist families and health care teams make complex end-of-life decisions (Ivany & Aitken, 2019; Turner & Hylton, 2019).

General Management Strategies in Shock

As described previously and in the discussion of types of shock to follow, management in all types and all phases of shock includes the following:

- Support of the respiratory system with supplemental oxygen and/or mechanical ventilation to provide optimal oxygenation (see Chapter 19)
- Fluid replacement to restore intravascular volume
- Vasoactive medications to restore vasomotor tone and improve cardiac function
- Nutritional support to address the metabolic requirements that are often dramatically increased in shock

Therapies described in this section require collaboration among all members of the health care team.

Fluid Replacement

Fluid replacement, also referred to as fluid resuscitation, is given in all types of shock. The type of fluids administered, and the speed of delivery vary; however, fluids are given to improve cardiac and tissue oxygenation, which in part depends on flow. The fluids given may include **crystalloids** (electrolyte solutions that move freely between intravascular compartment and interstitial spaces), **colloids** (large-molecule IV solutions), and blood components (packed red blood cells, fresh-frozen plasma, and platelets).

Crystalloid and Colloid Solutions

In emergencies, the "best" fluid is often the fluid that is readily available. Fluid resuscitation should be initiated early in shock to maximize intravascular volume. Isotonic crystalloid solutions are often selected because they contain the same concentration of electrolytes as the extracellular fluid and, therefore, can be given without altering the concentrations of electrolytes in the plasma. IV crystalloids commonly used for resuscitation in hypovolemic shock include

0.9% sodium chloride solution (normal saline) and lactated Ringer's solution. Lactated Ringer's is an electrolyte solution containing the lactate ion, which should not be confused with lactic acid. The lactate ion is converted to bicarbonate, which helps buffer the overall acidosis that occurs in shock. Lactated Ringer's solution more closely resembles plasma and is considered a more appropriate first choice solution over 0.9% normal saline (de-Madaria, Herrera-Marante, Gonzalez-Camacho, et al., 2018). While normal saline is an isotonic solution, large infusions may cause hypernatremia, hypokalemia, and hyperchloremic metabolic acidosis (de-Madaria et al., 2018; Sethi, Owyang, Meyers, et al., 2018). Hypertonic crystalloid solution, often 3% sodium chloride, does not improve patient outcomes and may result in unintended complications and is not recommended as a fluid for resuscitation (Bauer, MacLaren, & Erstad, 2019). A disadvantage of using isotonic crystalloid solutions is that some of the volume given is lost to the interstitial compartment and some remains in the intravascular compartment. This occurs as a consequence of cellular permeability that occurs during shock. Diffusion of crystalloids into the interstitial space means that more fluid may need to be given than the amount lost to support tissue perfusion (Lewis, Pritchard, Evans, et al., 2018).

Care must be taken when rapidly administering isotonic crystalloids to avoid both underresuscitating and overresuscitating the patient in shock. Insufficient fluid replacement is associated with a higher incidence of morbidity and mortality from lack of tissue perfusion, whereas excessive fluid administration can cause systemic and pulmonary edema that progresses to ALI (see Chapter 19), intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS), and MODS (see later discussion).

ACS is a serious complication that may occur when large volumes of fluid are given. It may also occur after trauma, abdominal surgery, pancreatitis, or sepsis (Harrell & Miller, 2017). In ACS, fluid leaks into the intra-abdominal cavity, increasing pressure that is displaced onto surrounding vessels and organs. Venous return, preload, and cardiac output are compromised. The pressure also elevates the diaphragm, making it difficult to breathe effectively. The renal and GI systems also begin to show signs of dysfunction (e.g., decreased urine output, absent bowel sounds, intolerance of tube feeding). Abdominal compartment pressure can be measured. Normally, it is 0 to 5 mm Hg, and a pressure of 12 mm Hg is considered to be indicative of IAH (Harrell & Miller, 2017). If ACS is present, interventions that usually include surgical decompression are necessary to relieve the pressure.

Generally, IV colloidal solutions are similar to plasma proteins, in that they contain molecules that are too large to pass through capillary membranes. Colloids expand intravascular volume by exerting oncotic pressure, thereby pulling fluid into the intravascular space, increasing intravascular volume. In addition, colloids have a longer duration of action than crystalloids, because

the molecules remain within the intravascular compartment longer. Typically, if colloids are used to treat tissue hypoperfusion, albumin is the agent prescribed. Albumin is a plasma protein; an albumin solution is prepared from human plasma and is heated during production to reduce its potential to transmit disease. The disadvantage of albumin is its high cost compared to crystalloid solutions. Resuscitation with colloid solutions has not reduced the risk of morbidity or death compared to resuscitation with crystalloid solutions; moreover, colloids can be considerably more expensive than crystalloid solutions (Annane, Siami, Jaber, et al., 2013; Lewis et al., 2018).

Quality and Safety Nursing Alert

With all colloidal solutions, side effects include the rare occurrence of anaphylactic reactions. Nurses must monitor patients closely.

Complications of Fluid Administration

Close monitoring of the patient during fluid replacement is necessary to identify side effects and complications. The most common and serious side effects of fluid replacement are cardiovascular overload, pulmonary edema, and ACS. The patient receiving fluid replacement must be monitored frequently for adequate urinary output, changes in mental status, skin perfusion, and changes in vital signs. Lung sounds are auscultated frequently to detect signs of fluid accumulation. Adventitious lung sounds, such as crackles, may indicate pulmonary edema and ALI and ARDS.

Quality and Safety Nursing Alert

When administering large volumes of crystalloid solutions, the nurse must monitor the lungs for adventitious sounds, signs and symptoms of interstitial edema, work of breathing (i.e., increasing effort required for the patient to breathe, depth of breathing, respiratory rate), and changes in oxygen saturation.

Often, a CVP line is inserted (typically into the subclavian or jugular vein) and is advanced until the tip of the catheter rests near the junction of the SVC and the right atrium. CVP measurements have traditionally been used to assess preload in the right side of the heart and fluid responsiveness during shock states. However, research confirms there is no direct relationship between CVP, circulating blood volume, and fluid responsiveness; thus, CVP is no longer used as a reliable measure to guide fluid replacement therapy (Laher et al., 2017; Marik, Baram, & Vahid, 2008; Marik & Cavallazzi, 2013;

Simmons & Ventetuolo, 2017). CVP devices provide access for large volumes of fluid replacement, and administration of blood products and vasoactive agents. If CVP measurements are still used to evaluate fluid needs of the patient, assessment variables such as BP, urine output, heart rate, and PLR should be considered when interpreting the CVP for clinical decisions (Laher et al., 2017; Simmons & Ventetuolo, 2017). Some CVP catheters allow the monitoring of intravascular measures and venous oxygen levels. Assessment of venous oxygenation (venous oxygen saturation $S\bar{v}O_2$, or $Sc\bar{v}O_2$ with a CVP line) may be helpful in evaluating the adequacy of intravascular volume (Rhodes et al., 2017; Rivers, McIntyre, Morro, et al., 2005). Hemodynamic monitoring with arterial lines may be implemented to allow close monitoring of the patient's BP and tissue perfusion. A pulmonary artery catheter may be inserted to assist with closer monitoring of a patient's cardiac status as well as response to therapy. Advances in noninvasive or minimally invasive technology (e.g., esophageal Doppler, arterial pulse contour analysis, cardiac output devices, intrathoracic impedance monitoring) provide additional hemodynamic monitoring options (Hallisey & Greenwood, 2019; Laher et al., 2017; Zhang et al., 2017). (For additional information about hemodynamic monitoring, see Chapter 21.)

Placement of central lines for fluid administration and monitoring requires collaborative practice between the provider and the nurse to ensure that all measures to prevent central line–associated bloodstream infection (CLABSI) are implemented. Several interventions aimed at preventing CLABSI should be implemented collaboratively while the central line is being placed as well as during ongoing nursing management of the central line itself. Chart 11-2 describes the evidence-based ("bundled") interventions that have been found to reduce CLABSI.

Vasoactive Medication Therapy

Vasoactive medications are given in all forms of shock to improve the patient's hemodynamic stability when fluid therapy alone cannot maintain adequate MAP. Specific medications are selected to correct the particular hemodynamic alteration that is impeding cardiac output. These medications help increase the strength of myocardial contractility, regulate the heart rate, reduce myocardial resistance, and initiate vasoconstriction.

Vasoactive medications are selected for their action on receptors of the sympathetic nervous system. These receptors are known as alpha-adrenergic and beta-adrenergic receptors. Beta-adrenergic receptors are further classified as beta-1 and beta-2 adrenergic receptors. When alpha-adrenergic receptors are stimulated, blood vessels constrict in the cardiorespiratory and GI systems, skin, and kidneys. When beta-1 adrenergic receptors are stimulated, heart rate and myocardial contraction increase. When beta-2 adrenergic receptors are

stimulated, vasodilation occurs in the heart and skeletal muscles, and the bronchioles relax. The medications used in treating shock consist of various combinations of vasoactive medications to maximize tissue perfusion by stimulating or blocking the alpha- and beta-adrenergic receptors.

When vasoactive medications are given, vital signs must be monitored frequently (at least every 15 minutes until stable, or more often if indicated). Vasoactive medications should be given through a central venous line, because infiltration and extravasation of some vasoactive medications can cause tissue necrosis and sloughing (Maclaren, Mueller, & Dasta, 2019). Individual medication dosages are usually titrated by the nurse, who adjusts drip rates on the basis of the prescribed dose and target outcome parameter (e.g., BP, heart rate) and the patient's response. Dosages are changed to maintain the MAP at a physiologic level that ensures adequate tissue perfusion (usually greater than 65 mm Hg).

Quality and Safety Nursing Alert

Vasoactive medications should never be stopped abruptly, because this could cause severe hemodynamic instability, perpetuating the shock state.

Dosages of vasoactive medications must be tapered. When vasoactive medications are no longer needed or are necessary to a lesser extent, the infusion should be weaned with frequent monitoring of BP (e.g., every 15 minutes). Table 11-2 presents some of the commonly prescribed vasoactive medications used in the treatment of shock.

Nutritional Support

Nutritional support is an important aspect of care for critically ill patients. Increased metabolic rates during shock increase energy requirements and therefore caloric requirements. Patients in shock may require more than 3000 calories daily. The release of catecholamines early in the shock continuum causes rapid depletion of glycogen stores. Nutritional energy requirements are then met by breaking down lean body mass. In this catabolic process, skeletal muscle mass is broken down even when the patient has large stores of fat or adipose tissue. Loss of skeletal muscle greatly prolongs the patient's recovery time.

Parenteral or enteral nutritional support should be initiated as soon as possible. Enteral nutrition is preferred, promoting GI function through direct exposure to nutrients and limiting infectious complications associated with parenteral feeding (Reintam, Blaser, Starkopf, et al., 2017). Implementation of

an evidence-based enteral feeding protocol that is tolerant of increased gastric residual volumes ensures the delivery of adequate nutrition to patients who are critically ill (Wang, Ding, Fang, et al., 2019). Gastric residual volume does not predict a patient's risk of aspiration (Wang et al., 2019). Implementing early enteral nutrition has been found to promote gut-mediated immunity, reduce metabolic response to stress, and improve overall patient morbidity and mortality (Reintam et al., 2017). (See Chapter 39 for further discussion of monitoring gastric residual volumes.)

Chart 11-2

Collaborative Practice Interventions to Prevent Central Line–Associated Bloodstream Infections (CLABSIs)

Current best practices can include the implementation of specific evidence-based bundle interventions that when used together (i.e., as a "bundle") improve patient outcomes. This chart outlines specific parameters for the central line bundled collaborative interventions that have been found to reduce central line–associated bloodstream infections (CLABSI).

What are the five key elements of the central line bundle?

- Hand hygiene
- Maximal sterile barrier precautions during line insertion (see later discussion)
- Chlorhexidine skin antisepsis
- Optimal catheter site selection with avoidance of using the femoral vein for central venous access in adult patients
- Daily review of line necessity, with prompt removal of unnecessary lines

When should hand hygiene be performed in the care of a patient with a central line?

- All clinicians who provide care to the patient should adhere to good hand hygiene practices, particularly:
  - Before and after palpating the catheter insertion site
  - With all dressing changes to the intravascular catheter access site
  - When hands are visibly soiled or contamination of hands is suspected
  - Before donning and after removing gloves

What changes can be made to improve hand hygiene?

- Implement a central line procedure checklist that requires that clinicians perform hand hygiene as an essential step in care.
- Post signage stating the importance of hand hygiene.
- Have soap and alcohol-based hand sanitizers prominently placed to facilitate hand hygiene practices.
- Model hand hygiene practices.
- Provide patient and family education and engage family in hand hygiene practices during visitation.

What are maximal sterile barrier precautions?

- These are implemented during central line insertion:
  - For the primary provider, this means strict adherence with wearing a cap, mask, sterile gown, and sterile gloves. The cap should cover all hair, and the mask should cover the nose and the mouth tightly. The nurse should also wear a cap and a mask.
  - For the patient, this means covering the patient from head to toe with a sterile drape, with a small opening for the site of insertion. If

a full-size drape is not available, two drapes may be applied to cover the patient, or the operating room may be consulted to determine how to procure full-size sterile drapes, because these are routinely used in surgical settings.

- Nurses should be empowered to enforce use of a central line checklist to be sure that all processes related to central line placement are properly executed for every line placed.

Which antiseptic should be used to prepare the patient's skin for central line insertion?

- Chlorhexidine skin antisepsis has been proven to provide better skin antisepsis than other antiseptic agents, such as povidone–iodine solution.
- An alcohol chlorhexidine antiseptic should be applied using a back-and-forth friction scrub for at least 30 s; this should not be wiped or blotted dry.
- The antiseptic solution should be allowed time to dry completely before the insertion site is punctured/accessed (approximately 2 min).

What nursing interventions are essential to reduce the risk of infection?

- Maintaining sterile technique when changing the central line dressing
- Always performing hand hygiene before manipulating or accessing the line ports
- Wearing clean gloves before accessing the line port
- Performing a 15- to 30-s "hub scrub" using chlorhexidine or alcohol and friction in a twisting motion on the access hub (reduces biofilm on the hub that may contain pathogens)
- Using chlorhexidine-containing dressings in patients older than 2 mo
- Consider using antiseptic-containing port protectors to cover connectors

When should central lines be discontinued?

- Assessment for removal of central lines should be included as part of the nurse's daily goal sheets.
- The time and date of central line placement should be recorded and evaluated by staff to aid in decision making.
- The need for the central line access should be reviewed as part of multidisciplinary rounds.
- During these rounds, the "line day" should be stated to remind everyone how long the central line has been in place (e.g., "Today is line day 6").
- An appropriate time frame for regular review of the necessity for a central line should be identified, such as weekly, when central lines are placed for long-term use (e.g., chemotherapy, extended antibiotic administration).

Quality improvement processes that trend CLABSI rates and the adherence with CLABSI bundle prevention strategies have been found to effectively engage the multidisciplinary team in achieving goals to reduce infections related to central lines.

Adapted from Institute for Healthcare Improvement (IHI). (2012). How-to guide: Prevent central line-associated bloodstream infection. Retrieved on 9/10/2019 at: www.ihi.org/resources/Pages/Tools/HowtoGuidePreventCentralLineAssociatedBloodstreamInfection.aspx; Marschall, J., Mermel, L. A., Fakih, M., et al. (2014). Strategies to prevent central-line associated bloodstream infections in acute care hospitals: 2014 update. *Infection Control and Hospital Epidemiology, 35*(7), 753–771.

Stress ulcers occur frequently in acutely ill patients because of the compromised blood supply to the GI tract. Therefore, antacids, H_2 blockers (e.g., famotidine), and proton pump inhibitors (e.g., lansoprazole, esomeprazole magnesium) are prescribed to prevent ulcer formation by inhibiting gastric acid secretion or increasing gastric pH.

TABLE 11-2 Select Vasoactive Agents Used in Treating Shock

Medication	Desired Action in Shock	Disadvantages
Inotropic Agents		
Dobutamine Dopamine Epinephrine Milrinone	Improve contractility, increase stroke volume, increase cardiac output	Increase oxygen demand of the heart
Vasodilators		
Nitroglycerin Nitroprusside	Reduce preload and afterload, reduce oxygen demand of heart	Cause hypotension
Vasopressor Agents		
Norepinephrine Dopamine Phenylephrine Vasopressin Epinephrine Angiotensin II	Increase blood pressure by vasoconstriction	Increase afterload, thereby increasing cardiac workload; compromise perfusion to skin, kidneys, lungs, gastrointestinal tract

Adapted from Annane, D., Ouanes-Besbes, L., DeBacker, D., et al. (2018). A global perspective on vasoactive agents in shock. *Intensive Care Medicine*, *44*(6), 833–346; Maclaren, R., Mueller, S. W., & Dasta, J. F. (2019). Use of vasopressors and inotropes in the pharmacotherapy of shock. In J. T. DiPiro, R. L. Talbert, G. C. Yee, et al. (Eds.). *Pharmacotherapy: A pathophysiologic approach* (11th ed.). New York: McGraw-Hill Medical.

Hypovolemic Shock

Hypovolemic shock, the most common type of shock, is characterized by decreased intravascular volume. Body fluid is contained in the intracellular and extracellular compartments. Intracellular fluid accounts for about two thirds of the total body water. The extracellular body fluid is found in one of two compartments: intravascular (inside blood vessels) or interstitial (surrounding tissues). The volume of interstitial fluid is about three to four times that of intravascular fluid. Hypovolemic shock occurs when there is a reduction in intravascular volume by 15% to 30%, which represents an approximate loss of 750 to 1500 mL of blood in a 70-kg (154-lb) person (American College of Surgeons, 2018).

Pathophysiology

Hypovolemic shock can be caused by external fluid losses, as in traumatic blood loss, or by internal fluid shifts, as in severe dehydration, severe edema, or ascites (Chart 11-3). Intravascular volume can be reduced by both fluid loss and fluid shifting between the intravascular and interstitial compartments.

Chart 11-3 RISK FACTORS

Hypovolemic Shock

External: Fluid Losses	Internal: Fluid Shifts
Trauma	Hemorrhage
Surgery	Burns
Vomiting	Ascites
Diarrhea	Peritonitis
Diuresis	Dehydration
Diabetic ketoacidosis	Necrotizing pancreatitis
Diabetes insipidus	

The sequence of events in hypovolemic shock begins with a decrease in the intravascular volume. This results in decreased venous return of blood to the heart and subsequent decreased ventricular filling. Decreased ventricular filling results in decreased stroke volume (amount of blood ejected from the heart) and decreased cardiac output. When cardiac output drops, BP drops and tissues cannot be adequately perfused (Fig. 11-4).

Medical Management

Major goals in the treatment of hypovolemic shock are to restore intravascular volume to reverse the sequence of events leading to inadequate tissue perfusion, to redistribute fluid volume, and to correct the underlying cause of the fluid loss as quickly as possible. Depending on the severity of shock and the patient's condition, often all three goals are addressed simultaneously.

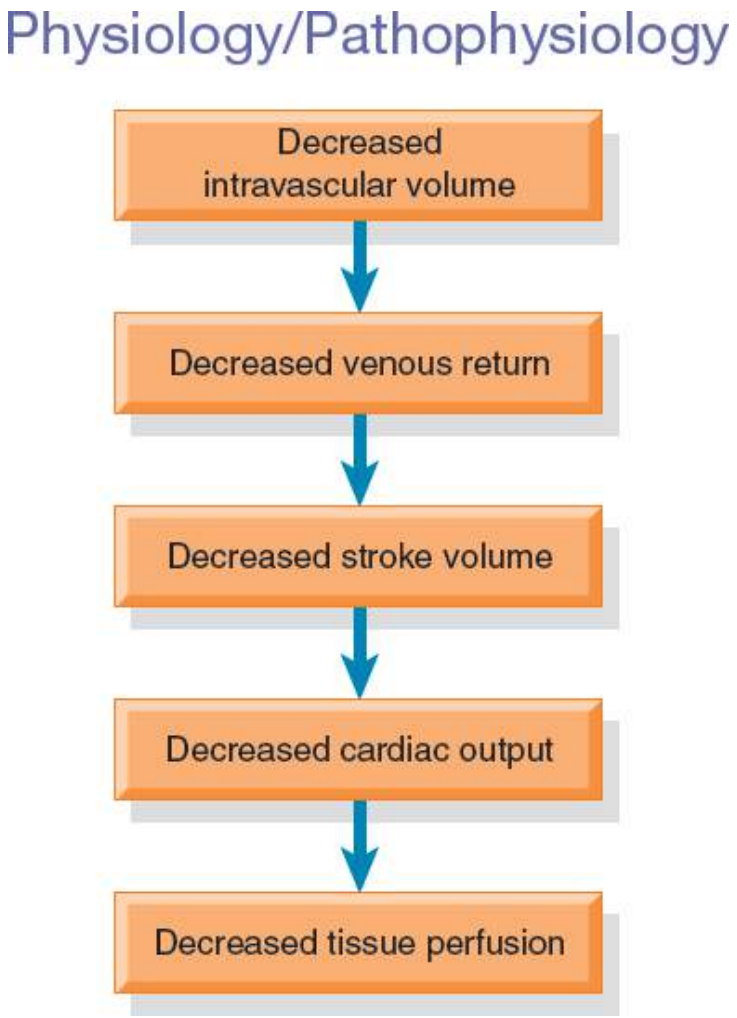

Figure 11-4 • Pathophysiologic sequence of events in hypovolemic shock.

Treatment of the Underlying Cause

If the patient is hemorrhaging, efforts are made to stop the bleeding. This may involve applying pressure to the bleeding site or surgical interventions to stop internal bleeding. If the cause of the hypovolemia is diarrhea or vomiting, medications to treat diarrhea and vomiting are given while efforts are made to identify and treat the cause. In older adult patients, dehydration may be the cause of hypovolemic shock.

Fluid and Blood Replacement

Beyond reversing the primary cause of the decreased intravascular volume, fluid replacement is of primary concern. At least two large-gauge IV lines are inserted to establish access for fluid administration. If an IV catheter cannot be quickly inserted, an intraosseous catheter may be used for access in the sternum, legs (tibia), or arms (humerus) to facilitate rapid fluid replacement (Clemency, Tanaka, May, et al., 2017). Multiple IV lines allow simultaneous

administration of fluid, medications, and blood component therapy if required. Because the goal of the fluid replacement is to restore intravascular volume, it is necessary to administer fluids that will remain in the intravascular compartment to avoid fluid shifts from the intravascular compartment into the intracellular compartment. Table 11-3 summarizes the fluids commonly used in the treatment of shock.

As discussed earlier, crystalloid solutions such as lactated Ringer's solution or 0.9% sodium chloride solution are commonly used to treat hypovolemic shock, as large amounts of fluid must be given to restore intravascular volume. If hypovolemia is primarily due to blood loss, the American College of Surgeons (2018) recommends administration of 3 mL of crystalloid solution for each milliliter of estimated blood loss. This is referred to as the 3:1 rule. Colloid solutions (e.g., albumin) may also be used. Hetastarch and dextran solutions are not indicated for fluid administration because these agents interfere with platelet aggregation.

TABLE 11-3 Fluid Replacement in Shock[a]

Fluids	Advantages	Disadvantages
Crystalloids		
Lactated Ringer's	Widely available; Lactate ion that helps buffer metabolic acidosis	Requires large volume of infusion; overresuscitation can result in pulmonary edema, abdominal compartment syndrome
0.9% Sodium chloride (normal saline solution)	Widely available	Requires large volume of infusion; can cause hypernatremia, hypokalemia, hyperchloremic metabolic acidosis; overresuscitation can result in pulmonary edema, abdominal compartment syndrome
Colloids		
Albumin (5%, 25%)	Rapidly expands plasma volume	Expensive; requires human donors; limited supply; can cause heart failure
Blood Products		
Plasma, packed red blood cells, and platelets	Rapidly replaces volume lost due to hemorrhage	Crossmatch type-specific blood is desired for optimal massive transfusion protocols to reduce transfusion-related complications (e.g., transfusion-related acute lung injury, hemolytic reactions, transfusion-associated circulatory overload)

[a]Deliver a minimum of 30 mL/kg of crystalloid.

Adapted from Holcomb, J. B., Tiley, B. C., Baraniuk, S., et al. (2015). Transfusion of plasma, platelets, and red blood cells in a 1:1:1 vs a 1:1:2 ratio and mortality in patients with severe trauma. *JAMA*, *313*(5), 471–482; Lewis, S. R., Pritchard, M. W., Evans, D. J. W., et al. (2018). Colloids versus crystalloids for fluid resuscitation in critically ill people. The *Cochrane Database of Systematic Reviews*, *8*(8), CD000567;

Rhodes, A., Evans, L., Alhazzani, W., et al. (2017). Surviving Sepsis Campaign: International guidelines for management of sepsis and septic shock: 2016. *Critical Care Medicine*, *45*(3), 486–552.

Blood products, which are also colloids, may need to be given, particularly if the cause of the hypovolemic shock is hemorrhage. The decision to give blood is based on the patient's lack of response to crystalloid resuscitation, the volume of blood lost, the need for hemoglobin to assist with oxygen transport, and the necessity to correct the patient's coagulopathy. Patients requiring massive transfusion respond better when blood products are given in a 1:1:1

ratio, meaning units of plasma, platelets, and packed red blood cells (Holcomb, Tiley, Baraniuk, et al., 2015).

Packed red blood cells are given to replenish the patient's oxygen-carrying capacity in conjunction with other fluids that will expand volume. Plasma and platelets are transfused to assist with coagulation and hemostasis. The need for transfusions is based on the patient's oxygenation needs and coagulation status, which are determined by vital signs, blood gas, chemistry, coagulation laboratory values, and clinical appearance.

Redistribution of Fluid

In addition to administering fluids to restore intravascular volume, positioning the patient properly assists fluid redistribution. PLR may be used to evaluate the patient's responsiveness to fluids and continued resuscitation efforts (Simmons & Ventetuolo, 2017). The nurse assesses for an improvement in the patient's vital signs, specifically a rise in the BP. Trendelenburg is not indicated as this position makes breathing difficult and does not increase BP or cardiac output (Bridges & Jarquin-Valdivia, 2005).

Pharmacologic Therapy

If fluid administration fails to reverse hypovolemic shock, then vasoactive medications that prevent cardiac failure are given. Medications are also given to reverse the cause of the dehydration. For example, insulin is given if dehydration is secondary to hyperglycemia, desmopressin is given for diabetes insipidus, antidiarrheal agents for diarrhea, and antiemetic medications for vomiting.

Nursing Management

Primary prevention of shock is an essential focus of nursing care. Hypovolemic shock can be prevented in some instances by closely monitoring patients who are at risk for fluid deficits and assisting with fluid replacement before intravascular volume is depleted. In other circumstances, nursing care focuses on assisting with treatment targeted at the cause of the shock and restoring intravascular volume.

General nursing measures include ensuring safe administration of prescribed fluids and medications and documenting their administration and effects. Volumetric IV pumps should be used to administer prescribed vasopressor medications. Another important nursing role is monitoring for complications and side effects of treatment and reporting them promptly.

Administering Blood and Fluids Safely

Administering blood transfusions safely is a vital nursing role. In emergency situations, it is important to acquire blood specimens quickly, to obtain a baseline complete blood count, and to type and crossmatch the blood in anticipation of blood transfusions. A patient who receives a transfusion of blood products must be monitored closely for adverse effects (see Chapter 28).

Fluid replacement complications can occur, especially when large volumes are given rapidly. Therefore, the nurse monitors the patient closely for cardiovascular overload and signs of difficulty breathing, a condition known as transfusion-associated circulatory overload. Transfusion-related ALI may occur and is characterized by pulmonary edema, hypoxemia, respiratory distress, and pulmonary infiltrates, usually within hours after massive transfusion (Vlaar & Kleinman, 2019). The risk of these complications is increased in older adults, in patients with preexisting cardiac disease, and with increasing number of blood products given. ACS is also a possible complication of excessive fluid resuscitation and may initially present with respiratory symptoms (difficulty breathing) and decreased urine output. Hemodynamic pressure, vital signs, arterial blood gases, serum lactate levels, hemoglobin and hematocrit levels, bladder pressure monitoring, and fluid intake and output (I&O) are among the parameters monitored. Temperature should also be monitored closely to ensure that rapid fluid resuscitation does not cause hypothermia. IV fluids may need to be warmed when large volumes are given. Physical assessment focuses on observing the jugular veins for distention and monitoring jugular venous pressure. Jugular venous pressure is low in hypovolemic shock; it increases with effective treatment and is significantly increased with fluid overload and heart failure. The nurse must monitor cardiac and respiratory status closely and report changes in BP, pulse pressure, CVP, heart rate and rhythm, and lung sounds to the primary provider.

Implementing Other Measures

Oxygen is given to increase the amount of oxygen carried by available hemoglobin in the blood. A patient who is confused may feel apprehensive with an oxygen mask or cannula in place, and frequent explanations about the need for the mask may reduce some of the patient's fear and anxiety. Simultaneously, the nurse must direct efforts to the safety and comfort of the patient.

Cardiogenic Shock

Cardiogenic shock occurs when the heart's ability to contract and to pump blood is impaired and the supply of oxygen is inadequate for the heart and the tissues. The causes of cardiogenic shock are known as either coronary or noncoronary. Coronary cardiogenic shock is more common than noncoronary

cardiogenic shock and is seen most often in patients with acute MI resulting in damage to a significant portion of the left ventricular myocardium (Wilcox, 2019). Patients who experience an anterior wall MI are at greatest risk for cardiogenic shock because of the potentially extensive damage to the left ventricle caused by occlusion of the left anterior descending coronary artery. Noncoronary causes of cardiogenic shock are related to conditions that stress the myocardium (e.g., severe hypoxemia, acidosis, hypoglycemia, hypocalcemia, tension pneumothorax) as well as conditions that result in ineffective myocardial function (e.g., cardiomyopathies, valvular damage, cardiac tamponade, arrhythmias).

Pathophysiology

In cardiogenic shock, cardiac output, which is a function of both stroke volume and heart rate, is compromised. When stroke volume and heart rate decrease or become erratic, BP falls and tissue perfusion is reduced. Blood supply for tissues and organs and for the heart muscle itself is inadequate, resulting in impaired tissue perfusion. Because impaired tissue perfusion weakens the heart and impairs its ability to pump, the ventricle does not fully eject its volume of blood during systole. As a result, fluid accumulates in the lungs. This sequence of events can occur rapidly or over a period of days (Fig. 11-5).

Clinical Manifestations

Patients in cardiogenic shock may experience the pain of angina, develop arrhythmias, complain of fatigue, express feelings of doom, and show signs of hemodynamic instability.

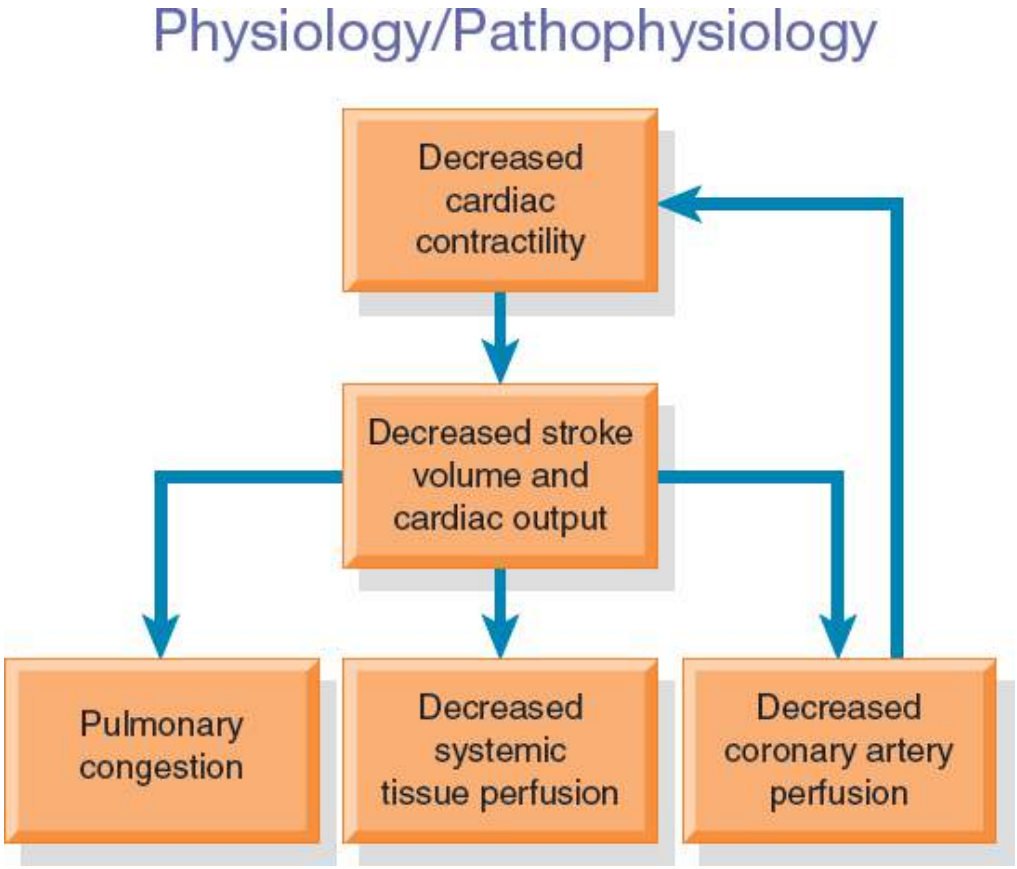

Figure 11-5 • Pathophysiologic sequence of events in cardiogenic shock.

Assessment and Diagnostic Findings

To assess the degree of myocardial damage, laboratory biomarkers for ventricular dysfunction (e.g., B-type natriuretic peptide), cardiac enzyme levels and biomarkers (cTn-I), and serum lactate are measured. In addition, a transthoracic echocardiography may be performed at the bedside, and serial 12-lead electrocardiograms are obtained (Bellumkonda, Gul, & Masri, 2018; Wilcox, 2019). Continuous ECG and ST segment monitoring is also done to closely monitor the patient for ischemic changes.

Medical Management

The goals of medical management in cardiogenic shock are to limit further myocardial damage and preserve the healthy myocardium and to improve cardiac function by increasing cardiac contractility, decreasing ventricular afterload, or both (Wilcox, 2019). In general, these goals are achieved by increasing oxygen supply to the heart muscle while reducing oxygen demands.

Correction of Underlying Causes

As with all forms of shock, the underlying cause of cardiogenic shock must be corrected. It is necessary first to treat the oxygenation needs of the heart muscle to ensure its continued ability to pump blood to other organs. In the case of coronary cardiogenic shock (e.g., acute coronary syndromes, ischemic cardiomyopathy, nonischemic cardiomyopathies, and myocarditis), the patient may require thrombolytic (fibrinolytic) therapy, a percutaneous coronary intervention, coronary artery bypass graft surgery, IABP therapy, ventricular assist device, or some combination of these treatments (Bellumkonda et al., 2018; Wilcox, 2019). In the case of noncoronary cardiogenic shock, interventions focus on correcting the underlying cause, such as replacement of an impaired cardiac valve, correction of an arrhythmia, correction of acidosis and electrolyte disturbances, or treatment of a tension pneumothorax. If the cause of the cardiogenic shock was related to a cardiac arrest, once the patient is successfully resuscitated, targeted temperature management, also called *therapeutic hypothermia,* may be initiated to actively lower the body temperature to a targeted core temperature (e.g., 32°C [89.6°F] to 36°C [96.8°F]) to preserve neurologic function (American Heart Association, 2018). (See Chapter 23 for more information regarding MI.)

Initiation of First-Line Treatment

Treatment priorities for patients in cardiogenic shock are focused upon ensuring adequate oxygenation, pain control, and maintaining hemodynamic stability.

Oxygenation

In the early stages of shock, if the patient's oxygen saturation is less than 90%, supplemental oxygen is given by nasal cannula at a rate of 2 to 6 L/min (Neto, 2018). Monitoring of arterial blood gas values, pulse oximetry values, and ventilatory effort (i.e., work of breathing) helps determine whether the patient requires a more aggressive method of oxygen delivery (including noninvasive and invasive mechanical ventilation).

Pain Control

If a patient experiences chest pain, IV morphine may be given for pain relief. In addition to relieving pain, morphine may dilate the blood vessels, reducing the workload of the heart by both decreasing the cardiac filling pressure (preload) and reducing the pressure against which the heart muscle has to eject blood (afterload). However, recent evidence suggests morphine may adversely affect antiplatelet agents used to treat the ischemic event; thus, the benefits of morphine may not outweigh its risks (McCarthy, Bhambhani, Pomerantsev, et al., 2018; Neto, 2018).

Hemodynamic Monitoring

Hemodynamic monitoring is initiated to assess the patient's response to treatment. In many institutions, this is performed in the intensive care unit (ICU), where an arterial line can be inserted. The arterial line enables accurate and continuous monitoring of BP and provides a port from which to obtain frequent arterial blood samples without having to perform repeated arterial punctures. A multilumen CVP and PA catheter may be inserted to allow measurement of myocardial filling pressures, pulmonary artery pressures, cardiac output, and pulmonary and systemic resistance. (For more information, see Chapter 21.)

Fluid Therapy

Appropriate fluid administration is also necessary in the treatment of cardiogenic shock. Administration of fluids must be monitored closely to detect signs of fluid overload. Incremental IV fluid boluses are cautiously given to determine optimal filling pressures for improving cardiac output.

Quality and Safety Nursing Alert

A fluid bolus should never be given rapidly, because rapid fluid administration in patients with cardiac failure may result in acute pulmonary edema.

Pharmacologic Therapy

Vasoactive medication therapy consists of multiple pharmacologic strategies to restore and maintain adequate cardiac output. In coronary cardiogenic shock, the aims of vasoactive medication therapy are improved cardiac contractility, decreased preload and afterload, and stabilized heart rate and rhythm.

Because improving contractility and decreasing cardiac workload are opposing pharmacologic actions, two types of medications may be given in combination: inotropic agents and vasodilators. Inotropic medications increase cardiac output by mimicking the action of the sympathetic nervous system, activating myocardial receptors to increase myocardial contractility (inotropic action), or increasing the heart rate (chronotropic action). These agents may also enhance vascular tone, increasing preload. Vasodilators are used primarily to decrease afterload, reducing the workload of the heart and oxygen demand. Vasodilators also decrease preload. Medications commonly combined to treat cardiogenic shock include dobutamine, nitroglycerin, and dopamine (see Table 11-2).

Dobutamine

Dobutamine produces inotropic effects by stimulating myocardial beta-receptors, increasing the strength of myocardial activity and improving cardiac output. Myocardial alpha-adrenergic receptors are also stimulated, resulting in decreased pulmonary and systemic vascular resistance (decreased afterload) (Maclaren et al., 2019).

Nitroglycerin

IV nitroglycerin in low doses acts as a venous vasodilator and therefore reduces preload. At higher doses, nitroglycerin causes arterial vasodilation and therefore reduces afterload as well. These actions, in combination with dobutamine, increase cardiac output while minimizing cardiac workload. In addition, vasodilation enhances blood flow to the myocardium, improving oxygen delivery to the weakened heart muscle (Maclaren et al., 2019; Wilcox, 2019).

Dopamine

Dopamine is a sympathomimetic agent that has varying vasoactive effects depending on the dosage. It may be used with dobutamine and nitroglycerin to improve tissue perfusion. Doses of 2 to 8 µg/kg/min improve contractility (inotropic action), slightly increase the heart rate (chronotropic action), and may increase cardiac output. Doses that are higher than 8 µg/kg/min predominantly cause vasoconstriction, which increases afterload and thus increases cardiac workload. Because this effect is undesirable in patients with cardiogenic shock, dopamine doses must be carefully titrated.

In severe metabolic acidosis, which occurs in the later stages of shock, metabolic acidosis must first be corrected to ensure maximum effectiveness of vasoactive medications (Maclaren et al., 2019).

Other Vasoactive Medications

Additional vasoactive agents that may be used in managing cardiogenic shock include norepinephrine, epinephrine, milrinone, vasopressin, phenylephrine, and angiotensin II. Each of these medications stimulates different receptors of the sympathetic nervous system. A combination of these medications may be prescribed, depending on the patient's response to treatment. All vasoactive medications have adverse effects, making specific medications more useful than others at different stages of shock (see Table 11-2). Diuretics such as furosemide may be given to reduce the workload of the heart by reducing fluid accumulation.

Antiarrhythmic Medications

Multiple factors, such as hypoxemia, electrolyte imbalances, and acid–base imbalances, contribute to serious cardiac arrhythmias in all patients with shock. In addition, as a compensatory response to decreased cardiac output and BP, the heart rate increases beyond normal limits. This impedes cardiac output further by shortening diastole and thereby decreasing the time for ventricular

filling. Consequently, antiarrhythmic medications are required to stabilize the heart rate. General principles regarding the administration of vasoactive medications are discussed later in this chapter. (For a full discussion of cardiac arrhythmias as well as commonly prescribed medications, see Chapter 22.)

Mechanical Assistive Devices

If cardiac output does not improve despite supplemental oxygen, vasoactive medications, and fluid boluses, mechanical assistive devices are used temporarily to improve the heart's ability to pump. Intra-aortic balloon counterpulsation with an IABP is one means of providing temporary circulatory assistance (Hochman & Reyentovich, 2019). The IABP is a catheter with an inflatable balloon at the end. The catheter is usually inserted through the femoral artery and threaded toward the heart, and the balloon is positioned in the descending thoracic aorta (Fig. 11-6). The IABP uses internal counterpulsation through the regular inflation and deflation of the balloon to augment the pumping action of the heart. It inflates during diastole, increasing the pressure in the aorta during diastole and therefore increasing blood flow through the coronary and peripheral arteries. It deflates just before systole, lessening the pressure within the aorta before left ventricular contraction, decreasing the amount of resistance the heart has to overcome to eject blood and therefore decreasing left ventricular workload. The device is connected to a console that synchronizes the inflation and deflation of the balloon with the ECG or the arterial pressure (as indicators for systole and diastole). Hemodynamic monitoring is often used to determine the patient's response to the IABP. The IABP provides short-term (days) support for the failing myocardium.

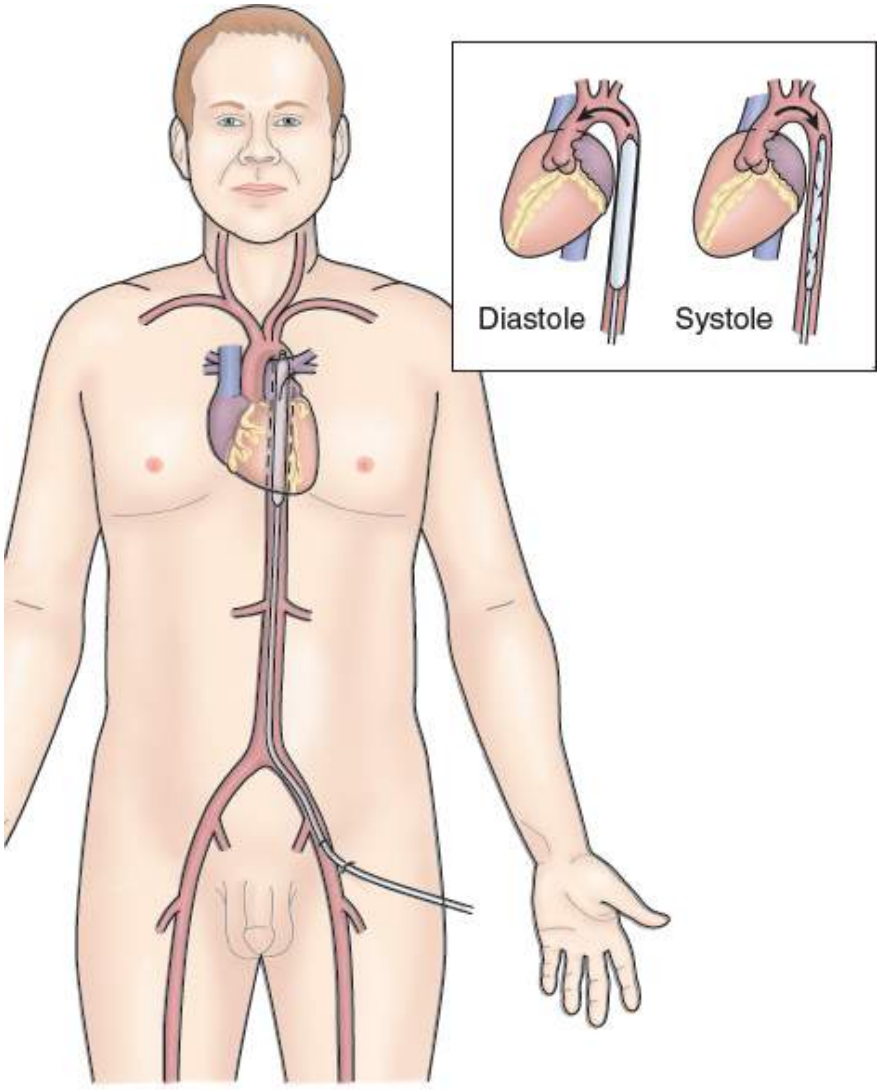

Figure 11-6 • The intra-aortic balloon pump inflates at the beginning of diastole, which results in increased perfusion of the coronary and peripheral arteries. It deflates just before systole, which results in a decrease in afterload (resistance to ejection) and in the left ventricular workload.

Other means of mechanical assistance include left and right ventricular assist devices and total temporary artificial hearts (see Chapters 24 and 25). Another short-term means of providing cardiac or pulmonary support to the patient in cardiogenic shock is through an extracorporeal device similar to the cardiopulmonary bypass (CPB) system used in open-heart surgery (see Chapter 23). CPB is used only in emergency situations until definitive treatment, such as heart transplantation, can be initiated.

Nursing Management

The role of the nurse managing the care of a patient with cardiogenic shock revolves around preventing its serious complications, monitoring hemodynamics, administering medications and fluids, maintaining intra-aortic counterpulsation as indicated, and promoting safety and comfort.

Preventing Cardiogenic Shock

Identifying at-risk patients early, promoting adequate oxygenation of the heart muscle, and decreasing cardiac workload can prevent cardiogenic shock. This can be accomplished by conserving the patient's energy, promptly relieving angina, and administering supplemental oxygen. Often, however, cardiogenic shock cannot be prevented. In such instances, nursing management includes working with other members of the health care team to prevent shock from progressing and to restore adequate cardiac function and tissue perfusion.

Monitoring Hemodynamic Status

A major role of the nurse is monitoring the patient's hemodynamic and cardiac status. Arterial lines and ECG monitoring equipment must be well maintained and functioning properly. The nurse anticipates the medications, IV fluids, and equipment that might be used and is ready to assist in implementing these measures. Changes in hemodynamic, cardiac, and pulmonary status and laboratory values are documented and reported promptly. In addition, adventitious breath sounds, changes in cardiac rhythm, and other abnormal physical assessment findings are reported immediately.

Administering Medications and Intravenous Fluids

The nurse plays a critical role in the safe and accurate administration of IV fluids and medications. Fluid overload and pulmonary edema are risks because of ineffective cardiac function and accumulation of blood and fluid in the pulmonary tissues. The nurse documents medications and treatments that are given as well as the patient's response to treatment.

The nurse must be knowledgeable about the desired effects as well as the side effects of medications. For example, the nurse monitors the patient for decreased BP after administering morphine or nitroglycerin. Arterial and venous puncture sites must be observed for bleeding, and pressure must be applied at the sites if bleeding occurs. IV infusions must be observed closely because tissue necrosis and sloughing may occur if vasopressor medications infiltrate the tissues. When possible, vasoactive medications should be given using central IV lines (Bauer et al., 2019). Furthermore, the need for the central IV access devices should be reviewed daily to reduce the risk of CLABSIs (Marschall, Mermel, Fakih, et al., 2014). The nurse must also monitor urine output, serum electrolytes, BUN, and serum creatinine levels to

detect decreased renal function secondary to the effects of cardiogenic shock or its treatment.

Maintaining Intra-Aortic Balloon Counterpulsation

The nurse plays a critical role in caring for the patient receiving intra-aortic balloon counterpulsation. The nurse makes ongoing timing adjustments of the balloon pump to maximize its effectiveness by synchronizing it with the cardiac cycle. The patient is at risk for circulatory compromise to the leg on the side where the catheter for the balloon has been inserted; therefore, the nurse must check the neurovascular status of the lower extremities frequently.

Enhancing Safety and Comfort

The nurse must take an active role in safeguarding the patient, enhancing comfort, and reducing anxiety. This includes administering medication to relieve chest pain, preventing infection at the multiple arterial and venous line insertion sites, protecting the skin, and monitoring respiratory and renal function. Proper positioning of the patient promotes effective breathing without decreasing BP and may also increase patient comfort while reducing anxiety.

Brief explanations about procedures that are being performed and the use of comforting touch often provide reassurance to the patient and the family. The family is usually anxious and benefits from opportunities to see and talk to the patient. Explanations of treatments and the patient's responses are often comforting to family members.

Family presence during a patient's critical illness has been a concern for family members, patients, nurses and other health care providers. Evidence-based clinical practice guidelines have outlined several elements that may enhance and support the patient and family experience during critical illness. Davidson and colleagues (2017) identified the importance of frequent, clear communication, an environment which encourages comfortable visitation, flexible visitation policies, including the option for family to stay overnight, and patient and family engagement in clinical decisions as mechanisms to enhance family support. A qualitative research study conducted by Wong and colleagues (2020) explored family perspectives of participation in patient care in the adult ICU. The nurse researchers interviewed and observed 30 family members. Findings demonstrated that families' perceptions of their contribution to the patient's psychosocial and emotional well-being were influenced by their engagement in care. See the Nursing Research Profile in Chart 11-4.

Distributive Shock

Distributive shock occurs when intravascular volume pools in peripheral blood vessels. This abnormal displacement of intravascular volume causes a relative hypovolemia because not enough blood returns to the heart, which leads to inadequate tissue perfusion. The ability of the blood vessels to constrict helps return the blood to the heart. Vascular tone is determined both by central regulatory mechanisms, as in BP regulation, and by local regulatory mechanisms, such as tissue demands for oxygen and nutrients. Therefore, distributive shock can be caused by either a loss of sympathetic tone or a release of biochemical mediators from cells that causes vasodilation.

The varied mechanisms leading to the initial vasodilation in distributive shock provide the basis for the further subclassification of shock into three types: septic shock, neurogenic shock, and anaphylactic shock. These subtypes of distributive shock cause variations in the pathophysiologic chain of events and are explained below separately. In all types of distributive shock, massive arterial and venous dilation promotes peripheral pooling of blood. Arterial dilation reduces systemic vascular resistance. Initially, cardiac output can be high, both from the reduction in afterload (systemic vascular resistance) and from the heart muscle's increased effort to maintain perfusion despite the incompetent vasculature. Pooling of blood in the periphery results in decreased venous return. Decreased venous return results in decreased stroke volume and decreased cardiac output. Decreased cardiac output, in turn, causes decreased BP and ultimately decreased tissue perfusion. Figure 11-7 presents the pathophysiologic sequence of events in distributive shock.

Chart 11-4 **NURSING RESEARCH PROFILE**

Family Participation in the Intensive Care Unit

Wong, P., Redley, B., Digby, R., et al. (2020). Families' perspectives of participation in patient care in an adult intensive care unit: A qualitative study. *Australian Critical Care, 33*(4), 317–325.

Purpose

The aim of this study was to describe family participation in patient care in the adult intensive care unit (ICU).

Design

This was a qualitative, descriptive observational study that enrolled a convenience sample of 30 family members who had an adult family member admitted to the ICU for more than 72 h. Researchers observed the family members' engagement in patient care activities and conducted semi-structured interviews focused on their experiences and perceptions of providing care.

Findings

Most of the family participants (77%) were female. Ages of the patient and family member were similar ranging from 28 to 73, with a median age for family members of 53. Researchers observed 193 activities in which 25% involved physical care for the patient, while the remaining 75% of activities were intangible care interventions such as communication and psychosocial/emotional care. Themes that emerged from the interviews revealed that the families felt part of the health care team and thus wanted to support the care and recovery of the loved one. Family members reported being motivated to provide care because they wanted the best care for the patient, desired to know the prognosis, treatment, and condition of the patient, and desired to help the patient recover. Lastly, family members wanted to advocate for their relatives, provide psychosocial and emotional care, and be supportive during medical treatments. The researchers observed that the physical environment was either a contributor or barrier to the family member's ability to engage in care. Equipment sometimes created physical barriers that made it hard for family to get close to the patient. Staff support and communication either encouraged or discouraged family participation in care. When nurses communicated openly, keeping families informed, family members felt more welcomed and better able to support the patient's treatment plans.

Nursing Implications

Most families wish to be engaged and to advocate for their loved ones in the treatment decision making process. The ability for family to feel part of the health care team and develop trust in the plan of care is influenced by positive relationships with the nursing and medical staff as well as the welcoming nature of the environment. Patient- and family-centered care is

facilitated when families are considered collaborative partners in the care of adult patients who are critically ill.

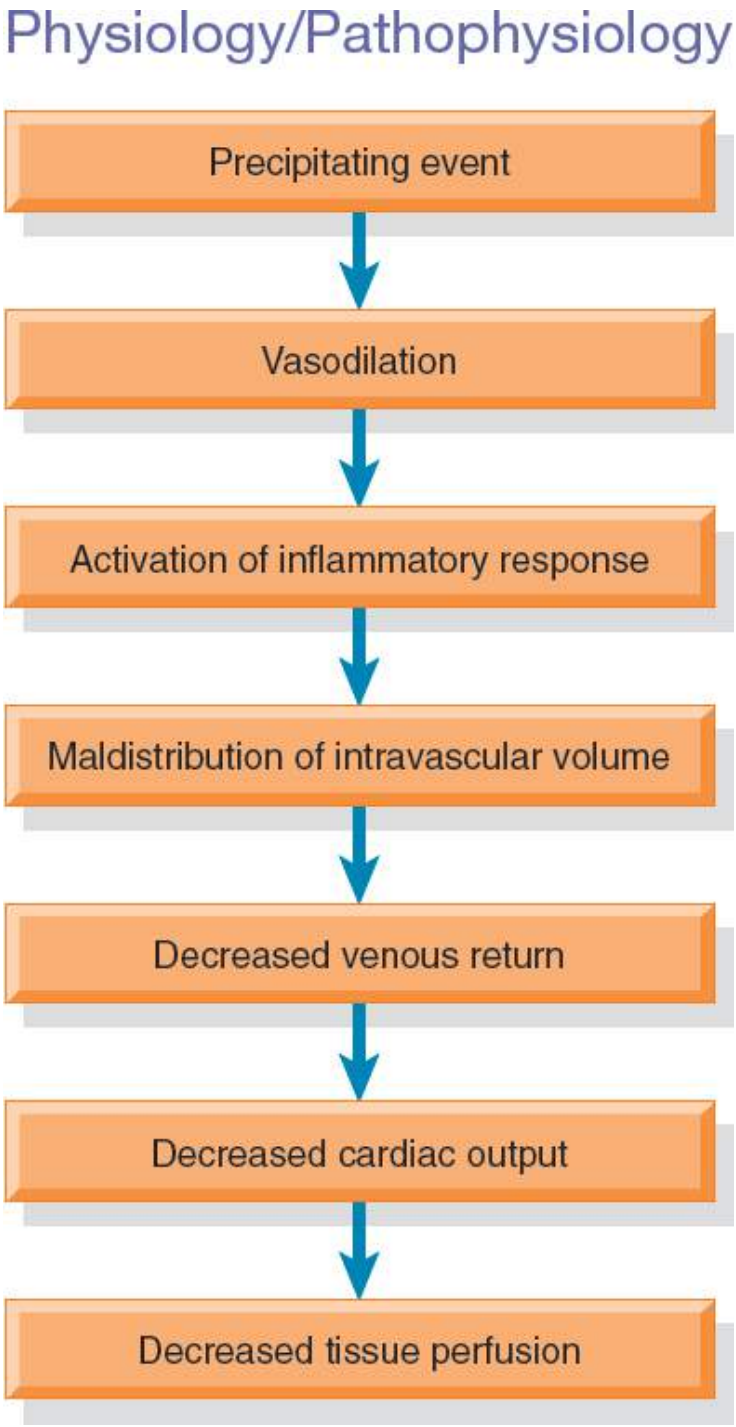

Figure 11-7 • Pathophysiologic sequence of events in distributive shock.

Sepsis and Septic Shock

Septic shock, the most common type of distributive shock, is caused by widespread infection or sepsis. According to the Third International Consensus Definitions for Sepsis and Septic Shock (*Sepsis-3*) Task Force, **sepsis** is "life-threatening organ dysfunction caused by a dysregulated host response to infection (Singer et al., 2016, p. 804)," and **septic shock** is "a subset of sepsis in which underlying circulatory and cellular metabolism abnormalities are profound enough to substantially increase mortality (Singer et al., 2016, p. 806)."

Despite the increased sophistication of antibiotic therapy, the incidence of both sepsis and septic shock has continued to rise; today sepsis and septic shock are the leading causes of death in noncoronary ICU patients. Worldwide, sepsis impacts more than 31 million people, and more than 6 million people die from it annually (Global Sepsis Alliance, 2017). The number of hospital admissions related to sepsis has increased threefold over the last decade (Surviving Sepsis Campaign, 2019). Identifying and aggressively treating the source of infection and quickly restoring tissue perfusion are important interventions that may positively influence clinical outcomes.

Hospital-acquired conditions, which may include hospital-associated infections (i.e., infections not present at the time of admission to the health care setting) in critically ill patients that may progress to septic shock, most frequently originate in the bloodstream (bacteremia), lungs (pneumonia), and urinary tract (urosepsis). Other infections include intra-abdominal infections and wound infections. Of increasing concern are bacteremias associated with intravascular catheters and indwelling urinary catheters (Centers for Disease Control and Prevention [CDC], 2019).

Additional risk factors that contribute to the growing incidence of sepsis are the increased use of invasive procedures and indwelling medical devices, the increased number of antibiotic-resistant microorganisms, and the aging population (CDC, 2019). Older adult patients are at particular risk for sepsis because of decreased physiologic reserves, an aging immune system, comorbid conditions and often nonspecific presentation of infection (Rowe & McKoy, 2017) (see Chapter 8). Other patients at risk are those undergoing surgical and other invasive procedures, especially patients who have undergone emergency surgery or multiple surgeries (Rhodes et al., 2017); those with malnutrition or immunosuppression; and those with chronic illness such as diabetes, hepatitis, chronic kidney disease, and immunodeficiency disorders (Keeley, Hine, & Nsutebu, 2017) (Chart 11-5).

The incidence of sepsis can be reduced by using strict infection control practices, beginning with thorough hand hygiene techniques (Dunne, Kingston, Slevin, et al., 2018). Other interventions include implementing programs to prevent central line infections and ventilator-associated events (e.g., aspiration) and pneumonia; ensuring early removal of invasive devices that are no longer necessary (e.g., indwelling urinary catheters); promoting

early ambulation and timely débridement of wounds; and adhering to standard precautions and infection prevention/control practices, including the use of meticulous aseptic technique and proper cleaning of equipment and the patient environment.

Chart 11-5 RISK FACTORS

Distributive Shock

Septic Shock

- Immunosuppression
- Extremes of age (<1 y and >65 y)
- Malnourishment
- Chronic illness
- Invasive procedures
- Emergent and/or multiple surgeries

Neurogenic Shock

- Spinal cord injury
- Spinal anesthesia
- Depressant action of medications

Anaphylactic Shock

- History of medication sensitivity
- Transfusion reaction
- History of reaction to insect bites/stings
- Food allergies
- Latex sensitivity

Adapted from Keeley, A., Hine, P., & Nsutebu, E. (2017). The recognition and management of sepsis and septic shock: A guide for non-intensivists. *Postgraduate Medicine Journal, 93*(1104), 626–634; Pajno, G. B., Fernandez-Rivas, M., Arasi, S., et al. (2018). EAACI guidelines on allergen immunotherapy: IgE-mediated food allergy. *Allergy, 73*(4), 799–815; Rhodes, A., Evans, L., Alhazzani, W., et al. (2017). Surviving Sepsis Campaign: International guidelines for management of sepsis and septic shock: 2016. *Critical Care Medicine, 45*(3), 486–552; Singer, M., Deutschman, C. S., Seymour, C. W., et al. (2016). The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA, 315*(8), 801–810.

Pathophysiology

Gram-negative bacteria traditionally were the most commonly implicated microorganisms in sepsis. However, there is an increased incidence of gram-positive bacterial infections, viral infections, and fungal infections that can also cause sepsis (Keeley et al., 2017). Although a site of infection is identified in most cases, in up to 30% of patients with sepsis an identifiable source of infection is not determined (Surviving Sepsis Campaign, 2019).

When microorganisms invade body tissues, patients exhibit an immune response. This immune response provokes the activation of biochemical cytokines and mediators associated with an inflammatory response and produces a complex cascade of physiologic events that leads to poor tissue perfusion. Increased capillary permeability results in fluid seeping from the capillaries. Capillary instability and vasodilation interrupt the body's ability to provide adequate perfusion, oxygen, and nutrients to the tissues and cells. The widespread inflammatory response that occurs is called the **systemic inflammatory response syndrome** (SIRS). SIRS, which is a type of cytokine release syndrome and is often referred to as cytokine storm, results from a clinical insult that initiates an inflammatory response that is systemic, rather than localized to the site of the insult (see Chapter 12 for further discussion of cytokine release syndrome). The insult may be a significant injury (e.g., multitrauma) or an infection (e.g., sepsis). A patient presenting with manifestations of SIRS may be exhibiting a protective inflammatory response to the initiating insult or may be exhibiting a response to infection, which may lead to sepsis. The clinical criteria used to identify SIRS, which include a temperature greater than 38.3°C (101°F) or less than 36°C (96.8°F), tachycardia, tachypnea, and a white blood cell (WBC) count greater than 12,000 cells/mm^3, less than 4000 cells/mm^3, or greater than 10% immature WBC (bands), have been found to be not helpful in diagnosing sepsis, however (Singer et al., 2016).

In addition to SIRS, proinflammatory and anti-inflammatory cytokines released during the inflammatory response activate the coagulation system, which begins to form clots regardless of whether or not bleeding is present (Seymour & Angus, 2018). This results not only in microvascular occlusions that further disrupt cellular perfusion but also in an inappropriate consumption of clotting factors. Imbalances among the inflammatory response and the clotting and fibrinolysis cascades are considered critical elements of the devastating physiologic progression that occurs in patients with sepsis.

Sepsis is an evolving process that may result in septic shock and life-threatening organ dysfunction if not recognized and treated early. In the early stage of septic shock, BP may remain within normal limits, or the patient may be hypotensive but responsive to fluids. The heart rate increases, progressing to tachycardia. Hyperthermia and fever, with warm, flushed skin and bounding pulses, are present. The respiratory rate is elevated. Urinary output may remain at normal levels or decrease. GI status may be compromised, as evidenced by

nausea, vomiting, diarrhea, or decreased gastric motility. Hepatic dysfunction is evidenced by rising bilirubin levels and worsening coagulopathies (e.g., decreasing platelet counts). Signs of hypermetabolism include increased serum glucose and insulin resistance. Subtle changes in mental status, such as confusion or agitation, may be present. The lactate level is elevated because of the maldistribution of blood. Inflammatory markers such as WBC counts, plasma C-reactive protein (CRP), and procalcitonin levels are also elevated (Rhodes et al., 2017; Seymour & Angus, 2018; Singer et al., 2016).

As sepsis progresses, tissues become less perfused and acidotic, compensation begins to fail, and the patient begins to show signs of organ dysfunction. The cardiovascular system also begins to fail, the BP does not respond to fluid resuscitation and vasoactive agents, and signs of end-organ damage are evident (e.g., AKI, pulmonary dysfunction, hepatic dysfunction, confusion progressing to nonresponsiveness). As sepsis progresses to septic shock, the BP drops and the skin becomes cool, pale, and mottled. Temperature may be normal or below normal. Heart and respiratory rates remain rapid. Urine production ceases, and multiple organ dysfunction progressing to death occurs.

Medical Management

A significant body of research has been conducted in the past few decades that is aimed at reducing the morbidity and mortality caused by sepsis and septic shock. In 1991, 2003, 2008, 2012, and again in 2016 (i.e., *Sepsis-3*), critical-care experts systematically reevaluated the body of research and provided evidence-based recommendations for the acute management of patients with sepsis and septic shock (Rhodes et al., 2017; Singer et al., 2016; Surviving Sepsis Campaign, 2019). Developing and implementing protocols, sepsis bundles, that focus on prevention and early detection and management of patients with sepsis have reduced the mortality of hospitalized patients (Kahn, Davis, Yabes, et al., 2019). *Sepsis-3* provides an overview of key concepts and principles germane to sepsis that must be understood in order for primary providers and nurses to be able to identify and manage patients with sepsis, including the following (Levy & Townsend, 2019; Singer et al., 2016):

- As the leading cause of death from infection, sepsis must be recognized and treated promptly.
- Sepsis is different from infection in that in sepsis there is a dysregulated host response with organ dysfunction. An infection may cause specific organ dysfunction without a dysregulated host response.
- Sepsis is caused by an interplay between infectious pathogens and a myriad of patient-specific risks, including genetics, age, and the

presence of other diseases/disorders.

- The organ dysfunction that occurs with sepsis may not be readily apparent; on the contrary, a new onset of organ dysfunction may be caused by an unrecognized infectious process.

Research efforts are focusing on better identification and early aggressive treatment of patients with sepsis, rapid and effective restoration of tissue perfusion, evaluation and treatment of the patient's immune response, and treatment of dysregulation of the coagulation system that occurs with sepsis (Keeley et al., 2017; Makic & Bridges, 2018).

Correction of Underlying Causes

Current treatment of sepsis and septic shock involves rapid identification and elimination of the cause of infection. Current goals are to identify and initiate treatment for patients in early sepsis within 1 hour to optimize patient outcomes (Levy et al., 2018; Levy & Townsend, 2019). Several evidence-based screening tools can be used to help identify patients for sepsis (see later discussion of assessment tools under the section Nursing Management).

In an effort to continue to reduce deaths from sepsis, Centers for Medicare and Medicaid Services (CMS) has identified sepsis and sepsis bundle adherence as a *Core Measure.* The focus on adherence with these evidence-based bundled interventions is to foster early recognition and interventions in patients with sepsis so that patient outcomes improve. These assessments and interventions are collectively referred to as the *Sepsis Bundles* (Chart 11-6).

Rapid identification of the infectious source is a critical element in managing sepsis. Specimens of blood, sputum, urine, wound drainage, and tips of invasive catheters are collected for culture using aseptic technique. IV lines are removed and reinserted at alternate sites. If possible, urinary catheters are removed or changed. Any abscesses are drained, and necrotic areas are débrided. All cultures should be obtained prior to antibiotic administration. Current guidelines suggest that antibiotics should be initiated within the first hour of treatment of a patient with sepsis (Surviving Sepsis Campaign, 2019).

Fluid Replacement Therapy

Fluid replacement must be instituted to correct tissue hypoperfusion that results from the incompetent vasculature and the inflammatory response. Reestablishing tissue perfusion through aggressive fluid resuscitation is key to the management of sepsis and septic shock (Rhodes et al., 2017; Singer et al., 2016). An initial fluid challenge, which includes an IV infusion of at least 30 mL/kg of crystalloids over 30 minutes, may be required to aggressively treat sepsis-induced tissue hypoperfusion. In addition to monitoring BP, patient mentation, respiratory rate, fluid responsiveness after PLR, urine output, and serum lactate levels are monitored to assess effectiveness of fluid resuscitation.

Pharmacologic Therapy

If the infecting organism is unknown, broad-spectrum antibiotic agents are started until culture and sensitivity reports are received (Levy & Townsend, 2019; Rhodes et al., 2017), at which time the antibiotic agents may be changed to agents that are more specific to the infecting organism and less toxic to the patient.

If fluid therapy alone does not effectively improve tissue perfusion, vasopressor agents, specifically norepinephrine or dopamine, may be initiated to achieve a MAP of 65 mm Hg or higher. Inotropic agents may also be given to provide pharmacologic support to the myocardium. Packed red blood cells may be prescribed to support oxygen delivery and transport to the tissues. Neuromuscular blockade agents and sedation agents may be required to reduce metabolic demands and provide comfort to the patient. Deep vein thrombosis (DVT) prophylaxis with low-dose unfractionated heparin or low-molecular-weight heparin, in combination with mechanical prophylaxis (e.g., sequential compression devices) should be initiated, as well as medications for stress ulcer prophylaxis (e.g., H_2-blocking agents, proton pump inhibitors).

Chart 11-6

Surviving Sepsis Campaign Bundle and CMS Core Measure Monitoring Metrics

Complete within 1 h of patient presentation/symptoms

- Measure lactate level. Remeasure if initial lactate is >2 mmol/L
- Obtain blood cultures prior to administration of antibiotics
- Administer broad-spectrum antibiotics
- Begin rapid administration of 30 mL/kg crystalloid for hypotension or lactate ≥4 mmol/L (within 30 min)
- Administer vasopressors if patients is hypotensive during or after fluid resuscitation to maintain MAP ≥65 mm Hg

Reprinted with permission from Levy, M., Evans, L., & Rhodes, A. (2018). The Surviving Sepsis Campaign bundle: 2018 update. *Critical Care Medicine, 46*(6), 997–1000.

CMS Core Measure Metrics and Surviving Sepsis Bundles 2016:

Complete within 3 h of patient presentation/symptoms

- Obtain serum lactate level
- Obtain blood culture prior to administration of antibiotics
- Administer prescribed broad-spectrum antibiotics
- Initiate aggressive fluid resuscitation in patients with hypotension or elevated serum lactate (>4 mmol/L):
  - Minimum initial fluid bolus of 30 mL/kg using crystalloid solutions

Complete as soon as possible or within the first 6 h of patient presentation/symptoms

- Begin vasopressor agents if hypotension is not improved (MAP <65 mm Hg) after initial fluid resuscitation
- If hypotension persists after initial fluid administration (MAP <65 mm Hg) or initial lactate was ≥4 mmol/L, reassess intravascular volume status and tissue perfusion using two of the following assessment parameters, including vital signs, capillary refill, pulse, and skin findings, or two of the following:
  - Measurement of CVP and/or $Scv\bar{O}_2$ (goal >70%)
  - Bedside cardiovascular ultrasound
  - Dynamic assessment of fluid responsiveness with passive leg raise or fluid challenge

Additional interventions and targets for therapy in the early management of sepsis

- Support blood pressure to achieve a urine output of >0.5 mL/kg/h over a 6-h period
- Administer vasopressor agents if fluid resuscitation does not restore an effective BP and cardiac output:
  - Norepinephrine centrally given is the initial vasopressor of choice.

    - Epinephrine, phenylephrine, or vasopressin should not be given as the initial vasopressor in septic shock.
- Obtain blood, sputum, urine, and wound cultures and administer broad-spectrum antibiotics:
    - Cultures should be obtained prior to antibiotic administration.
    - Antibiotic administration should occur within 3 h of admission to the emergency department or within 1 h of inpatient admission.
- Support the respiratory system with supplemental oxygen and mechanical ventilation.
- Transfuse with packed red blood cells when hemoglobin is <7 g/dL to achieve a target hemoglobin of 7–9 g/dL in adults.
- Provide adequate IV sedation and analgesia; avoid the use of neuromuscular blockade agents when possible.
- Control serum glucose <180 mg/dL with IV insulin therapy.
- Implement interventions and medications to prevent deep vein thrombosis and stress ulcer prophylaxis.
- Discuss advance care planning with patients and families.

BP, blood pressure; CVP, central venous pressure; IV, intravenous; MAP, mean arterial pressure.

Adapted from Centers for Medicare & Medicaid Services (CMS). (2019). Hospital Toolkit for Adult Sepsis Surveillance. Retrieved on 9/10/19 at: www.cdc.gov/sepsis/clinicaltools/index.html; Levy, M., Evans, L., & Rhodes, A. (2018). The Surviving Sepsis Campaign bundle: 2018 update. *Critical Care Medicine, 46*(6), 997–1000; Levy, M. M., & Townsend, S. R. (2019). Early identification of sepsis on the hospital floors: Insights for implementation of the hour-1 bundle. *Society of Critical Care Medicine*. Retrieved on 9/10/19 at: www.survivingsepsis.org/SiteCollectionDocuments/Surviving-Sepsis-Early-Identify-Sepsis-Hospital-Floor.pdf

Nutritional Therapy

Aggressive nutritional supplementation should be initiated within 24 to 48 hours of ICU admission to address the hypermetabolic state present with septic shock (Reintam et al., 2017; Wang et al., 2019). Malnutrition further impairs the patient's resistance to infection. Enteral feedings are preferred to the parenteral route because of the increased risk of iatrogenic infection associated with IV catheters; however, enteral feedings may not be possible if decreased perfusion to the GI tract reduces peristalsis and impairs absorption.

Nursing Management

Nurses caring for patients in any setting must keep in mind the risks of sepsis and the high mortality rate associated with sepsis and septic shock. All invasive procedures must be carried out with aseptic technique after careful hand hygiene. In addition, IV lines, arterial and venous puncture sites, surgical incisions, traumatic wounds, and urinary catheters must be monitored for signs

of infection. Nursing interventions to prevent infection need to be implemented in the care of all patients. Nurses should identify patients who are at particular risk for sepsis and septic shock (i.e., older adults and immunosuppressed patients and those with extensive trauma, burns, or diabetes), keeping in mind that these high-risk patients may not develop typical or classic signs of infection and sepsis. However, confusion with or without agitation along with an increased respiratory rate may be the first sign of infection and sepsis in any adult patient (Ferguson, Coates, Osborn, et al., 2019).

Sepsis-3 recommends that patients in the ICU setting with infection be monitored for the development of sepsis by using the *Sepsis-Related Organ Failure Assessment Score* (also known as the *Sequential Organ Failure Assessment* [SOFA] score) (Singer et al., 2016; Vincent, Moreno, Takala, et al., 1996) (Table 11-4). The parameters that are monitored on the SOFA which include assessment of respiratory rate, platelets, bilirubin, MAP (and use of any vasopressors), serum creatinine, urine output, and Glasgow Coma Scale (GCS) score (see Chapter 63), may all be gathered and assessed by the nurse in the ICU setting. A drop of 2 points or more in a patient's SOFA score from baseline is suggestive of organ dysfunction. In a patient with infection, the presence of organ dysfunction suggests the development of sepsis (Singer et al., 2016).

For a patient not in the ICU setting who has an infection, *Sepsis-3* recommends that the Quick SOFA (qSOFA) scale be used to screen for the development of sepsis. The qSOFA is an easy measurement tool that nurses may readily use; the presence of any two of the three parameters on this scale suggests the development of sepsis. These parameters include a respiratory rate of 22 breaths/min or higher, a GCS score of less than 15 (any change in the patient's mentation), and a systolic BP of 100 mm Hg or less. In order to facilitate ease of use, therefore, *Sepsis-3* recommends that any change in the patient's mentation status be used when computing the qSOFA scale score (Singer et al., 2016). Another assessment tool that is frequently used in hospital-based settings that can identify patients with sepsis is the *Modified Early Warning System* (MEWS) (Institute for Healthcare Improvement [IHI], 2017). The nurse assesses the patient for changes in respiratory rate, heart rate, BP, consciousness, temperature, and urine output. Scores ranging from 0 to 3 are assigned to each variable, and a MEWS score greater than 4 is suggestive of the development of sepsis (IHI, 2017) (Table 11-5).

TABLE 11-4 The Sepsis-Related Organ Failure Assessment Score (Sequential Organ Failure Assessment [SOFA] Score)

SOFA Score	1	2	3	4
Respiration PaO_2/FiO_2, mm Hg	<400	<300	<200	<100 —with respiratory support—
Coagulation Platelets × 10^3/mm^3	<150	<100	<50	<20
Liver Bilirubin, mg/dL (μmol/L)	1.2–1.9 (20–32)	2.0–5.9 (33–101)	6.0–11.9 (102–204)	>12.0 (>204)
Cardiovascular Hypotension	MAP <70 mm Hg	Dopamine ≤5 or dobutamine (any dose)*	Dopamine >5 or epinephrine ≤0.1 or norepinephrine ≤0.1	Dopamine >15 or epinephrine >0.1 or norepinephrine >0.1
Central Nervous System Glasgow Coma Scale	13–14	10–12	6–9	<6
Renal Creatinine, mg/dL (μmol/L) or urine output	1.2–1.9 (110–170)	2.0–3.4 (171–299)	3.5–4.9 (300–440) or <500 mL/day	>5.0 (>440) or <200 mL/day

MAP, mean arterial pressure.
*Adrenergic agents given for at least 1 h (doses given are in μg/kg/min).
Reprinted with permission from Vincent, J. L., Moreno, R., Takala, J., et al. (1996). The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. On behalf of the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine. *Intensive Care Medicine, 22*(7), 707–710.

When caring for a patient with sepsis or septic shock, the nurse collaborates with other members of the health care team to identify the site and source of sepsis and the specific organisms involved. The nurse often obtains appropriate specimens for culture and sensitivity. Prescribed antibiotics are not given until these specimens are obtained. Hyperthermia (elevated body temperature) is common with sepsis and raises the patient's metabolic rate and oxygen consumption. Efforts may be made to reduce the temperature by administering acetaminophen or applying a hypothermia blanket. During these therapies, the nurse monitors the patient closely for shivering, which increases oxygen consumption. Efforts to increase comfort are important if the patient experiences fever, chills, or shivering.

The nurse administers prescribed IV fluids and medications, including antibiotic agents and vasoactive medications, to restore vascular volume. Because of decreased perfusion, serum concentrations of antibiotic agents that are normally cleared by the kidneys and liver may increase and produce toxic effects. Therefore, the nurse monitors blood levels (serum levels of antibiotic agents, procalcitonin, CRP, BUN, creatinine, WBC count, hemoglobin, hematocrit, platelet levels, coagulation studies) and reports changes to the primary provider. As with other types of shock, the nurse monitors the patient's hemodynamic status, fluid I&O, daily weight, and nutritional status. Close monitoring of serum albumin and prealbumin levels helps determine the patient's protein requirements.

TABLE 11-5 The MEWS (Modified Early Warning System)

	NEWS (Modified Early Warning System)						
	3	2	1	0	1	2	3
Respiration rate per minute		<8		9–14	15–20	21–29	>30
Heart rate per minute		<40	40–50	51–100	101–110	111–129	>129
Systolic blood pressure	<70	71–80	81–100	101–199		>200	
Conscious level (AVPU)	Unresponsive	Responds to Pain	Responds to Voice	Alert	New agitation, Confusion		
Temperature (°C)		<35.0	35.1–36	36.10–38	38.1–38.5	>38.6	
Hourly urine for 2 h	<10 mL/h	<30 mL/h	<45 mL/h				

Developed by Yduyn, Glan Clwyd, Conwy & Denbighshire National Health Service Trust, North Wales. Reprinted with permission from Institute for Healthcare Improvement (IHI). (2017). Improvement stories: Early warning systems: Scorecards that save lives. Retrieved on 1/16/19 at http://www.ihi.org/resources/Pages/ImprovementStories/EarlyWarningSystemsScorecardsThatSaveLives.aspx .

Neurogenic Shock

In **neurogenic shock,** vasodilation occurs as a result of a loss of balance between parasympathetic and sympathetic stimulation. Sympathetic stimulation causes vascular smooth muscle to constrict, and parasympathetic stimulation causes vascular smooth muscle to relax or dilate. The patient experiences a predominant parasympathetic stimulation that causes vasodilation lasting for an extended period, leading to a relative hypovolemic state. However, blood volume is adequate, because the vasculature is dilated; the blood volume is displaced, producing a hypotensive (low BP) state. The overriding parasympathetic stimulation that occurs with neurogenic shock causes a drastic decrease in the patient's systemic vascular resistance and bradycardia. Inadequate BP results in the insufficient perfusion of tissues and cells that is common to all shock states.

Neurogenic shock can be caused by spinal cord injury, spinal anesthesia, or other nervous system damage. It may also result from the depressant action of medications or from lack of glucose (e.g., insulin reaction) (see Chart 11-5). Neurogenic shock may have a prolonged course (spinal cord injury) or a short one (syncope or fainting). Normally, during states of stress, the sympathetic stimulation causes the BP and heart rate to increase. In neurogenic shock, the sympathetic system is not able to respond to body stressors. Therefore, the clinical characteristics of neurogenic shock are signs of parasympathetic stimulation. It is characterized by dry, warm skin rather than the cool, moist skin seen in hypovolemic shock. Another characteristic is hypotension with bradycardia, rather than the tachycardia that characterizes other forms of shock.

Medical Management

Treatment of neurogenic shock involves restoring sympathetic tone, either through the stabilization of a spinal cord injury or, in the instance of spinal

anesthesia, by positioning the patient properly. Specific treatment depends on the cause of the shock. (Further discussion of management of patients with a spinal cord injury is presented in Chapter 63.)

Nursing Management

It is important to elevate and maintain the head of the bed at least 30 degrees to prevent neurogenic shock when a patient receives spinal or epidural anesthesia. Elevation of the head helps prevent the spread of the anesthetic agent up the spinal cord. In suspected spinal cord injury, neurogenic shock may be prevented by carefully immobilizing the patient to prevent further damage to the spinal cord (Kessler, Traini, Welk, et al., 2018). Nursing interventions are directed toward supporting cardiovascular and neurologic function until the usually transient episode of neurogenic shock resolves.

Patients with neurogenic shock have a higher risk for venous thromboembolism (VTE) formation because of increased pooling of blood from vascular dilation; this risk is greater in patients with neurogenic shock related to spinal cord injury. The nurse must assess the patient daily for any lower extremity pain, redness, tenderness, and warmth. If the patient complains of pain and objective assessment of the calf is suspicious, the patient should be evaluated for DVT. Passive range of motion of the immobile extremities helps promote circulation. Early interventions to prevent VTE include the application of pneumatic compression devices often combined with antithrombotic agents (e.g., low-molecular-weight heparin).

A patient who has experienced a spinal cord injury may not report pain caused by internal injuries. Therefore, in the immediate post-injury period, the nurse must monitor the patient closely for signs of internal bleeding that could lead to hypovolemic shock.

Anaphylactic Shock

Anaphylactic shock is caused by a severe allergic reaction when patients who have already produced antibodies to an antigen (foreign substance) develop a systemic antigen–antibody reaction; specifically, an immunoglobulin E (IgE)-mediated response. This antigen–antibody reaction provokes mast cells to release potent vasoactive substances, such as histamine or bradykinin, and activates inflammatory cytokines, causing widespread vasodilation and capillary permeability. The most common triggers are foods (especially peanuts), medications, and insect stings and bites (Pajno, Fernandez-Rivas, Arasi, et al., 2018) (see Chart 11-5). Anaphylaxis has three defining characteristics:

- Acute onset of symptoms

- Presence of two or more symptoms that include respiratory compromise, reduced BP, GI distress, and skin or mucosal tissue irritation
- Cardiovascular compromise from minutes to hours after exposure to the antigen

Signs and symptoms of anaphylaxis may present within 2 to 30 minutes of exposure to the antigen; however, occasionally some reactions may not develop for several hours (Chan & John, 2020). The patient may report headache, lightheadedness, nausea, vomiting, acute abdominal pain or discomfort, pruritus, and feeling of impending doom. Assessment may reveal diffuse erythema and generalized flushing, dyspnea (laryngeal edema), bronchospasm, cardiac arrhythmias, and hypotension. Characteristics of severe anaphylaxis usually include rapid onset of hypotension, neurologic compromise, respiratory distress, and cardiac arrest (Chan & John, 2020). Anaphylactoid reactions present similarly to anaphylaxis but are not mediated by IgE responses. Anaphylaxis and anaphylactoid reactions are often clinically indistinguishable (Pajno et al., 2018).

Medical Management

Treatment of anaphylactic shock requires removing the causative antigen (e.g., discontinuing an antibiotic agent), administering medications that restore vascular tone, and providing emergency support of basic life functions. Fluid management is critical, as massive fluid shifts can occur within minutes due to increased vascular permeability (Pajno et al., 2018). Intramuscular epinephrine is given for its vasoconstrictive action. Diphenhydramine is given intravenously to reverse the effects of histamine, thereby reducing capillary permeability. Nebulized medications, such as albuterol, may be given to reverse histamine-induced bronchospasm.

If cardiac arrest and respiratory arrest are imminent or have occurred, cardiopulmonary resuscitation (CPR) is performed. Endotracheal intubation may be necessary to establish an airway. IV lines are inserted to provide access for administering fluids and medications. See Chapter 33 for further discussion of anaphylaxis and specific chemical mediators.

Nursing Management

The nurse has an important role in prevention and early recognition of anaphylactic shock. The nurse must assess all patients for allergies or previous reactions to antigens (e.g., medications, blood products, foods, contrast agents, latex) and communicate the existence of these allergies or reactions to others. In addition, the nurse assesses the patient's understanding of previous reactions

and steps taken by the patient and the family to prevent further exposure to antigens. When new allergies are identified, the nurse advises the patient to wear or carry identification that names the specific allergen or antigen.

When administering any new medication, the nurse observes all patients for allergic reactions. This is especially important with antibiotics, beta-blockers, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, aspirin, and nonsteroidal anti-inflammatory drugs (Chan & John, 2020). Previous adverse drug reactions increase the risk that the patient will develop a reaction to a new medication. If the patient reports an allergy to a medication, the nurse must be aware of the risks involved in the administration of similar medications.

At any diagnostic testing site, the nurse must identify patients who are at risk for anaphylactic reactions to contrast agents (radiopaque, dyelike substances that may contain iodine) used for diagnostic tests. The nurse must be knowledgeable about the clinical signs of anaphylaxis, must take immediate action if signs and symptoms occur, and must be prepared to begin CPR if cardiorespiratory arrest occurs.

Quality and Safety Nursing Alert

Patients with a known allergy to iodine or fish and those who have had previous allergic reactions to contrast agents are at high risk for anaphylactic reactions. The nurse should ask the patient about the allergy, signs and symptoms and severity, and if the patient has been tested for the allergy or carries an autoinjectable epinephrine device. This information must be communicated to the staff at the diagnostic testing site, including x-ray personnel.

Community health and home health nurses who administer medications, including antibiotic agents, in the patient's home or other settings, must be prepared to administer epinephrine intramuscularly in the event of an anaphylactic reaction.

After recovery from anaphylaxis, the patient and the family require an explanation of the event. Furthermore, the nurse provides education about avoiding future exposure to antigens and administering emergency medications to treat anaphylaxis (see Chapter 33).

Multiple Organ Dysfunction Syndrome

MODS is altered organ function in acutely ill patients that requires medical intervention to support continued organ function. It is another phase in the

progression of shock states. The actual incidence of MODS is difficult to determine, because it develops with acute illnesses that compromise tissue perfusion. Dysfunction of one organ system is associated with 20% mortality, and if more than four organs fail, the mortality is at least 60% (Sauaia, Moore, & Moore, 2017).

Pathophysiology

The precise mechanism by which MODS occurs remains unknown, but it is most commonly seen in patients with sepsis as a result of inadequate tissue perfusion. MODS frequently occurs toward the end of the continuum of septic shock when tissue perfusion cannot be effectively restored. It is not possible to predict which patients who experience shock will develop MODS, partly because much of the organ damage occurs at the cellular level and, therefore, cannot be directly observed or measured.

The clinical presentation of MODS is insidious; tissues become hypoperfused at both a microcellular and macrocellular level, eventually causing organ dysfunction that requires mechanical and pharmacologic intervention to support organ function. Organ failure usually begins in the lungs, and cardiovascular instability, as well as failure of the hepatic, GI, renal, immunologic, and central nervous systems, follows (Sauaia et al., 2017).

Clinical Manifestations

While it is not possible to predict MODS, clinical severity assessment tools may be used to anticipate patient risk of organ dysfunction and mortality. These clinical assessment tools include APACHE (Acute Physiology and Chronic Health Evaluation); SAPS (Simplified Acute Physiology Score); PIRO (Predisposing factors, the Infection, the host Response, and Organ dysfunction); and SOFA score (see Table 11-4) (Gustot, 2011; Kress & Hall, 2018).

In MODS, the sequence of organ dysfunction varies depending on the patient's primary illness and comorbidities before experiencing shock. Advanced age, malnutrition, and coexisting disease appear to increase the risk of MODS in acutely ill patients. For simplicity of presentation, the classic pattern is described. Typically, the lungs are the first organs to show signs of dysfunction. The patient experiences progressive dyspnea and respiratory failure that are manifested as ALI or ARDS, requiring intubation and mechanical ventilation (see Chapters 19). The patient usually remains hemodynamically stable but may require increasing amounts of IV fluids and vasoactive agents to support BP and cardiac output. Signs of a hypermetabolic state, characterized by hyperglycemia (elevated blood glucose level), hyperlactic acidemia (excess lactic acid in the blood), and increased BUN, are

present. The metabolic rate may be 1.5 to 2 times the basal metabolic rate. At this time, there is a severe loss of skeletal muscle mass (autocatabolism) to meet the high energy demands of the body.

After approximately 7 to 10 days, signs of hepatic dysfunction (e.g., elevated bilirubin and liver function tests) and renal dysfunction (e.g., elevated creatinine and anuria) are evident. As the lack of tissue perfusion continues, the hematologic system becomes dysfunctional, with worsening immunocompromise, increasing the risk of bleeding. The cardiovascular system becomes unstable and unresponsive to vasoactive agents, and the patient's neurologic response progresses to a state of unresponsiveness or coma.

The goal of all shock states is to reverse the tissue hypoperfusion and hypoxia. If effective tissue perfusion is restored before organs become dysfunctional, the patient's condition stabilizes. Along the septic shock continuum, the onset of organ dysfunction is an ominous prognostic sign; the more organs that fail, the worse the outcome.

Medical Management

Prevention remains the top priority in managing MODS. Older adult patients are at increased risk for MODS because of the lack of physiologic reserve and the natural degenerative process, especially immune compromise (Kress & Hall, 2018). Early detection and documentation of initial signs of infection are essential in managing MODS in older adult patients. Subtle changes in mentation and a gradual rise in temperature are early warning signs. Other patients at greater risk for MODS are those with chronic illness, malnutrition, immunosuppression, or surgical or traumatic wounds.

If preventive measures fail, treatment measures to reverse MODS are aimed at (1) controlling the initiating event, (2) promoting adequate organ perfusion, (3) providing nutritional support, and (4) maximizing patient comfort.

Nursing Management

The general plan of nursing care for patients with MODS is the same as that for patients with shock. Primary nursing interventions are aimed at supporting the patient and monitoring organ perfusion until primary organ insults are halted. Providing information and support to family members is a critical role of the nurse. The health care team must address end-of-life decisions to ensure that supportive therapies are congruent with the patient's wishes (see Chapter 13).

Promoting Communication

Nurses should encourage frequent and open communication about treatment modalities and options to ensure that the patient's wishes regarding medical management are met. Patients who survive MODS must be informed about the goals of rehabilitation and expectations for progress toward these goals, because massive loss of skeletal muscle mass makes rehabilitation a long, slow process. A strong nurse–patient relationship built on effective communication provides needed encouragement during this phase of recovery.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

Patients who experience and survive any type of shock or sepsis may have been unable to get out of bed for an extended period of time and are likely to have a slow, prolonged recovery. The patient and the family are educated about strategies to prevent further episodes of shock or sepsis by identifying the factors implicated in the initial episode (Ferguson et al., 2019). In addition, the patient and the family require education about assessments needed to identify the complications that may occur after the patient is discharged from the hospital. Depending on the type of shock and its management, the patient or the family may require education about treatment modalities such as emergency administration of medications, IV therapy, parenteral or enteral nutrition, skin care, exercise, and ambulation. The patient and the family are also educated about the need for gradual increases in ambulation and other activity. The need for adequate nutrition is another crucial aspect of education.

Continuing and Transitional Care

Because of the physical toll associated with recovery from shock and sepsis, patients may be cared for in a long-term care facility or rehabilitation setting after hospital discharge. Alternatively, a referral may be made for home, community-based, or transitional care. Patients may also experience PICS, a condition that is gaining increased recognition. PICS occurs after critically ill patients are discharged from the hospital. PICS involves physical, cognitive, and mental impairments that may adversely impact the patient's long-term recovery (Inoue, Hatakeyama, Kondo, et al., 2019). Nursing interventions to prevent PICS occur during the patient's critical illness and include early mobilization, assessment and management of delirium, promoting adequate

sleep, and assisting with mechanical ventilation liberation (e.g., weaning) as soon as possible. The nurse assesses the patient's physical status and monitors recovery. The adequacy of treatments continued at home and the ability of the patient and the family to cope with these treatments are also assessed. The patient is likely to require close medical supervision until complete recovery occurs. The nurse reinforces the importance of continuing medical care and helps the patient and the family identify and mobilize community resources.

CRITICAL THINKING EXERCISES

1 pq A 32-year-old patient is admitted after falling from a second-story balcony. The patient has a fractured femur, several fractured ribs, and possible head injury. The primary provider has prescribed lactated Ringer's solution to be infused at 250 mL/h to maintain a blood pressure >120 mm Hg and urine output >50 mL/h. Two large-bore IVs are started in each arm and IV fluids are initiated. The patient is alert to name only. The patient is typed and crossed for blood products, and a series of metabolic labs and a lactate level are drawn for analysis. The patient becomes unresponsive to name and begins moaning and grimacing. Vital signs are as follows: BP 92/72, HR 132 bpm, RR 32 bpm, SpO_2 92% on 40% FiO_2 via a facemask with a urine output of 15 mL over the last hour. Identify 3–5 priority interventions that you should implement, the order in which they should be implemented, and explain how you made these decisions.

2 ebp A 76-year-old patient is scheduled for surgery for benign prostatic enlargement that is causing significant obstruction to his urinary function. The patient's past medical history includes chronic obstructive pulmonary disease, hypertension, and type 2 diabetes. Due to his medical history and surgical risks, he is not a candidate for general anesthesia and instead receives spinal anesthesia. Midway through the surgery his vital signs decrease abruptly to BP 88/32 mm Hg and HR 62 bpm, while his RR remains stable controlled by anesthesia with ventilatory support. Surgery is aborted for suspected neurogenic shock. The patient is transferred to the postanesthesia care unit (PACU) for monitoring. The surgeon explains the complication that has occurred to the patient's wife and tells her that a nurse will continue to provide updates to her by phone. The wife asks to see her husband, but the waiting room clerk says that family is not allowed in the PACU. An hour passes and the nurse does not call to update the wife. The clerk observes the wife quietly crying in a corner and calls the nurse caring for the patient to inform her of the wife's distress. As the nurse, what actions would you implement to facilitate patient- and family-centered care? What evidence supports these actions?

3 ipc An 88-year-old woman is admitted from an assisted living facility with acute decline in mental status. On admission vital signs are as follows: BP 100/76 mm Hg, HR 126 bpm, and RR 26 bpm. The patient is also incontinent of urine. As the nurse, you suspect a possible urinary tract infection and immediately assess the patient for sepsis. What other members of the interprofessional team will you need to collaborate with to facilitate early interventions to minimize the risk of complications? To implement a sepsis protocol, what additional information should you obtain prior to calling the provider? What should you anticipate from the

provider? How will you effectively communicate your assessment and recommendations to the provider and other members of the interprofessional team?

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

American Association of Critical-Care Nurses Resources for Sepsis, www.aacn.org/clinical-resources/sepsis
Institute for Healthcare Improvement, www.ihi.org
Sepsis Alliance, www.sepsis.org
Surviving Sepsis Campaign, www.survivingsepsis.org

12 Management of Patients with Oncologic Disorders

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Differentiate between characteristics of benign and malignant tumors.
2. Discuss the role of the nurse in the prevention and management of cancer.
3. Compare and contrast the goals of cancer care in prevention, diagnosis, cure, control, and palliation.
4. Describe the role of surgery, radiation therapy, chemotherapy, hematopoietic stem cell transplantation, immunotherapy, and targeted therapy in the treatment of cancer.
5. Use the nursing process as a framework for the care of the patient with cancer throughout the disease trajectory, from the time of diagnosis, to survivorship, and at the end of life.

NURSING CONCEPTS

Cellular Regulation
Managing Care
Tissue Integrity

GLOSSARY

alopecia: hair loss

anaplasia: pattern of growth in which cells lack normal characteristics and differ in shape and organization with respect to their cells of origin; usually, anaplastic cells are malignant

angiogenesis: growth of new blood vessels that allow cancer cells to grow

apoptosis: a normal cell mechanism of programmed cell death

benign: not cancerous; benign tumors may grow but are unable to spread to other organs or body parts

brachytherapy: delivery of radiation therapy through internal implants placed inside or adjacent to the tumor

cancer: a group of disorders characterized by abnormal cell proliferation, in which cells ignore growth-regulating signals in the surrounding environment

carcinogenesis: process of transforming normal cells into malignant cells

carcinogens: chemicals, physical factors, and other agents that cause cancer

chemotherapy: the use of medications to kill tumor cells by interfering with cellular functions and reproduction

cytokines: messenger substances that may be released by a cell to create an action at that site or may be carried by the bloodstream to a distant site before being activated; (*synonyms*: biochemical mediators, inflammatory mediations)

extravasation: leakage of intravenous medication from the veins into the subcutaneous tissues

grading: identification of the type of tissue from which the tumor originated and the degree to which the tumor cells retain the functional and structural characteristics of the tissue of origin

graft-versus-host disease (GVHD): an immune response initiated by T lymphocytes of donor tissue against the recipient's tissues (skin, gastrointestinal tract, liver); an undesirable response

graft-versus-tumor effect: the donor immune cell response against the malignancy; a desirable response

immunotherapy: the use of medications or other agents to stimulate or suppress components of the immune system to kill cancer cells

malignant: having cells or processes that are characteristic of cancer

metastasis: spread of cancer cells from the primary tumor to distant sites

mucositis: inflammation of the lining of the mouth, throat, and gastrointestinal tract often associated with cancer therapies

myelosuppression: suppression of the blood cell–producing function of the bone marrow

nadir: the lowest serum level of blood cells (i.e., white blood cells, red blood cells, and platelets) after therapy that has toxic effects on the bone marrow. Clinically, the nadir is most often used to describe the lowest absolute neutrophil count following chemotherapy

neoplasia: uncontrolled cell growth that follows no physiologic demand; cancer

neutropenia: abnormally low absolute neutrophil count

oncology: field or study of cancer

palliation: relief of symptoms and promotion of comfort and quality of life regardless of the disease stage

precision medicine: using advances in research, technology, and policies to develop individualized plans of care to prevent and treat disease

radiation therapy: the use of ionizing radiation to kill malignant cells

staging: process of determining the extent of disease, including tumor size and spread or metastasis to distant sites

stomatitis: inflammation of the oral tissues, often associated with some chemotherapeutic agents and radiation therapy to the head and neck region

targeted therapies: the use of medications or other agents to kill or prevent the spread of cancer cells by targeting specific part of the cell, with less negative effects on healthy cells

thrombocytopenia: decrease in the number of circulating platelets; associated with the potential for bleeding

toxicity: an unfavorable and unintended sign, symptom, or condition associated with cancer treatment

vesicant: substance that can cause inflammation, damage, and necrosis with extravasation from blood vessels and contact with tissues

Cancer is a large group of disorders with different causes, manifestations, treatments, and prognoses. Because cancer can involve any organ system and treatment approaches have the potential for multisystem effects, cancer nursing practice overlaps with numerous nursing specialties. Cancer nursing practice covers all age groups and is carried out in various settings, including acute care institutions, outpatient centers, physician offices, rehabilitation facilities, the home, and long-term care facilities. The scope, responsibilities, and goals of cancer nursing, also called **oncology** nursing, are as diverse and complex as those of any nursing specialty. Nursing management of the patient with oncologic disorders includes care of patients throughout the cancer trajectory from prevention through end-of-life care (see Fig. 12-1).

Precision medicine is possible because of the recent development of biologic databases (e.g., human genome sequencing), technologic advances that can identify unique characteristics of individual persons (e.g., genomics, cellular

assay tests), and computer-driven systems that can mine and analyze datasets (see Chapter 1). This is an exciting time for oncology as the overall goal of the precision medicine initiative is to focus on preventing and curing cancers (Ginsburg & Phillips, 2018).

Epidemiology

Cancer is a common health problem worldwide. In the United States, it was estimated in 2019 that more than 1,700,000 new cancer cases would be diagnosed, and that more than 600,000 Americans would die as a result of cancer (Siegel, Miller, & Jemal, 2019). Despite significant advances in science and technology, cancer is the second leading cause of death in the United States. The leading causes of cancer-related death in the United States in order of frequency and location are lung, prostate, and colorectal cancer in men and lung, breast, and colorectal cancer in women. Most cancer occurs in older adults; according to the American Cancer Society (ACS), 80% of all cancer diagnoses are in people 55 years of age or older (2019a). Overall, the incidence of cancer is slightly higher in women than in men (ACS, 2019a).

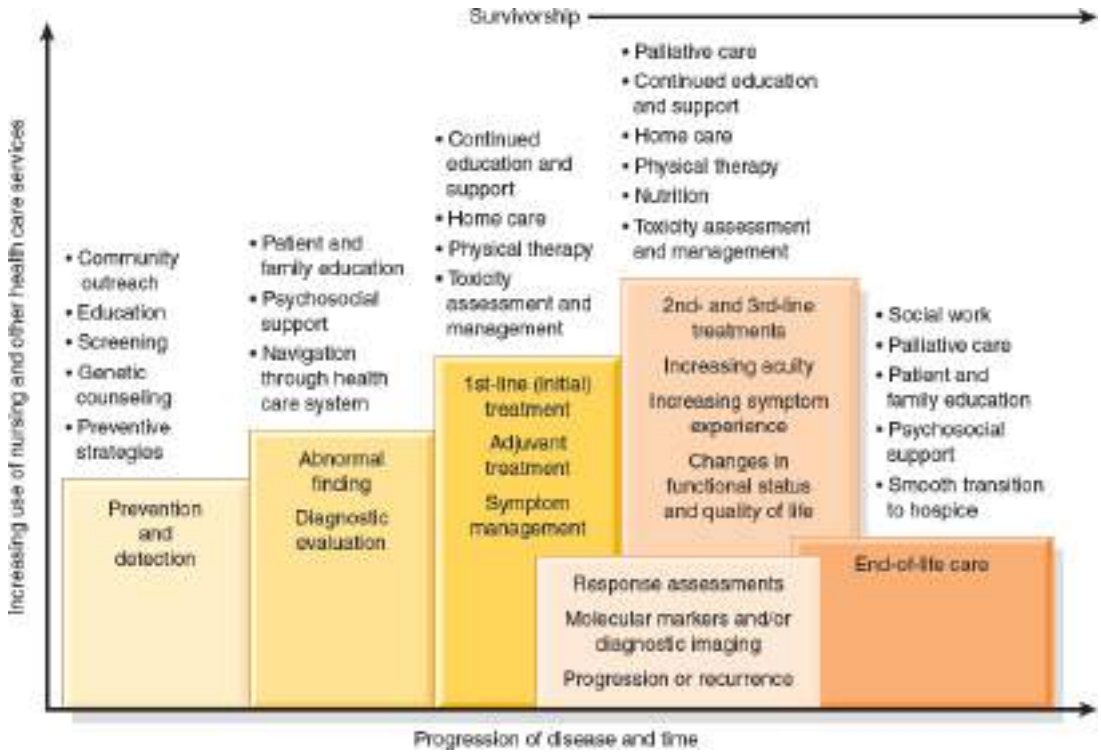

Figure 12-1 • Cancer care trajectory. The cancer care trajectory reflects the phases and care required during the continuum of the cancer experience from prevention and early detection through end-of-life care. Specialized nursing care is provided throughout the entire trajectory.

Cancer affects all groups of people; however, some groups are more adversely affected by cancer than others (National Cancer Institute [NCI], 2019a). Differences in cancer measures (e.g., incidence, screening rates, stage of diagnosis, morbidity, mortality) or cancer-related health conditions are termed *cancer health disparities*. These disparities often result from multiple, complex interrelated factors, including indicators of socioeconomic status (e.g., income, educational level, health care access), culture, diet, stress, the environment, and biology.

Cancer health disparities are most often observed among people of low-socioeconomic status, certain races/ethnicities, and those who reside in particular geographical locations (NCI, 2019a). For example, even though the overall rate of cancer deaths has declined, cancer death rates in non-Hispanic Black men and women remain substantially higher compared to all other racial and ethnic groups for most cancer types (DeSantis, Miller, Goding Sauer, et al., 2019). Hispanic/Latino Americans have a lower overall cancer incidence when compared to non-Hispanic White Americans; however, the incidence of infection-related cancers (e.g., liver cancer) is two times higher in those of Hispanic/Latino origin compared to non-Hispanic White Americans (Miller, Goding Sauer, Ortiz, et al., 2018).

Cancer incidence and death rates also vary by geography. In states where the prevalence of tobacco use is high (e.g., Kentucky), the incidence of lung cancer tends to be greater than in states where smoking is not as common (e.g., Utah) (Siegel et al., 2019). In locations where there is greater socioeconomic disparity, the incidence of cancer and overall cancer death rates are higher than in regions where there is not such a disparity (Siegel et al., 2019). For example, the incidence of cancers of the lung, colon and rectum, and cervix are substantially higher in Appalachian Ohio (southwestern region of the state) than in more affluent and more populated regions of the state (NCI, 2019a).

Pathophysiology of the Malignant Process

Cancer is a disease process that begins when a cell is transformed by genetic mutations of the cellular deoxyribonucleic acid (DNA). Genetic mutations may be inherited or acquired, leading to abnormal cell behavior (Norris, 2019). The initial genetically altered cell forms a clone and begins to proliferate abnormally, evading normal intracellular and extracellular growth-regulating processes or signals as well as the immune system defense mechanisms of the body. Genetic mutations may lead to abnormalities in cell signaling transduction processes (signals from outside and within cells that turn cell activities either on or off) that can in turn lead to cancer development. Ultimately cells acquire a variety of capabilities that allow them to invade surrounding tissues or gain access to lymph and blood vessels, which carry the cells to other areas of the body

resulting in **metastasis** or spread of the cancer (Pachmayr, Treese, & Stein, 2017).

Benign (noncancerous) and **malignant** (cancerous) cells differ in many cellular growth characteristics, including the method and rate of growth, ability to metastasize or spread, destruction of tissue, and ability to cause death. These differences are summarized in Table 12-1. The degree of **anaplasia** (a pattern of growth in which cells lack normal characteristics and differ in shape and organization with respect to their cells of origin) is associated with increased malignant potential.

TABLE 12-1 Characteristics of Benign and Malignant Cells

Characteristics	Benign	Malignant
Cell	Well-differentiated cells resemble normal cells of the tissue from which the tumor originated.	Cells are undifferentiated and may bear little resemblance to the normal cells of the tissue from which they arose.
Mode of growth	Tumor grows by expansion and does not infiltrate the surrounding tissues; usually encapsulated.	Grows at the periphery and overcomes contact inhibition to invade and infiltrate surrounding tissues
Rate of growth	Rate of growth is usually slow.	Rate of growth is variable and depends on level of differentiation; the more anaplastic the tumor, the faster its growth.
Metastasis	Does not spread by metastasis.	Gains access to the blood and lymphatic channels and metastasizes to other areas of the body or grows across body cavities such as the peritoneum.
General effects	Usually a localized phenomenon that does not cause generalized effects unless its location interferes with vital functions.	Often causes generalized effects, such as anemia, weakness, systemic inflammation, weight loss, and CACS.
Tissue destruction	Does not usually cause tissue damage unless its location interferes with blood flow.	Often causes extensive tissue damage as the tumor outgrows its blood supply or encroaches on blood flow to the area; may also produce substances that cause cell damage.
Ability to cause death	Does not usually cause death unless its location interferes with vital functions.	Eventually causes death unless growth can be controlled.

CACS, cancer-related anorexia-cachexia syndrome.

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Carcinogenesis

Understanding the pathophysiology of cancer involves knowledge of the molecular process and proliferation patterns of cancers as well as the numerous etiologic factors that induce the malignant transformation of cells.

Molecular Process

Malignant transformation, or **carcinogenesis**, is thought to be at least a three-step cellular process, involving initiation, promotion, and progression (Norris, 2019). Agents that initiate or promote malignant transformation are referred to as **carcinogens**. A complete carcinogen is an agent that both initiates and promotes the development of cancer (e.g., cigarette smoking, asbestos).

During *initiation,* carcinogens (substances that can cause cancer), such as chemicals, physical factors, or biologic agents, cause mutations in the cellular DNA. Normally, these alterations are reversed by DNA repair mechanisms or the changes initiate **apoptosis** (programmed cellular death) or cell senescence. Cells can escape these protective mechanisms with permanent cellular mutations occurring, but these mutations usually are not significant to cells until the second step of carcinogenesis.

During *promotion,* repeated exposure to promoting agents (co-carcinogens) causes proliferation and expansion of initiated cells with increased expression or manifestations of abnormal genetic information, even after long latency periods. Promoting agents are not mutagenic and do not need to interact with the DNA. Promotion is reversible if the promoting substance is removed (a key focus in the prevention of cancer). Latency periods for the promotion of cellular mutations vary with the type of agent, the dosage of the promoter, and the innate characteristics and genetic stability of the target cell.

During *progression,* the altered cells exhibit increasingly malignant behavior. These cells acquire the ability to stimulate **angiogenesis** (growth of new blood vessels that allow cancer cells to grow), to invade adjacent tissues, and to metastasize. Cellular oncogenes are responsible for vital cell functions, including proliferation and differentiation. Cellular proto-oncogenes, such as those for the epidermal growth factor receptor (EGFR), transcription factors such as *c-Myc,* or cell signaling proteins such as *Kirsten ras* (*KRAS*), act as "on switches" for cellular growth. Amplification of proto-oncogenes or overexpression of growth factors, such as epidermal growth factor (EGF), can lead to uncontrolled cell proliferation. Mutations that increase the activity of oncogenes also deregulate cell proliferation. Genetic alterations in the gene for *KRAS* have been associated with pancreatic, lung, and colorectal cancers (Mainardi, Mulero-Sánchez, Prahallad, et al., 2018). Just as proto-oncogenes "turn on" cellular growth, cancer suppressor genes "turn off," or regulate, unneeded cellular proliferation. When suppressor genes are mutated, resulting in loss of function or expression, the cells begin to produce mutant cell populations that are different from their

original cellular ancestors. See Chart 12-1 for further discussion of genetics concepts and cancer.

Proliferative Patterns

During the lifespan, various body tissues normally undergo periods of rapid or proliferative growth that must be distinguished from malignant growth activity. Several patterns of cellular adaptation include atrophy, hypertrophy, hyperplasia, metaplasia, and dysplasia (see Chapter 5, Fig. 5-4). Cancerous cells, described as malignant, demonstrate **neoplasia**, or uncontrolled cell growth that follows no physiologic demand. Although both benign and malignant growths are classified and named by tissue of origin, the *International Classification of Diseases for Oncology* (Fritz, Percy, Jack et al., 2013) is used by scientists and clinicians around the world as the nomenclature for malignant disease (see Table 12-2).

Etiology

Factors implicated or known to induce carcinogenesis include viruses and bacteria, physical agents, chemicals, genetic or familial factors, lifestyle factors, and hormones. Additional research is needed for a better understanding of the relationships among etiologic factors and cancer.

Viruses and Bacteria

It is estimated that 10% to 12% of all cancers worldwide are linked to viral infections (Lunn, Jahnke, & Rabkin, 2017). After infecting individuals, DNA viruses insert a part of their own DNA near the infected cell genes causing cell division. The newly formed cells that now carry viral DNA lack normal controls on growth. Examples of these viruses that are known to cause cancer include human papillomavirus (HPV) (cervical and head and neck cancers), hepatitis B virus (HBV) (liver cancer), and Epstein–Barr virus (EBV) (Burkitt lymphoma and nasopharyngeal cancer).

While there is little evidence to support a direct link between most bacteria and cancer, secondary responses to certain bacterial infections, such as the production of carcinogenic metabolites and inflammatory reactions, are suspected mechanisms of cancer development (van Elsland & Neefjes, 2018). Examples of bacteria that are associated with an increased risk of cancer include: *Helicobacter pylori* (stomach cancer), *Salmonella enteritidis* (colon cancer), and *Chlamydia trachomatis* (ovarian and cervical cancers).

Physical Agents

Physical factors associated with carcinogenesis include exposure to sunlight, radiation, chronic irritation or inflammation, tobacco carcinogens, industrial chemicals, and asbestos (ACS, 2019b).

Excessive exposure to the ultraviolet rays of the sun is associated with skin cancers in all individuals, although those with fair-skin are at highest risk.

Factors such as clothing styles (sleeveless shirts or shorts), the use of sunscreens, occupation, recreational habits, and environmental variables, including humidity, altitude, and latitude, all play a role in the amount of exposure to ultraviolet light (ACS, 2019c).

Chart 12-1 GENETICS IN NURSING PRACTICE

Genetics Concepts and Oncologic Disorders

Cancer is a genetic disease. Every phase of carcinogenesis is affected by multiple gene mutations. Some of these mutations are inherited (present in germ-line cells) and present a greater risk for a person to develop oncologic disorders; however, most (90%) are somatic mutations that are acquired mutations in specific cells. Examples of cancers influenced by genetics include:

Autosomal dominant:

- Breast and ovarian cancer
- Colorectal cancer
- Familial adenomatous polyposis
- Cowden syndrome
- Li–Fraumeni syndrome
- Lynch syndrome (hereditary nonpolyposis colon cancer)
- Multiple endocrine neoplasia types 1 and 2
- Neurofibromatosis types 1 and 2
- Prostate cancer
- Retinoblastoma
- Von Hippel–Lindau syndrome
- Wilms tumor

Autosomal recessive:

- Ataxia telangiectasis
- Endometrial cancer
- Gastrointestinal stromal tumor
- Familial melanoma syndrome
- Xeroderma pigmentosum

Nursing Assessments

Refer to Chapter 4, Chart 4-2: Genetics in Nursing Practice: Genetic Aspects of Health Assessment

Family History Assessment Specific to Oncologic Disorders

- Obtain information about both maternal and paternal sides of family for three generations.
- Obtain cancer history for at least three generations.
- Look for clustering of cancers that occur at young ages, multiple primary cancers in one individual, cancer in paired organs, and two or more close relatives with the same type of cancer suggestive of hereditary cancer syndromes.

Patient Assessment

- Assess for the following:
  - Physical findings that may predispose the patient to cancer, such as multiple colon polyps or the presence of more than one tumor. If a

tumor was previously diagnosed, inquire about the age of the patient when the first tumor was noted.
    - Skin findings, such as atypical moles, that may be related to familial melanoma syndrome.
    - Multiple *café-au-lait* spots, axillary freckling, and two or more neurofibromas associated with neurofibromatosis type 1.
    - Facial trichilemmomas, mucosal papillomatosis, multinodular thyroid goiter or thyroid adenomas, macrocephaly, fibrocystic breasts, and other fibromas or lipomas related to Cowden syndrome.
- Assess for lifestyle risks (e.g., smoking, obesity, alcohol use).
- Determine potential occupational or environmental hazards that may generate exposure to inhaled chemicals, gases, or other irritants (e.g., toxic metals, asbestos, radon).

Management Issues Specific to Oncologic Disorders

- Assess patient's understanding of genetics factors related to their cancer.
- Offer appropriate genetics information and resources.
- Refer for cancer risk assessment when a hereditary cancer syndrome is suspected so that patient and family can discuss inheritance risk with other family members and availability of genetic testing.
- Provide support to patients and families with known genetic test results for hereditary cancer syndromes. Refer to support groups as appropriate.
- Participate in the management and coordination of risk reduction measures for those with known gene mutations.

Genetics Resources Specific to Oncologic Disorders

American Cancer Society: www.cancer.org
National Cancer Institute: www.cancer.gov
See also Chapter 6, Chart 6-7 for additional components of genetic counseling.

Exposure to ionizing radiation from repeated diagnostic x-ray procedures or with radiation therapy used to treat disease can cause cancer (ACS, 2019c). Improved x-ray equipment minimizes the risk of extensive radiation exposure. Radiation therapy used in cancer treatment and exposure to radioactive materials at nuclear weapon manufacturing sites or nuclear power plants in the past have been associated with a higher incidence of leukemia, multiple myeloma, and cancers of the breast, thyroid, and other tissues. Background radiation from the natural decay processes that produce radon has also been associated with lung cancer. Ventilation is advised in homes with high levels of trapped radon to allow the gas to disperse into the atmosphere.

Chemical Agents

Most cancers are thought to be related to environmental factors (ACS, 2019b). Most hazardous chemicals produce their toxic effects by altering DNA structure. This can occur in body sites distant from that of initial chemical exposure.

Tobacco use is thought to be the single most lethal chemical carcinogen; it accounts for about 30% of all cancer-related deaths (ACS, 2019a). Cigarette smoking is strongly associated with 12 different cancer types including: cancers of the oral cavity and pharynx, larynx, lung, esophagus, pancreas, uterine cervix, kidney, bladder, stomach, colorectal, liver, and myeloid leukemia.

Environmental tobacco smoke (ETS), otherwise known as secondhand smoke, has been linked to lung cancer—even in people who never smoked (ACS, 2019d). Nonsmokers who were exposed to ETS in the home or workplace have about a 20% to 30% greater risk of developing lung cancer (Centers for Disease Control and Prevention [CDC], 2019). There is also some evidence that ETS may be linked with cancers of the larynx, pharynx, nasal sinuses, brain, bladder, rectum, stomach, and breast (ACS, 2019d).

Other combustible forms of tobacco, such as cigars, pipes, roll-your-own products, and water pipes (or hookah), are also associated with increased cancer risk (ACS, 2019d).

TABLE 12-2 Classification of Cancer by Tissue of Origin

Classification	Tissue of Origin	Characteristics	Term	Examples
Carcinoma	Epithelial • Glandular epithelium	Account for 80–90% of all cancers Organs or glands capable of secretion	Adenocarcinoma	Adenocarcinoma of the breast, lung, prostate
	• Squamous epithelium	Covers or lines all external and internal body surfaces	Squamous cell carcinoma	Squamous cell cancer of the skin, lung, esophagus
Sarcoma	Connective or Supportive • Bone	Most common form of cancer of the bone	Osteosarcoma	Osteosarcoma of the femur, humerus
	• Cartilage	Rare, arises from within bones	Chondrosarcoma	Chondrosarcoma of the femur, pelvis
	• Adipose	Arises from deep soft tissue	Liposarcoma	Liposarcoma of the retroperitoneum, thigh
	• Smooth muscle	Very rare	Leiomyosarcoma	Leiomyosarcoma of the uterus, intestines, stomach
	• Skeletal muscle	Most common in young children	Rhabdosarcoma	Rhabdosarcoma of the head and neck, limbs
	• Fibrous tissue	Often involves long or flat bones	Fibrosarcoma	Fibrosarcoma of the femur, ribs, mandible
	• Membranes lining body cavities	Most often related to asbestos exposure	Mesothelial sarcoma or mesothelioma	Mesothelioma of the pleura or peritoneum
	• Blood vessels	With liver involvement may be related to occupational exposure to vinyl chloride monomer	Angiosarcoma	Angiosarcoma of the liver, heart
Myeloma	Plasma cells	Produced by B-cell lymphocytes; plasma cells produce antibodies	Not applicable (N/A)	N/A
Lymphoma	Lymphocytes	Two main classifications; may involve lymph nodes or body organs	Non-Hodgkin lymphoma	B-cell lymphoma, T-cell lymphoma
			Hodgkin lymphoma	N/A
Leukemia	Hematopoietic cells in the bone marrow	May involve various cell lines produced in the bone marrow		
	• White blood cells (WBCs)	N/A	Myelogenous	Acute myelogenous leukemia
	• Lymphocytes	N/A	Lymphocytic	Acute lymphocytic leukemia
	• Red blood cells (RBCs)	Involves overproduction of RBCs and is associated with increased levels of WBCs and platelets; also risk of additional bone marrow disease	Erythremia	Polycythemia vera

Adapted from Fritz, A., Percy, C., Jack, A., et al.; World Health Organization. (2013). International classification of diseases for oncology (ICD-O)–3rd edition, 1st revision. Retrieved on 1/22/2019 at: codes.iarc.fr/home

Electronic nicotine delivery systems (ENDS) including e-cigarettes, e-pens, e-pipes, e-hookah and e-cigars have gained increased popularity as an alternative to tobacco. While ENDS do not contain tobacco, most contain nicotine, which is highly addictive, and other potentially harmful substances, such as volatile organic compounds, formaldehyde, and flavoring chemicals (ACS, 2019d). Given that ENDS are relatively new to the market, the long-term health effects of these products remain unknown.

Smokeless tobacco products, such as chewing tobacco, snuff and snus, used most often by young adults aged 18 to 25 years, are associated with an increased risk of oral, pancreatic, and esophageal cancer (ACS, 2019d; Lipari & Van Horn, 2017).

Many chemical substances found in the workplace are carcinogens or co-carcinogens (ACS, 2019e). In the United States, carcinogens are classified by two federal agencies: the National Toxicology Program of the Department of Health and Human Services (HHS) and the Environmental Protection Agency's (EPA) Integrated Risk Information System (IRIS) (CDC, 2017). The CDC established the National Institute for Occupational Safety and Health (NIOSH) to provide occupational exposure limits and guidelines for protection of the workforce as regulated by the Occupational Safety and Health Act of 1970 (U.S. EPA, 2017). The extensive list of suspected chemical substances continues to grow and includes aromatic amines and aniline dyes; pesticides and formaldehydes; arsenic, soot, and tars; asbestos; benzene; cadmium; chromium compounds; nickel and zinc ores; wood dust; beryllium compounds; and polyvinyl chloride (ACS, 2019e). Betel quid, which are chewed as stimulants in some cultures, are also included (ACS, 2019e; Chen, Mahmood, Mariottini, et al., 2017).

Genetics and Familial Factors

Almost every cancer type has been shown to run in families. This may be due to a combination of genetic, environmental, and lifestyle factors. Genetic factors play a fundamental role in cancer cell development. Cancer has been associated with extra chromosomes, too few chromosomes, or translocated chromosomes (NCI, 2019b).

Approximately 5% to 10% of cancers in adults display a pattern of cancers suggestive of a familial predisposition (NCI, 2019b). Hereditary cancer syndromes represent a cluster of cancers identified by a specific genetic alteration that is inherited across generations. In these families, the associated genetic mutation is found in all cells in the body (germline mutation) and represents an inherited susceptibility to cancer for all family members who carry the mutation.

There are more than 50 hereditary syndromes identified by scientists that may predispose individuals to develop certain cancers (NCI, 2019b). The hallmarks of families with a hereditary cancer syndrome include cancer in two or more first-degree relatives (the parent, sibling, or child of an individual), onset of

cancer in family members younger than 50 years, the same type of cancer in several family members, individual family members with more than one type of cancer, and a rare cancer in one or more family members. There is also evidence of an autosomal dominant inheritance pattern of cancers affecting several generations of a family (NCI, 2019b).

There have been considerable advances in the recognition of inherited cancer susceptibility syndromes and in the ability to isolate and identify the inherited genetic mutations responsible. These advances have enabled the appropriate identification of families at risk for certain syndromes. Examples include hereditary breast and ovarian cancer syndrome (*BRCA1* and *BRCA2*) and multiple endocrine neoplasia syndrome (*MEN1* and *MEN2*) (see Chart 12-1). Other cancers associated with familial inheritance syndromes include nephroblastomas, pheochromocytomas, and colorectal, stomach, thyroid, renal, prostate, and lung cancers (NCI, 2019b).

Lifestyle Factors

Lifestyle factors (e.g., obesity, alcohol intake, poor diet, physical inactivity) were estimated to account for 16% of all cancer cases and 18% of all cancer deaths in 2017 (Islami, Goding Sauer, Miller, et al., 2018). These lifestyle factors were second only to cigarette smoking as a major modifiable risk factor associated with both cancer development and cancer mortality.

The risk of cancer increases with long-term ingestion of carcinogens or co-carcinogens or the absence of protective substances in the diet. Dietary substances that appear to increase the risk of cancer include fats, alcohol, salt-cured or smoked meats, nitrate- and nitrite-containing foods, and red and processed meats (World Cancer Research Fund [WCRF], 2018). Heavy alcohol use increases the risk of cancers of the mouth, pharynx, larynx, esophagus, liver, colon, rectum, and breast (WCRF, 2018).

Obesity has been linked to the development of cancers of the breast (in postmenopausal women), colon and rectum, endometrium, esophagus, kidney, and pancreas (WCRF, 2018). Obesity may be also associated with an increased risk for cancers of the gallbladder, liver, ovary, and cervix, and for multiple myeloma, Hodgkin lymphoma, and aggressive forms of prostate cancer. While there is a clear relationship between obesity and cancer, the etiology of cancer in the context of obesity remains poorly understood (NCI, 2017). Several possible mechanisms have been suggested, however, including that excess fat may cause chronic inflammation resulting in DNA damage, increased levels of certain hormones (e.g., estrogen, insulin, adipokines), and disruptions in levels of cell growth regulators (e.g., mammalian target of rapamycin and AMP-activated protein kinase)—all of which may increase the development of certain types of cancer. Multiple studies have long linked a sedentary lifestyle and lack of regular exercise to cancer development (Cannioto, Etter, Guterman, et al., 2017; Cannioto, Etter, LaMonte, et al., 2018).

Hormonal Agents

Tumor growth may be promoted by disturbances in hormonal balance, either by the body's own (endogenous) hormone production or by administration of exogenous hormones (Norris, 2019). Cancers of the breast, prostate, ovaries, and endometrium are thought to depend on endogenous hormonal levels for growth. Prenatal exposure to diethylstilbestrol (a synthetic form of the female hormone estrogen) has long been recognized as a risk factor for clear cell adenocarcinoma of the lower genital tract (Huo, Anderson, Palmer, et al., 2017).

Hormonal changes related to the female reproductive cycle are also associated with cancer incidence. Early onset of menses before age 12 and delayed onset of menopause after age 55, null parity (never giving birth), and delayed childbirth after age 30 are all associated with an increased risk of breast cancer (Chen, 2019). Increased numbers of pregnancies are associated with a decreased incidence of breast, endometrial, and ovarian cancers.

Women who take estrogen after menopause appear to have a decreased risk of breast cancer, but an increased risk of developing endometrial cancers (NCI, 2018). Thus, estrogen replacement alone is not used in women who have not had a hysterectomy. Combination estrogen and progesterone therapy is linked to a higher risk of breast cancer. The longer the combined therapy is used, the higher the risk of developing breast cancer. However, the risk substantially decreases when therapy is discontinued (NCI, 2018).

Role of the Immune System

In humans, transformed cells arise on a regular basis, but are recognized by surveillance cells of the immune system that destroy them before cell growth becomes uncontrolled (immune surveillance) (Norris, 2019). When the immune system fails to identify and stop the growth of transformed cells, a tumor can develop and progress.

Patients who are immunocompromised have an increased incidence of cancer. Transplant recipients who receive immunosuppressive therapy to prevent rejection of the transplanted organ have an increased incidence of cancer (Norris, 2019). Patients with acquired immune deficiency syndrome (AIDS) have an increased incidence of Kaposi sarcoma and other cancers. Patients who were previously treated for one cancer are at increased risk for secondary cancers (Norris, 2019).

Normal Immune Responses

Through the process of immune surveillance, an intact immune system usually has the ability to recognize and combat cancer cells through multiple, interacting cells and actions of the innate, humoral, and cellular components of the immune system (Jameson, Fauci, Kasper, et al., 2018; Norris, 2019). Tumor-associated antigens (TAAs; also called *tumor cell antigens*) are found on the membranes of many cancer cells. TAAs are processed by antigen-presenting cells (APCs) (e.g.,

macrophages and dendritic cells [very specialized cells of the immune system] that present antigens to both T and B lymphocytes) and are presented to T lymphocytes that recognize the antigen-bearing cells as foreign. Multiple TAAs have been identified—some are found in many types of cancer, some exist in the normal tissues of origin as well as the cancer cells, some exist in both normal and cancer cells but are overexpressed (exist in higher concentrations) in cancer cells, and others are very specific to certain cancer types (Norris, 2019).

In response to recognizing TAAs as foreign, T lymphocytes release several cytokines that elicit various immune system actions, including (1) proliferation of cytotoxic (cell-killing) T lymphocytes capable of direct destruction of cancer cells, (2) induction of cancer cell apoptosis, and (3) recruitment of additional immune system cells (B-cell lymphocytes that produce antibodies, natural killer cells, and macrophages) that contribute to the destruction and degradation of cancer cells (Jameson et al., 2018; Norris, 2019).

Immune System Evasion

Several theories postulate how malignant cells survive and proliferate, evading the elaborate immune system defense mechanisms (Jameson et al., 2018; Norris, 2019). If the body fails to recognize the TAAs on cancer cells or the function of the APCs is impaired, the immune response is not stimulated. Some cancer cells have been found to have altered cell membranes that interfere with APC binding and presentation to T lymphocytes. Tumors can also express molecules that induce T-lymphocyte anergy or tolerance such as PD-1 ligand. These molecules bind to PD-1 proteins on T lymphocytes and either block the killing of the tumor or induce cell death in the lymphocyte. In addition, cancer cells have been found to release cytokines that inhibit APCs as well as other cells of the immune system. When tumors do not possess TAAs that label them as foreign, the immune response is not alerted. This allows the tumor to grow too large to be managed by normal immune mechanisms.

The immunogenicity (immunologic appearance) of cancer cells can be altered through genetic mutations, allowing the cells to evade immune cell recognition (Norris, 2019). Conversely, mutations are the source for some TAAs. Tumor antigens may combine with the antibodies produced by the immune system and hide or disguise themselves from normal immune defense mechanisms. The tumor antigen–antibody complexes that evade recognition lead to a false message to decrease further production of antibodies as well as other immune system components.

Overexpression (abnormally high concentrations) of host suppressor T lymphocytes induced through the release of cytokines by malignant cells is thought to downregulate the immune response, thus permitting uncontrolled cell growth (Jameson et al., 2018). Suppressor T lymphocytes normally assist in regulating lymphocyte production and diminishing immune responses (e.g., antibody production) when they are no longer required. Low levels of antibodies and high levels of suppressor cells have been found in patients with multiple

myeloma, which is a cancer associated with hypogammaglobulinemia (low amounts of serum antibodies). Conversely, there is evidence that proliferation of helper T lymphocytes, which promote the immune response, is impaired by cytokines produced by cancer cells (Jameson et al., 2018). Without helper T lymphocytes, the immune system response is limited, and the cancer cells continue to proliferate. Understanding the role of the immune system and identification of the ways in which cancer evades the body's natural defenses provide the foundation for therapeutic approaches that seek to support and enhance the immune system's role in combating cancer (see Chapter 31).

Detection and Prevention of Cancer

Nurses in all settings play a key role in cancer detection and prevention. Primary, secondary, and tertiary prevention of cancer are all important.

Primary Prevention

Primary prevention is about reducing the risks of disease through health promotion and risk reduction strategies. Guidelines on nutrition and physical activity for cancer prevention can be found in Chart 12-2.

An example of primary prevention is the use of immunization to reduce the risk of cancer through prevention of infections associated with cancer. The HPV vaccine is recommended to prevent cervical and head and neck cancers (Hashim, Genden, Posner, et al., 2019). The vaccine to prevent HBV infection is recommended by the CDC (2018) to reduce the risk of hepatitis and subsequent development of liver cancer.

Secondary Prevention

Secondary prevention involves screening and early detection activities that seek to identify precancerous lesions and early-stage cancer in individuals who lack signs and symptoms of cancer. ACS screening is advocated for many types of cancer (see Table 12-3) (ACS, 2018). Detection of cancer at an early stage may reduce costs, use of resources, and the morbidity associated with advanced stages of cancer and their associated complex treatment approaches. Many screening and detection programs target people who do not regularly practice health-promoting behaviors or lack access to health care. Nurses continue to develop community-based screening and detection programs that address barriers to health care or reflect the socioeconomic and cultural beliefs of the target population (Rees, Jones, Jones, et al., 2018; So, Kwong, Chen, et al., 2019).

The evolving understanding of the role of genetics in cancer cell development has contributed to prevention and screening efforts. Many centers offer cancer

risk evaluation programs that provide interdisciplinary in-depth assessment, screening, education, and counseling as well as follow-up monitoring for people at high risk for cancer (National Comprehensive Cancer Network [NCCN] 2019a,b). The NCI provides guidance for cancer risk assessment, counseling, education, and genetic testing (NCI, 2019b).

Chart 12-2 **HEALTH PROMOTION**

American Cancer Society Guidelines on Nutrition and Physical Activity for Cancer Prevention

Individual Choices

Achieve and Maintain a Healthy Weight Throughout Life

- Be as lean as possible throughout life without being underweight.
- Avoid excessive weight gain at all ages. For those who are currently overweight or have obesity, losing even a small amount of weight has health benefits and is a good place to start.
- Engage in regular physical activity and limit consumption of high-calorie foods and beverages as key strategies for maintaining a healthy weight.

Adopt a Physically Active Lifestyle

- Adults should engage in at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity physical activity each week, or an equivalent combination, preferably spread throughout the week.
- Children and adolescents should engage in at least 1 hour of moderate- or vigorous-intensity physical activity each day, with vigorous-intensity activity at least 3 days each week.
- Limit sedentary behavior such as sitting, lying down and watching television, and other forms of screen-based entertainment.
- Doing any intentional physical activity above usual activities, no matter what one's level of activity, can have many health benefits.

Consume a Healthy Diet, with an Emphasis on Plant Sources

- Choose foods and beverages in amounts that help achieve and maintain a healthy weight.
- Limit consumption of processed meat and red meats.
- Eat at least 2½ cups of vegetables and fruits each day.
- Choose whole grains in preference to processed (refined) grains.

If You Drink Alcoholic Beverages, Limit Consumption

- Drink no more than one drink per day for women or two per day for men.

Community Action

Public, private, and community organizations should work collaboratively at national, state, and local levels to implement policy environmental changes that:

- Increase access to affordable, healthy foods in communities, worksites, and schools, and decrease access to and marketing of foods and beverages of low nutritional value, particularly to youth.
- Provide safe, enjoyable, and accessible environments for physical activity in schools and worksites, and for transportation and recreation in communities.

Adapted from American Cancer Society. (2019i). ACS guidelines on nutrition and physical activity for cancer. Retrieved on 9/28/2018 at: Prevention www.cancer.org/healthy/eat-healthy-get-active/acs-guidelines-nutrition-physical-activity-cancer-prevention.html.

Unfolding Patient Stories: Doris Bowman • Part 1

Doris Bowman, a 39-year-old diagnosed with uterine fibroids, dysmenorrhea, and menorrhagia, is scheduled for a total abdominal hysterectomy with bilateral salpingoopherectomy. She has a family history of uterine and ovarian cancer. She asks the nurse what she can do to further reduce her risk for cancer and is also concerned for her family members. What patient and family education should the nurse present on risk reduction strategies, health promotion, and cancer screening? (Doris Bowman's story continues in Chapter 51.)

Care for Doris and other patients in a realistic virtual environment: vSim (**thepoint.lww.com/vSimMedicalSurgical**). Practice documenting these patients' care in DocuCare (**thepoint.lww.com/DocuCareEHR**).

Tertiary Prevention

Improved screening, diagnosis, and treatment approaches have led to an estimated 16.9 million cancer survivors in the United States (ACS, 2019f). Tertiary prevention efforts focus on monitoring for and preventing recurrence of the primary cancer as well as screening for the development of second malignancies in cancer survivors. Survivors are assessed for the development of second malignancies such as lymphoma and leukemia, which have been associated with certain chemotherapy agents and the use of radiation therapy (ACS, 2019f). Survivors may also develop second malignancies not related to treatment, but rather genetic mutations related to inherited cancer syndromes, environmental exposures, and lifestyle factors.

Diagnosis of Cancer

A cancer diagnosis is based on assessment of physiologic and functional changes and results of the diagnostic evaluation. Patients with suspected cancer undergo extensive testing to (1) determine the presence and extent of cancer, (2) identify possible disease metastasis, (3) evaluate the function of involved and uninvolved body systems and organs, and (4) obtain tissue and cells for analysis, including evaluation of tumor stage and grade. The diagnostic evaluation includes a review

of systems; physical examination; imaging studies; laboratory tests of blood, urine, and other body fluids; procedures; and pathologic analysis. A selection of diagnostic tests is found in Table 12-4.

Patients undergoing extensive testing may be fearful of the procedures and anxious about possible test results. Nurses help address the patient's fear and anxiety by explaining the tests to be performed, the sensations likely to be experienced, and the patient's role in the test procedures. The nurse encourages the patient and family to voice their fears about the test results, supports the patient and family throughout the diagnostic evaluation, and reinforces and clarifies information conveyed by the primary provider. The nurse also encourages the patient and family to communicate, share their concerns, and discuss their questions and concerns with one another.

Tumor Staging and Grading

A complete diagnostic evaluation includes identifying the stage and grade of the tumor. This is accomplished prior to treatment to provide baseline data for evaluating outcomes of therapy and to maintain a systematic and consistent approach to ongoing diagnosis and treatment. Cancer treatment options and prognosis are based on the cancer type; stage and grade of cancer; as well as the individual's health status and response to treatment (NCI, 2019c).

TABLE 12-3 American Cancer Society Screening Guidelines for the Early Detection of Cancer[a]

Cancer Site	Population	Test or Procedure	Recommendation
Breast	Women, ages 40–54	Mammography	Women should undergo regular screening mammography starting at age 45 yrs. Women ages 45–54 should be screened annually. Women should have the opportunity to begin annual screening between the ages of 40 and 44.
	Women age 55 and over	Mammography	Transition to biennial screening or can continue annual screening. Continue screening if overall health is good and life expectancy is 10+ yrs.
Cervix	Women, ages 21–29	Papanicolaou (Pap) test	Screening should be done every 3 yrs with conventional or liquid-based Pap tests. HPV DNA testing only for abnormal Pap test.
	Women ages 30–65 Women ages 66+	Pap test and HPV DNA test	Screening should be done every 5 yrs with both the HPV test and the Pap test (preferred), or every 3 yrs with the Pap test alone (acceptable). Women ages 66+ who have regular cervical cancer screening with negative results should stop cervical cancer screening. Women who have had a total hysterectomy should stop cervical cancer screening.
Colorectal[b]	Men and women, ages 45–75. People aged 76–84, should discuss continued screening with their provider. People 85+ should no longer participate in colorectal cancer screenings.	Highly sensitive guaiac-based fecal occult blood test (gFOBT) or highly sensitive fecal immunochemical test (FIT)	Annual highly sensitive gFOBT or FIT testing.
		Multi-targeted	MT-sDNA testing every 3 yrs.

		stool DNA test (MT-sDNA) test	
		Flexible sigmoidoscopy (FSIG), or	Every 5 yrs.
		Colonoscopy, or	Every 10 yrs.
		CT colonography (virtual colonoscopy)	Every 5 yrs.
Endometrial	Women, at menopause	At the time of menopause, women at average risk should be informed about risks and symptoms of endometrial cancer and encouraged to report any unexpected bleeding or spotting to their providers.	Not applicable (N/A)
Lung	Current or former smokers (quit within past 15 yrs) ages 55–74 in fairly good health with at least a 30 pack-year history.	Low-dose CT (LDCT)	LDCT annually. Providers with access to high-volume, high-quality lung cancer screening and treatment centers should initiate a discussion about lung cancer screening with apparently healthy patients aged 55–74 who have at least a 30 pack-year smoking history, and who currently smoke or have quit within the past 15 yrs. Patient has been involved in the process of informed and shared decision making with a provider related to the potential benefits, limitations, and harms associated with screening for lung cancer with LDCT should occur before any decision is made to initiate lung cancer screening. Smoking cessation counseling remains a high priority for clinical attention in discussions with current smokers, who should be informed of their continuing risk of lung cancer. Screening should not be

			viewed as an alternative to smoking cessation.
Prostate	Men, age 50+, African American Men, age 45+	Digital rectal examination (DRE) and prostate-specific antigen (PSA) test	Men who have at least a 10-yr life expectancy should have an opportunity to make an informed decision with their providers about whether to be screened for prostate cancer, after receiving information about the potential benefits, risks, and uncertainties associated with prostate cancer screening. Prostate cancer screening should not occur without an informed decision making process.
Cancer-related checkup	Men and women, age 20+	On the occasion of a periodic health examination, the cancer-related checkup should include examination for cancers of the thyroid, testicles, ovaries, lymph nodes, oral cavity, and skin, as well as health counseling about tobacco, sun exposure, diet and nutrition, risk factors, sexual practices, and environmental and occupational exposures.	N/A

CT, computed tomography; DNA, deoxyribonucleic acid; HPV, human papillomavirus.

[a]All individuals should become familiar with the potential benefits, limitations, and harms associated with cancer screening.

[b]All positive tests (other than colonoscopy) should be followed up with colonoscopy.

Adapted from American Cancer Society (ACS). (2018). American Cancer Society guidelines for the early detection of cancer. Retrieved on 7/5/2019 at: www.cancer.org/healthy/find-cancer-early/cancer-screening-guidelines/american-cancer-society-guidelines-for-the-early-detection-of-cancer.html

TABLE 12-4 Select Diagnostic Tests Used to Detect Cancer

Test	Description	Examples of Diagnostic Uses
Tumor marker identification	Analysis of biochemical mediators found in tumor tissue, blood, or other body fluids that are indicative of cancer cells or specific characteristics of cancer cells. These biochemical mediators may also be found in some normal body tissues.	Breast, colon, lung, ovarian, testicular, prostate cancers
Genetic tumor markers (also called prognostic indicators)	Analysis for the presence of mutations (alterations) in genes found in tumors or body tissues. Assists in diagnosis, selection of treatment, prediction of response to therapy, and risk of progression or recurrence.	Breast, lung, kidney, ovarian, brain cancers; leukemia; and lymphoma. Many uses of genetic profiling are considered investigational.
Mammography	Use of x-ray images of the breast.	Breast cancer
Magnetic resonance imaging (MRI)	Use of magnetic fields and radiofrequency signals to create sectioned images of various body structures.	Neurologic, pelvic, abdominal, thoracic, breast cancers
Computed tomography (CT) scan	Use of narrow-beam x-ray to scan successive layers of tissue for a cross-sectional view.	Neurologic, pelvic, skeletal, abdominal, thoracic cancers
Fluoroscopy	Use of x-rays that identify contrasts in body tissue densities; may involve the use of contrast agents.	Skeletal, lung, gastrointestinal cancers
Ultrasonography (ultrasound)	High-frequency sound waves echoing off body tissues are converted electronically into images; used to assess tissues deep within the body.	Abdominal and pelvic cancers
Endoscopy	Direct visualization of a body cavity or passageway by insertion of an endoscope into a body cavity or opening; allows tissue biopsy, fluid aspiration, and excision of small tumors. Used for diagnostic and therapeutic purposes.	Bronchial, gastrointestinal cancers
Nuclear medicine imaging	Uses IV injection or ingestion of radioisotopes followed by imaging of tissues that have concentrated the radioisotopes.	Bone, liver, kidney, spleen, brain, and thyroid cancers
Positron emission tomography (PET)	Through the use of a tracer, provides black-and-white or color-coded images of the biologic activity of a particular area, rather than its structure. Used in	Lung, colon, liver, pancreatic, head and neck cancers; Hodgkin and non-

	detection of cancer or its response to treatment.	Hodgkin lymphoma and melanoma
PET fusion	Use of a PET scanner and a CT scanner in one machine to provide an image combining anatomic detail, spatial resolution, and functional metabolic abnormalities.	See PET
Radioimmunoconjugates	Monoclonal antibodies are labeled with a radioisotope and injected IV into the patient; the antibodies that aggregate at the tumor site are visualized with scanners.	Colorectal, breast, ovarian, head and neck cancers; lymphoma and melanoma
Vascular imaging	Use of contrast agents that are injected into veins or arteries and monitored by fluoroscopy, CT, or MRI imaging in order to assess tumor vasculature. Used to assess tumor vascularity prior to surgical procedures.	Liver and brain cancers

Adapted from Fischbach, F. T., & Fischbach, M. A. (2018). *Fischbach's manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Wolters Kluwer Health.

Chart 12-3

TNM Classification System

T The extent of the primary tumor
N The absence or presence and extent of regional lymph node metastasis
M The absence or presence of distant metastasis
The use of numerical subsets of the TNM components indicates the progressive extent of the malignant disease.

Primary Tumor (T)

Tx Primary tumor cannot be assessed
T0 No evidence of primary tumor
Tis Carcinoma in situ
T1, T2, T3, T4 Increasing size or local extent of the primary tumor

Regional Lymph Nodes (N)

Nx Regional lymph nodes cannot be assessed
N0 No regional lymph node metastasis
N1, N2, N3 Increasing involvement of regional lymph nodes

Distant Metastasis (M)

Mx Distant metastasis cannot be assessed
M0 No distant metastasis
M1 Distant metastasis

Adapted from National Comprehensive Cancer Network (NCCN). (2019c). Cancer staging guide. Retrieved on 7/20/2019 at: www.nccn.org/patients/resources/diagnosis/staging.aspx

Staging describes the size of the tumor, the existence of local invasion, lymph node involvement, and distant metastasis. Several systems exist for classifying the anatomic extent of disease. The tumor, nodes, and metastasis (TNM) system (see Chart 12-3) is the most common system used to describe the stage of many solid tumors (Amin, Greene, Edge, et al., 2017; NCCN, 2019c).

Staging provides a common language used by health care providers and scientists to accurately communicate about cancer across clinical settings and in research. These systems also provide a convenient shorthand notation that condenses lengthy descriptions into manageable terms for comparisons of treatments and prognoses.

Grading is the pathologic classification of tumor cells (NCI, 2019c). Grading systems seek to define the type of tissue from which the tumor originated and the degree to which the tumor cells retain the functional and histologic characteristics of the tissue of origin (differentiation). Samples of cells used to establish the tumor grade may be obtained from tissue scrapings, body fluids, secretions, washings, biopsy, or surgical excision. This information helps providers predict the behavior and prognosis of various tumors. The grade corresponds with a numeric value ranging from I to IV. Grade I tumors, also

known as well-differentiated tumors, closely resemble the tissue of origin in structure and function. Tumors that do not clearly resemble the tissue of origin in structure or function are described as poorly differentiated or undifferentiated and are assigned grade IV. These tumors tend to be more aggressive, less responsive to treatment, and associated with a poorer prognosis as compared to well-differentiated, grade I tumors. Various staging and grading systems are used to characterize cancers.

Anatomic Stage Group

Once the diagnosis, clinical stage, and histologic grade have been determined, the anatomic stage group, designated by I through IV (representing increasing severity of disease), is assigned to facilitate communication, treatment decisions, and estimation of prognosis. The anatomic stage group is also useful for comparing clinical outcomes.

Management of Cancer

Treatment options offered to patients with cancer are based on treatment goals for each specific type, stage, and grade of cancer. The range of possible treatment goals includes cure, a complete eradication of malignant disease; control, which includes prolonged survival and containment of cancer cell growth; or **palliation,** which involves relief of symptoms associated with the disease and improvement of quality of life. Treatment approaches are not initiated until the diagnosis of cancer has been confirmed and staging and grading have been completed.

The health care team and the patient and family must have a clear understanding of the treatment options and goals. Open communication and support are vital as those involved periodically reassess treatment plans and goals when complications of therapy develop or disease progresses.

Multiple modalities are commonly used in cancer treatment. Various approaches, including surgery, radiation therapy, chemotherapy, hematopoietic stem cell transplantation (HSCT), immunotherapy, and targeted therapy may be used together or at different times throughout treatment. Understanding the principles of each and how they interrelate is important in understanding the rationale and goals of treatment.

Surgery

Surgical removal of the entire cancer remains the ideal and most frequently used treatment method. However, the specific surgical approach may vary for several reasons. Diagnostic surgery is the definitive method for obtaining tissue to identify the cellular characteristics that influence all treatment decisions. Surgery

may be the primary method of treatment, or it may be prophylactic, palliative, or reconstructive.

Diagnostic Surgery

Diagnostic surgery, or biopsy, is performed to obtain a tissue sample for histologic analysis of cells suspected to be malignant. In most instances, the biopsy is taken from the actual tumor; however, in some situations, it is necessary to take a sample of lymph nodes near a suspicious tumor. Many cancers can metastasize from the primary site to other areas of the body through the lymphatic circulation. Knowing whether adjacent lymph nodes contain tumor cells helps the health care team plan the best therapeutic approach to combat cancer that has spread beyond the primary tumor site. The use of injectable dyes and nuclear medicine imaging can help identify the sentinel lymph node or the initial lymph node to which the primary tumor and surrounding tissue drain. Sentinel lymph node biopsy (SLNB), also known as sentinel lymph node mapping, is a minimally invasive surgical approach that in many instances has replaced lymphadenectomy (more invasive lymph node dissections) and the associated complications such as lymphedema and delayed healing. SLNB has been widely adopted for regional lymph node staging in selected cases of melanoma and breast cancer (NCCN, 2019d, 2019e).

Biopsy Types

Biopsy methods include excisional, incisional, and needle biopsy. The biopsy type is determined by the size and location of the tumor, the type of treatment anticipated if the cancer diagnosis is confirmed, and the need for surgery and general anesthesia. The biopsy method that allows for the least invasive approach while permitting the most representative tissue sample is chosen. Diagnostic imaging techniques can be used to assist in locating the suspicious lesion and to facilitate accurate tissue sampling. The patient and family are provided the opportunity and time to discuss the options before definitive plans are made.

Excisional biopsy is used for small, easily accessible tumors. In many cases, the surgeon can remove the entire tumor as well as the surrounding marginal tissues. The removal of normal tissue beyond the tumor area decreases the possibility that residual microscopic malignant cells may lead to a recurrence of the tumor. This approach not only provides the pathologist with the entire tissue specimen for the determination of stage and grade but also decreases the chance of seeding tumor cells (disseminating cancer cells throughout surrounding tissues).

Incisional biopsy is performed if the tumor mass is too large to be removed. In this case, a wedge of tissue from the tumor is removed for analysis. The cells of the tissue wedge must be representative of the tumor mass so that the pathologist can provide an accurate diagnosis. If the specimen does not contain

representative tissue and cells, negative biopsy results do not guarantee the absence of cancer.

Excisional and incisional approaches are often performed through endoscopy. However, a surgical procedure may be required to determine the anatomic extent or stage of the tumor. For example, a diagnostic or staging laparotomy (the surgical opening of the abdomen to assess malignant abdominal disease) may be necessary to assess malignancies such as gastric or colon cancer.

Needle biopsy is performed to sample suspicious masses that are easily and safely accessible, such as some masses in the breasts, thyroid, lung, liver, and kidney. Needle biopsies are most often performed on an outpatient basis. They are fast, relatively inexpensive, easy to perform, and may require only local anesthesia. In general, the patient experiences slight and temporary physical discomfort. In addition, the surrounding tissues are minimally disturbed, thus decreasing the likelihood of seeding cancer cells. Fine-needle aspiration (FNA) biopsy involves aspirating cells rather than intact tissue through a needle that is guided into a suspected diseased area. This type of specimen can only be analyzed by cytologic examination (viewing only cells, not tissue). Often, x-ray, computed tomography (CT) scanning, ultrasonography, or magnetic resonance imaging (MRI) is used to help locate the suspicious area and guide placement of the needle. FNA does not always yield enough material to permit accurate diagnosis, necessitating additional biopsy procedures. A core needle biopsy uses a specially designed needle to obtain a small core of tissue that permits histologic analysis. Most often, this specimen is sufficient to permit accurate diagnosis.

Surgery as Primary Treatment

When surgery is the primary approach in treating cancer, the goal is to remove the entire tumor or as much as is feasible (a procedure sometimes called *debulking*) as well as any involved surrounding tissue, including regional lymph nodes.

Two common surgical approaches used for treating primary tumors are local and wide excisions. Local excision, often performed on an outpatient basis, is warranted when the mass is small. It includes removal of the mass and a small margin of normal tissue that is easily accessible. Wide or radical excisions (en bloc dissections) include removal of the primary tumor, lymph nodes, adjacent involved structures, and surrounding tissues that may be at high risk for tumor spread. This surgical method may result in disfigurement and altered functioning, necessitating rehabilitation, reconstructive procedures, or both. However, wide excisions are considered if the tumor can be removed completely and the chances of cure or control are good.

Minimally invasive surgical techniques are increasingly replacing traditional surgery associated with large incisions for a variety of cancers (Yarbro, Wujcik, & Gobel, 2018). Advantages of minimally invasive approaches include less

surgical trauma, decreased blood loss, decreased incidence of wound infection and other complications associated with surgery, decreased surgical time and requirement for anesthesia, decreased postoperative pain and limited mobility, and shorter periods of recovery (Pache, Hübner, Jurt, et al., 2017).

Endoscopic surgery, an example of minimally invasive surgery, uses an endoscope with intense lighting and an attached multichip mini camera that is inserted into the body through a small incision. The surgical instruments are inserted into the surgical field through one or two additional small incisions, each about 1 to 2 cm in length. The camera transmits the image of the involved area to a monitor so that the surgeon can manipulate the instruments to perform the necessary procedure. Endoscopic surgery is used to treat many cancer-related conditions of the thorax (thoracoscopy) and abdomen (laparoscopy).

The use of robotics is another advancement in the surgical treatment of cancer (Yarbro, et al., 2018). The use of robotics during laparoscopic procedures permits the removal of tumors with more precision and dexterity than could be accomplished by laparoscopic surgery alone. Laparoscopic robotic-assisted surgery has been used to treat cancers of the colon, prostate and uterus; however, it remains unclear if long-term cancer-related outcomes are improved with robotic surgery when compared to more conventional surgical approaches (U.S. Food and Drug Administration [FDA], 2019).

Salvage surgery is an additional treatment option that uses an extensive surgical approach to treat the local recurrence of cancer after the use of a less extensive primary approach. Mastectomy to treat recurrent breast cancer after primary lumpectomy and radiation is an example of salvage surgery.

Surgery may completely excise limited areas of metastatic disease (referred to as oligometastatic disease) as well. An example would be colon cancer with one to three small areas of liver metastasis and no evidence of cancer elsewhere. In the past, patients with recurrent or metastatic disease were treated with palliation only as their disease was considered incurable. However, evidence now suggests that there is a possibility of a cure or prolonged survival for select subgroups of patients with certain cancer types (Jang, Kim, Jeong, et al., 2018; Ruiz, Sebagh, Wicherts, et al., 2018).

In addition to surgery that uses surgical blades or scalpels to excise the mass and surrounding tissues, several other types of techniques are available. Table 12-5 provides examples of select techniques.

A multidisciplinary approach to patient care is essential for the patient undergoing cancer-related surgery. The effects of surgery on the patient's body image, self-esteem, and functional abilities are addressed. If necessary, a plan for postoperative rehabilitation is made before the surgery is performed. The growth and dissemination of cancer cells may have produced distant micrometastases by the time the patient seeks treatment. Therefore, attempting to remove wide margins of tissue in the hope of "getting all the cancer" may not be feasible. This reality substantiates the need for a coordinated multidisciplinary approach to cancer therapy.

Once the surgery has been completed, one or more additional (or adjuvant) modalities may be chosen to increase the likelihood of eradicating the remaining microscopic cancer cells that are undetectable by available diagnostic procedures. However, some cancers that are treated surgically in the very early stages (e.g., skin and testicular cancers) are curable without additional therapy.

TABLE 12-5 Select Techniques Used for Localized Destruction of Tumor Tissue

Type of Procedure	Description	Examples of Use
Chemosurgery	Use of chemicals or chemotherapy applied directly to tissue to cause destruction.	Intraperitoneal chemotherapy for ovarian cancer involving the abdomen and peritoneum.
Cryoablation	Use of liquid nitrogen or a very cold probe to freeze tissue and cause cell destruction.	Cervical, prostate, and rectal cancers.
Electrosurgery	Use of an electric current to destroy tumor cells.	Basal and squamous cell skin cancers.
Laser surgery	Use of light and energy aimed at an exact tissue location and depth to vaporize cancer cells (also referred to as photocoagulation or photoablation).	Dyspnea associated with endobronchial obstructions.
Photodynamic therapy	Intravenous (IV) administration of a light-sensitizing agent (hematoporphyrin derivative) that is taken up by cancer cells, followed by exposure to laser light within 24–48 h; causes cancer cell death.	Palliative treatment of dysphagia associated with esophageal and dyspnea associated with endobronchial obstructions.
Radiofrequency ablation (RFA)	Uses localized application of thermal energy that destroys cancer cells through heat: temperatures exceed 50°C (122°F).	Nonresectable liver tumors, pain control with bone metastasis.

Adapted from DeVita, V. T., Rosenberg S. A., & Lawrence, T. S., (Eds.). (2018). *Cancer: Principles & practice of oncology* (11th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

TABLE 12-6 Types of Palliative Surgery and Interventions

Procedure	Indications
Abdominal shunt placement	Ascites
Biliary stent placement	Biliary obstruction
Bone stabilization	Displaced bone fracture related to metastatic disease
Colostomy or ileostomy	Bowel obstruction
Cordotomy	Pain
Epidural catheter placement (for administering epidural analgesics)	Pain
Excision of solitary metastatic lesion	Metastatic lung, liver, or brain lesion
Gastrostomy, jejunostomy tube placement	Upper gastrointestinal tract obstruction
Hormone manipulation (removal of ovaries, testes, adrenals, pituitary)	Tumors that depend on hormones for growth
Nerve block	Pain
Percutaneous enteral gastrostomy (PEG) tube placement	Enteral nutrition
Pericardial drainage tube placement	Pericardial effusion
Peritoneal drainage tube placement	Ascites
Pleural drainage tube placement	Pleural effusion
Ureteral stent placement	Ureteral obstruction
Venous access device placement (for administering parenteral analgesics)	Pain

Prophylactic Surgery

Prophylactic or risk reduction surgery involves removing nonvital tissues or organs that are at increased risk of developing cancer. The following factors are considered when discussing possible prophylactic surgery:

- Family history and genetic predisposition
- Presence or absence of signs and symptoms
- Potential risks and benefits
- Ability to detect cancer at an early stage
- Alternative options for managing increased risk
- The patient's acceptance of the postoperative outcome

Colectomy, mastectomy, and oophorectomy are examples of prophylactic surgeries. Identification of genetic markers indicative of inherited cancer syndromes or a predisposition to develop some types of cancer plays a role in decisions concerning prophylactic surgeries. However, what is adequate justification for prophylactic surgery remains controversial. For example, several

factors are considered when deciding to proceed with a prophylactic mastectomy, including a family history of breast cancer; positive *BRCA1* or *BRCA2* findings; severity of overall breast cancer risk; a personal history of breast cancer; and individual factors (e.g., younger age, psychological well-being that may influence the patient's decision making process) (Chagpar, 2018; Schott, Vetter, Keller, et al., 2017). Prophylactic surgery is discussed with patients and families along with other approaches for managing increased risk of cancer development. Preoperative education and counseling, as well as long-term follow-up, are provided.

Palliative Surgery

The overall goal of palliative surgery in cancer care is to relieve symptoms and to improve the patient's quality of life (Fahy, 2019; Hanna, Blazer, & Mosca, 2012). Palliative surgery is often performed in an attempt to relieve symptoms such as ulceration, obstruction, hemorrhage, pain, and malignant effusions (see Table 12-6). When surgical cure is not possible, honest and informative communication with the patient and family about the goal of palliative surgery is essential to avoid false hope and disappointment. In certain cases, however, surgical intervention with palliative intent may also be performed as a supportive treatment to relieve symptoms along with other potentially curative cancer treatments (Fahy, 2019; Hanna et al., 2012). Thus, the role of palliative surgery today is no longer limited to end-of-life care.

Reconstructive Surgery

Reconstructive surgery may follow curative or extensive surgery in an attempt to improve function or obtain a more desirable cosmetic effect. It may be performed in one operation or in stages. The surgeon who will perform the surgery discusses possible reconstructive surgical options with the patient before the primary surgery is performed. Reconstructive surgery may be indicated for breast, head and neck, and skin cancers.

The nurse assesses the patient's needs and the impact that altered functioning and body image may have on quality of life. Nurses provide patients and families with opportunities to discuss these issues. The individual needs of the patient undergoing reconstructive surgery and their families must be accurately recognized and addressed.

Nursing Management

Patients undergoing surgery for cancer require general perioperative nursing care (see Chapters 14, 15, and 16). Surgical care is individualized according to age, organ impairment, specific deficits, comorbidities, cultural implications, and altered immunity. Combining other treatment methods, such as radiation and

chemotherapy, with surgery also contributes to postoperative complications, such as infection, impaired wound healing, altered pulmonary or renal function, and the development of venous thromboembolism (VTE). The nurse completes a thorough preoperative assessment for factors that may affect the patient undergoing the surgical procedure.

Preoperatively, the nurse provides the patient and family with verbal and written information about the surgical procedure as well as other interventions that may take place intraoperatively (e.g., radiation implants). Instructions concerning prophylactic antibiotic requirements, diet, and bowel preparation are also provided.

Patients who are undergoing surgery for the diagnosis or treatment of cancer may be anxious about the surgical procedure, possible findings, postoperative limitations, changes in normal body functions, and prognosis. The patient and family require time and assistance to process this information, possible changes, and expected outcomes resulting from the surgery.

The nurse serves as the patient advocate and liaison and encourages the patient and family to take an active role in decision making when possible. If the patient or family asks about the results of diagnostic testing and surgical procedures, the nurse's response is guided by the information that was conveyed previously. The nurse may be asked to explain and clarify information for patients and families that was provided initially but was not grasped because of intense anxiety. It is important that the nurse, as well as other members of the health care team, provide information that is consistent.

Postoperatively, the nurse assesses patient responses to surgery and monitors the patient for possible complications, such as infection, bleeding, thrombophlebitis, wound dehiscence, fluid and electrolyte imbalance, and organ dysfunction. The nurse also provides for the patient's comfort. Postoperative education addresses wound care, pain management, activity, nutrition, and medication information.

Plans for discharge, follow-up, home care, and subsequent treatment and rehabilitation are initiated as early as possible to ensure continuity of care from hospital to home or from a cancer referral center to the patient's local hospital and health care provider. Patients and families are encouraged to use community resources such as the ACS for support and information (see the Resources section at the end of this chapter).

Radiation Therapy

Approximately 60% of patients with cancer receive **radiation therapy** at some point during treatment (Halperin, Wazer, Perez, et al., 2019). Radiation may be used to cure cancer, as in thyroid carcinomas, localized cancers of the head and neck, and cancers of the cervix. Radiation therapy may also be used to control cancer when a tumor cannot be removed surgically or when local nodal metastasis is present. Neoadjuvant (prior to local definitive treatment) radiation

therapy, with or without chemotherapy, is used to reduce tumor size in order to facilitate surgical resection. Radiation therapy may be given prophylactically to prevent local recurrence or spread of microscopic cells from the primary tumor to a distant area (e.g., irradiating the breast and axilla following lumpectomy or mastectomy for breast cancer). Palliative radiation therapy is used to relieve the symptoms of locally advanced or metastatic disease, especially when the cancer has spread to the brain, bone, or soft tissue, or to treat oncologic emergencies, such as superior vena cava syndrome, bronchial airway obstruction, or spinal cord compression.

Two types of ionizing radiation—electromagnetic radiation (x-rays and gamma rays) and particulate radiation (electrons, beta particles, protons, neutrons, and alpha particles)—can be used to kill cells. The most lethal damage is the direct alteration of the DNA molecule within the cells of both malignant and normal tissues. Ionizing radiation can directly break the strands of the DNA helix, leading to cell death. It can also indirectly damage DNA through the formation of free radicals. If the DNA cannot be repaired, the cell may die immediately or may initiate apoptosis (Yarbro et al., 2018).

Replicating cells are most vulnerable to the disruptive effects of radiation (during DNA synthesis and mitosis, e.g., early S, G_2, and M phases of the cell cycle; see Fig. 12-2). Therefore, those body tissues that undergo frequent cell division are most sensitive to radiation therapy. These tissues include bone marrow, lymphatic tissue, epithelium of the gastrointestinal tract, hair follicles, and gonads. Slower-growing tissues and tissues at rest (e.g., muscle, cartilage, nervous system, connective tissues) are relatively radioresistant (less sensitive to the effects of radiation). However, it is important to remember that radiation therapy is localized treatment, and only the tissues that are within the treatment field are affected.

A radiosensitive tumor is one that can be destroyed by a dose of radiation that still allows for cell repair and regeneration in the surrounding normal tissue. If the radiation is delivered when most tumor cells are cycling through the cell cycle, the number of cancer cells destroyed (cell kill) is maximal. Radiation sensitivity is enhanced in tumors that are smaller in size and that contain cells that are rapidly dividing (highly proliferative) and poorly differentiated (no longer resembling the tissue of origin).

Radiation Dosage

The radiation dosage depends on the sensitivity of the target tissues to radiation, the size of the tumor, radiation tolerance of the surrounding normal tissues, and critical structures adjacent to the tumor target. The lethal tumor dose is defined as the dose that will eradicate 95% of the tumor yet preserve normal tissue. In external-beam radiation therapy (EBRT), the total radiation dose is delivered over several weeks in daily doses called *fractions*. This allows healthy tissue to repair and achieves greater cell kill by exposing more cells to the radiation as

they begin active cell division. Repeated radiation treatments over time (fractionated doses) also allow for the periphery of the tumor to be reoxygenated repeatedly, because tumors shrink from the outside inward. This increases the radiosensitivity of the tumor, thereby increasing tumor cell death (Morgan, Ten Haken, & Lawrence, 2018). Newer approaches take advantage of increased radiation beam conformality (better tumor targeting) to administer radiation in fewer doses with larger fractions sizes (hypo-fractionation and stereotactic body radiotherapy [SBRT]).

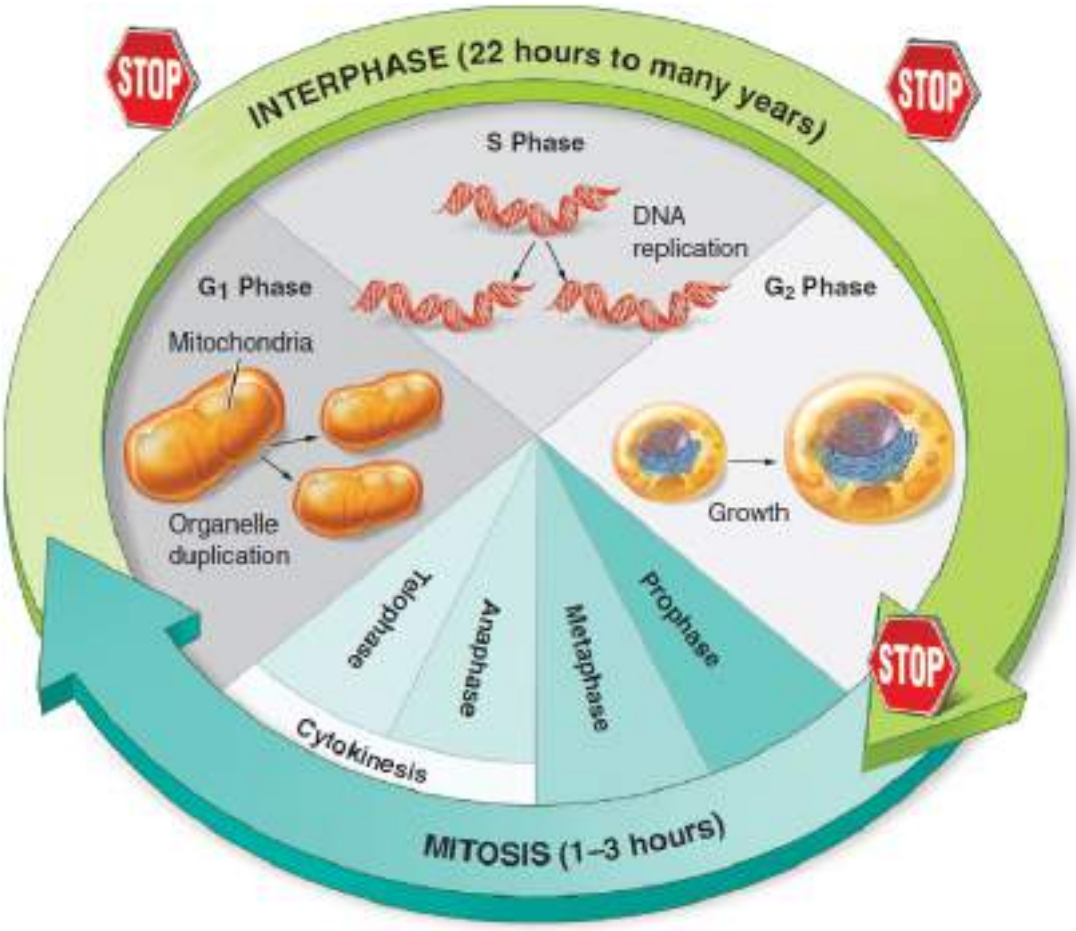

Figure 12-2 • Cell cycle. The cell cycle's four steps are illustrated beginning with G_1 and proceeding to M. The first growth phase (G_1), DNA synthesis phase (S), second growth phase ($G_{2)}$, and mitosis (M) are illustrated. Reprinted with permission from Grossman, S. G., & Porth, C. M. (2014). *Porth's pathophysiology: Concepts of altered health states* (9th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Administration of Radiation

Radiation therapy can be given in various ways depending on the source of radiation used, the location of the tumor, and the type of cancer. The primary

radiotherapy modalities include EBRT, **brachytherapy** (a form of internal radiation), systemic (radioisotopes), and contact or surface molds.

External Radiation

EBRT is the most commonly used form of radiation therapy. The energy utilized in EBRT is generated either from a linear accelerator or from a unit that generates energy directly from a core source of radioactive material such as a GammaKnife™ unit. Through computerized software programs, both approaches can shape an invisible beam of highly charged photons or gamma rays to penetrate the body and target the tumor with pinpoint accuracy.

Advances in computer technology allow multiple imaging modalities (CT, MRI, and PET scans) to be used to provide three-dimensional images of the tumor, neighboring tissues at risk for microscopic spread, and surrounding normal tissues or organs at risk for radiation-induced injury. These images, referred to as volumetric images, allow the radiation oncologist to plan for multiple radiation beams directed from different angles and different planes so that the beams conform precisely around the tumor (referred to as conformal radiation). The dose of radiation that reaches the surrounding normal tissues is reduced, leading to much less tissue injury than in older forms of radiation therapy (Halperin et al., 2019). Treatment enhancements in EBRT include the ability to control different intensity or energy levels of radiation beams at different angles directed at the tumor, a process known as intensity-modulated radiation therapy (IMRT), which enables higher doses to be delivered to the tumor while sparing the important healthy structures surrounding the tumor (Halperin et al., 2019). IMRT can be given as standard daily fractions or as "hyperfractionated" twice-daily fractions, which shortens the duration of the patient's treatment schedule. Image-guided radiation therapy (IGRT) uses continuous monitoring of the tumor with ultrasound, x-ray, or CT scans during the treatment to allow for automatic adjustment of the beams as the tumor changes shape or position in an effort to spare the healthy surrounding tissue and reduce side effects. Additional treatment enhancements include respiratory gating, where the treatment delivery is synchronized with the patient's respiratory cycle, enabling the beam to be adjusted as the tumor or organ moves. These treatment advancements improve tumor destruction while reducing acute and long-term toxicities (Halperin et al., 2019).

Gamma rays generated from the spontaneous decay of naturally occurring solid source of radioactivity, such as cobalt-60, are one of the oldest forms of EBRT. With the advent of modern linear accelerators, the use of solid radioactive elements is confined primarily to the GammaKnife™ stereotactic radiosurgery unit, which is used as a one-time, high-dose delivery of EBRT for treatment of both benign and malignant intracranial lesions.

SBRT is another form of EBRT that uses higher doses of radiation to penetrate very deeply into the body to control deep-seated tumors that cannot be treated by other approaches such as surgery. SBRT is delivered with

considerably higher treatment fraction doses over a short span of time, usually 1 to 5 treatment days, in contrast to daily treatments for 5 days per week for 6 to 8 weeks for conventional EBRT. Specialized linear accelerators with the capability of robotically moving around the patient are used to deliver SBRT, such as the CyberKnife™, Trilogy™, and TomoTherapy™ delivery systems, which are now more commonly available.

Proton therapy is another approach to EBRT. Proton therapy utilizes high linear energy transfer (LET) in the form of charged protons generated by a large magnetic unit called a *cyclotron.* The advantage of proton therapy is that it is capable of delivering its high-energy dose to a deep-seated tumor, with decreased doses of radiation to the tissues in front of the tumor while virtually no energy exits through the patient's healthy tissue behind the tumor (Halperin et al., 2019). Proton therapy permits treatment of deep tumors near critical structures, such as the heart or major blood vessels.

Internal Radiation

Internal radiation includes localized implantation or systemic radionuclide administration. Brachytherapy delivers the dose of radiation to a localized area while systemic radiotherapy relies on strategies for getting the radionuclides closer to the tumor. The specific radioisotope used is selected based on its half-life, which is the time it takes for half of its radioactivity to decay, and the depth of penetration of the radiation.

Brachytherapy

Brachytherapy is the placement of radioactive sources within or immediately next to the cancer site in order to provide a highly targeted, intense dose of radiation beyond a dose that is usually provided by EBRT. In addition, this form of radiation delivery helps to spare exposure to normal surrounding tissue. The radiation source can be implanted by means of needles or rods, seeds, beads, ribbons, or catheters placed into body cavities (vagina, abdomen, pleura), lumens within organs, or interstitial tissue compartments (breast, prostate). Multiple imaging techniques such as ultrasound, CT, or MRI are used to guide placement of radiation sources. Patients may have many fears or concerns about internal radiation, and the nurse explains the various approaches and safety precautions that will be used to protect the patient, family, and health care staff.

Brachytherapy may be delivered as a temporary or a permanent implant. Temporary applications are delivered as high-dose radiation (HDR) for short periods of time, while low-dose radiation (LDR) is delivered over a more extended period. The primary advantage of HDR brachytherapy is that treatment time is shorter, there is reduced exposure to personnel, and the procedure can be performed on an outpatient basis over several days. HDR brachytherapy can be used for intraluminal, surface, interstitial, and intracavitary lesions. Intraluminal HDR brachytherapy involves the insertion of catheters or hollow tubes into the lumens of organs so that the radioisotope can be delivered as close to the tumor

bed as possible. Lesions in the bronchus, esophagus, rectum, or bile duct can be treated with this approach. Contact or surface application is used for treatment of tumors of the eye, such as retinoblastoma in children or ocular melanoma in adults.

Interstitial HDR implants, used in treating such malignancies as prostate, pancreatic, or breast cancer, may be temporary or permanent, depending on the site and radioisotope used. Based on the dose to be delivered (LDR or HDR), the implants may consist of seeds, needles, wires, strands, or small catheters positioned to provide a local radiation source. Prostate HDR therapy is one form of interstitial brachytherapy, in which radioactive strands or wires are placed, while the patient is under anesthesia, into hollow catheters that have been inserted in the perineum close to the prostate gland (Halperin et al., 2019).

Intracavitary radioisotopes are used to treat gynecologic cancers. In these malignancies, the radioisotopes are inserted into specially positioned applicators within the vagina. The applicator placement is verified by x-ray. Treatment can be achieved with either HDR or LDR brachytherapy sources, depending on the extent of disease. LDR therapy requires hospitalization because the patient is treated over several days. HDR intraoperative radiotherapy (IORT) has been used as a treatment approach for advanced gynecologic cancer that has spread to the paraaortic area or pelvic wall (Krengli, Pisani, Deantonio, et al., 2017).

Systemic radiotherapy (radiopharmaceutical therapy) involves oral or intravenous (IV) administration of a therapeutic radioactive isotope targeted to a specific tumor. Radioactive iodine (I-131) is a widely used form of systemic brachytherapy that is the primary treatment for thyroid cancer (Divgi, 2018). Radium-223 dichloride selectively targets prostate cancer bone metastases with high-energy, short-range alpha particles and is approved for the treatment of patients with symptomatic bone metastases and no known visceral metastatic disease (NCCN, 2019f). Radioisotopes are also used as a form of radioimmunotherapy for the treatment of refractory non-Hodgkin lymphoma (see Chapter 30 for more information on lymphoma).

Toxicity

A **toxicity** is an unfavorable and unintended sign, symptom, or condition associated with cancer treatment. Toxicities associated with radiation therapy are most often localized in the region being irradiated and may be increased if concomitant chemotherapy is given (Yarbro et al., 2018). Acute or early toxicities most often begin within 2 weeks of the initiation of treatment and occur when normal cells within the treatment area are damaged and cellular death exceeds regeneration. Body tissues most affected are those that normally proliferate rapidly, such as the skin, the epithelial lining of the gastrointestinal tract, and the bone marrow.

Altered skin integrity is common and can include **alopecia** (hair loss) associated with whole brain radiation. Other skin reactions, referred to as

radiodermatitis, occur along a continuum ranging from erythema and dry desquamation (flaking of skin) to moist or wet desquamation (dermis exposed, skin oozing serous fluid) to, potentially, ulceration. Factors that contribute to the severity of radiodermatitis include the dose and form of radiation; use of concurrent chemotherapy, immunotherapy, or targeted therapy; inclusion of skin folds in the irradiated area; increased age, poor nutritional status, chronic sun exposure, current smoking status, and the presence of medical comorbidities, such as diabetes or kidney failure (Yarbro et al., 2018). Symptoms of radiodermatitis may necessitate treatment interruption, delays, or cessation of therapy. Re-epithelialization occurs after treatments have been completed. Hyperpigmentation, a less severe radiation-associated skin reaction, may develop about 2 to 4 weeks after the initiation of treatment.

Alterations in oral mucosa secondary to radiation therapy in the head and neck region include stomatitis (inflammation of the oral tissues), decreased salivation and xerostomia (dryness of the mouth), and change in or loss of taste. Depending on the targeted region, any portion of the gastrointestinal mucosa may be involved, causing **mucositis** (inflammation of the lining of the mouth, throat, and gastrointestinal tract). For example, patients receiving thoracic irradiation for lung cancer may experience acute esophageal irritation—associated chest pain and dysphagia. Anorexia, nausea, vomiting, and diarrhea may occur if the stomach or colon is in the radiation field. Symptoms subside and gastrointestinal re-epithelialization occurs after treatments have been completed. Bone marrow cells proliferate rapidly, and if sites containing bone marrow (e.g., the iliac crest or sternum) are included in the radiation field, anemia, leukopenia (decreased white blood cells [WBCs]), and thrombocytopenia (a decrease in platelets) may result. The patient is then at increased risk for infection and bleeding until blood cell counts return to normal.

Systemic side effects are commonly experienced by patients receiving radiation therapy. These include fatigue, malaise, and anorexia that may be secondary to biochemical mediators released when tumor cells are destroyed. Fatigue is commonly reported as one of the most distressing cancer-related symptoms. According to Kessels, Husson, and Van Der Feltz-Cornelis (2018), up to 99% of patients with cancer undergoing radiation therapy will experience fatigue. Additionally, patients often report increased severity of fatigue when radiation therapy is used along with other cancer treatments. These early effects tend to be temporary and most often subside within 6 months of the cessation of treatment.

Late effects (approximately 6 months to years after treatment) of radiation therapy may occur in body tissues that were in the field of radiation. These effects are chronic, usually a result of permanent damage to tissues, loss of elasticity, and changes secondary to a decreased vascular supply. Severe late effects include fibrosis, atrophy, ulceration, and necrosis and may affect the lungs, heart, central nervous system, and bladder. With advances in treatment planning and the accuracy of treatment delivery, the occurrence of late toxicities

has diminished. However, late or chronic symptoms, such as dysphagia, incontinence, cognitive impairment, and sexual dysfunction, may persist for several years with implications for survivors' overall health and quality of life (Kessels et al., 2018).

Nursing Management

Nurses anticipate, prevent, and work collaboratively with other providers to manage symptoms associated with radiation therapy in order to promote healing, patient comfort, and quality of life. Symptoms that are not appropriately managed may lead to poor outcomes as a result of interruptions, decreased doses, or early cessation of treatment (Lazarev, Gupta, Ghiassi-Nejad, et al., 2018; Wagner, Zhao, Goss, et al., 2018).

Ideally, nurses consider factors that may be predictive of radiation toxicities or radiosensitivity of tissues. In particular, advanced age, elevated radiation dose, and BMI have been associated with greater toxicity and symptoms (O'Gorman, Sasiadek, Denieffe, et al., 2015). The nature of the relationship between body mass index (BMI) and radiation toxicities is less clear. For example, a decreased BMI was found to be associated with an increased incidence of toxicities in women with cervical cancer (Rubinsak, Kang, Fields, et al., 2018); whereas, an increased BMI (obesity) was associated with increased incidence of late toxicities in men being treated for prostate cancer (Akthar, Liao, Eggener, et al., 2019). Consequently, the area of the body being irradiated must be used as the focus of nursing assessments of radiation toxicities.

In patients receiving EBRT, the nurse assesses the patient's skin, nutritional status, and general feelings of well-being throughout the course of treatment. Evidence-based protocols for nursing management of the toxicities associated with radiation therapy are used. If systemic symptoms such as fatigue occur the nurse explains that these symptoms are a result of the treatment and do not represent deterioration or progression of the disease. The nurse should recommend evidence-based interventions for the management of fatigue, which should include aerobic exercise, which is most effective when adherence is high (Kessels et al., 2018).

Protecting Caregivers

When the patient has a radioactive implant in place, the nurse and other health care providers need to protect themselves, as well as the patient, from the effects of radiation. Patients receiving internal radiation emit radiation while the implant is in place; therefore, contact with the health care team is guided by principles of time, distance, and shielding to minimize exposure of personnel to radiation. Specific instructions are provided by the radiation safety officer from the radiology department and specify the maximum time that can be spent safely in the patient's room, the shielding equipment to be used, and special precautions

and actions to be taken if the implant is dislodged (Halperin et al., 2019). Safety precautions used in caring for a patient receiving brachytherapy include assigning the patient to a private room, posting appropriate notices about radiation safety precautions, having staff members wear dosimeter badges, making sure that pregnant staff members are not assigned to the patient's care, prohibiting visits by children or pregnant visitors, limiting visits from others to 30 minutes daily, and seeing that visitors maintain a 6-foot distance from the radiation source.

Patients with seed implants typically return home; radiation exposure to others is minimal. Information about any precautions, if needed, is provided to the patient and family members to ensure safety. Depending on the dose and energy emitted by a systemic radionuclide, patients may or may not require special precautions or hospitalization (Halperin et al., 2019). The nurse should explain the rationale for these precautions to keep the patient from feeling unduly isolated.

Chemotherapy

Chemotherapy involves the use of antineoplastic drugs in an attempt to destroy cancer cells by interfering with cellular functions, including replication and DNA repair (Norris, 2019). Chemotherapy is used primarily to treat systemic disease rather than localized lesions that are amenable to surgery or radiation. Chemotherapy may be combined with surgery, radiation therapy, or both to reduce tumor size preoperatively (neoadjuvant), to destroy any remaining tumor cells postoperatively (adjuvant), or to treat some forms of leukemia or lymphoma (primary). The goals of chemotherapy (cure, control, or palliation) must be realistic because they will determine the medications that are used and the aggressiveness of the treatment plan.

Cell Kill and the Cell Cycle

Each time a tumor is exposed to chemotherapy, a percentage of the tumor cells (20% to 99%, depending on dosage and agent) are destroyed. Repeated doses of chemotherapy are necessary over a prolonged period to achieve regression of the tumor. Eradication of 100% of the tumor is almost impossible; the goal of treatment is eradication of enough of the tumor so that the remaining malignant cells can be destroyed by the body's immune system (Norris, 2019).

Actively proliferating cells within a tumor are the most sensitive to chemotherapy (the ratio of dividing cells to resting cells is referred to as the growth fraction). Nondividing cells capable of future proliferation are the least sensitive to antineoplastic medications and consequently are potentially dangerous. However, the nondividing cells must be destroyed to eradicate the disease. Repeated cycles of chemotherapy or sequencing of multiple

chemotherapeutic agents is used to achieve more tumor cell destruction by destroying the nondividing tumor cells as they begin active cell division.

Reproduction of both healthy and malignant cells follows the cell cycle pattern (see Fig. 12-2). All cells in the body (healthy and malignant) are affected by chemotherapy. The effect of chemotherapy on the body's cells is best described in relation to the cell cycle. The cell cycle time is the time required for one cell to divide and reproduce two identical daughter cells. The cell cycle of any cell has four distinct phases, each with a vital underlying function (Norris, 2019):

- G_1 phase—RNA and protein synthesis occurs
- S phase—DNA synthesis occurs
- G_2 phase—premitotic phase; DNA synthesis is complete, mitotic spindle forms
- Mitosis—duplicated chromosomes separate, and cell division occurs

Classification of Chemotherapeutic Agents

Chemotherapeutic agents may be classified by their mechanism of action in relation to the cell cycle. Agents that exert their maximal effect during specific phases of the cell cycle are termed *cell cycle–specific agents* (e.g., docetaxal, vinblastine, etoposide). These agents destroy cells that are actively reproducing by means of the cell cycle; most affect cells in the S phase by interfering with DNA and RNA synthesis. Other agents, such as plant alkaloids, are specific to the M phase, where they halt mitotic spindle formation. Chemotherapeutic agents that act independently of the cell cycle phases are termed *cell cycle–nonspecific agents* (e.g., busulfan, cisplatin, bleomycin). These agents usually have a prolonged effect on cells, leading to cellular damage or death. Many treatment plans combine agents that target different phases of the cell cycle to increase the number of vulnerable tumor cells killed during a treatment period (Dickens & Ahmed, 2018).

Chemotherapeutic agents are also classified by chemical group, each with a different mechanism of action. These include the alkylating agents, nitrosoureas, antimetabolites, antitumor antibiotics, topoisomerase inhibitors, plant alkaloids (also referred to as mitotic inhibitors), hormonal agents, and miscellaneous agents. The classification, mechanism of action, cell cycle specificity, and common side effects of select antineoplastic agents are listed in Table 12-7.

Chemotherapeutic agents from multiple categories may be used together to maximize cell destruction. Combination chemotherapy relies on agents with varying mechanisms, potential synergistic actions, and differing toxicities. The use of combination therapy also helps prevent the development of drug-resistant cells (Dickens & Ahmed, 2018).

Adjunct Chemotherapeutic Agents

In certain regimens, additional medications are given with chemotherapy agents to enhance activity or protect normal cells from injury. For example, leucovorin is often given with fluorouracil to treat colorectal cancer. Leucovorin, a compound similar to folic acid, helps fluorouracil bind with an enzyme inside of cancer cells and enhances the ability of fluorouracil to remain in the intracellular environment. Leucovorin also rescues normal cells from the toxic effects of high doses of methotrexate. When given at certain doses for the treatment of some forms of leukemia or lymphoma, methotrexate causes a folic acid deficiency in cells, resulting in cell death. Significant toxicity, including severe bone marrow suppression, mucositis, diarrhea and liver, and lung and kidney damage, can occur. Leucovorin helps to prevent or lessen these toxicities.

Administration of Chemotherapeutic Agents

Chemotherapy may be given in the hospital, outpatient center, or home setting by multiple routes. The route of administration depends on the type of agent; the required dose; and the type, location, and extent of malignant disease being treated. Standards for the safe administration of chemotherapy have been developed by the Oncology Nursing Society (ONS) and the American Society of Clinical Oncology (ASCO) (Neuss, Gilmore, Belderson, et al., 2017). Patient education is essential to maximize safety when chemotherapy is given in the home.

Dosage

The dosage of chemotherapeutic agents is based primarily on the patient's total body surface area, weight, previous exposure and response to chemotherapy or radiation therapy, and function of major organ systems. Dosages are determined to maximize cell kill while minimizing impact on healthy tissues and subsequent toxicities. The therapeutic effect may be compromised if modified and inadequate dosing is required due to toxicities. Modification of dosage is often required if critical laboratory values or the patient's symptoms indicate unacceptable or dangerous toxicities. Chemotherapy treatment regimens include standard-dose therapy, dose-dense regimens (giving chemotherapy more frequently than standard treatment regimens), and myeloablative therapy for HSCT. For certain chemotherapeutic agents, there is a maximum lifetime dose limit that must be adhered to because of the danger of long-term irreversible organ complications (e.g., because of the risk of cardiomyopathy, doxorubicin has a cumulative lifetime dose limit of 550 mg/m^2).

Extravasation

Intravenously administered chemotherapy agents are additionally classified by their potential to damage tissue if they inadvertently leak from a vein into surrounding tissue; this leakage is called **extravasation**. The consequences of extravasation range from mild discomfort to severe tissue destruction, depending

on whether the agent is classified as an irritant or vesicant. Irritant agents induce a localized inflammatory reaction at the infusion or injection site, but usually do not cause permanent tissue damage (Olsen, LeFebvre, & Brassil, 2019).

Unlike irritants, **vesicants** are agents that cause inflammation, tissue damage, and possibly necrosis of tendons, muscles, nerves, and blood vessels if extravasation occurs (Olsen et al., 2019). Although the mechanism of vesicant actions varies with each drug, some agents bind to cell DNA and cause cell death that progresses to involve neighboring cells, whereas other agents are metabolized into cells and cause a localized, painful reaction that usually improves over time. Sloughing and ulceration of the tissue may progress to tissue necrosis that is so severe that skin grafting becomes necessary. The full extent of tissue damage may take several weeks to become apparent. Examples of commonly used agents classified as vesicants include dactinomycin, daunorubicin, doxorubicin, nitrogen mustard, mitomycin, vinblastine, and vincristine. Chemotherapy administration safety standards require the availability of defined extravasation management procedures, including antidote order sets and accessibility of antidotes in all settings where vesicant chemotherapy is given (Neuss et al., 2017; Olsen et al., 2019).

Chemotherapy is given only by those who have the knowledge and established competencies for vesicant and extravasation management (Neuss et al., 2017; Olsen et al., 2019). Prevention and management of extravasation are essential. Vesicant chemotherapy should never be given in peripheral veins involving the hand or wrist. Peripheral administration is permitted for short-duration infusions only, and placement of the venipuncture site should be on the forearm area using a soft, plastic catheter. For any frequent or prolonged administration of antineoplastic vesicants, right atrial silastic catheters, implanted venous access devices, or peripherally inserted central catheters (PICCs) should be inserted to promote safety during medication administration and reduce problems with access to the circulatory system (Figs. 12-3 and 12-4).

Hypersensitivity Reactions

Although hypersensitivity reactions (HSRs) can occur with any medication, many chemotherapy agents pose a high risk and have been associated with life-threatening outcomes (Olsen et al., 2019). HSRs are a subgroup of adverse drug reactions that are unexpected and associated with mild or progressively worsening signs and symptoms, such as rash, urticaria, fever, hypotension, cardiac instability, dyspnea, wheezing, throat tightness, and syncope. Immediate HSRs may appear within 5 minutes and up to 6 hours of an infusion. Delayed HSRs may occur after the completion of the infusion. Although patients may or may not react to the first infusion of a chemotherapy agent, repeated exposure increases the likelihood of a reaction.

TABLE 12-7 Select Antineoplastic Agents

Drug Class and Examples	Mechanism of Action	Cell Cycle Specificity	Common Side Effects
Alkylating Agents			
Busulfan, carboplatin, chlorambucil, cisplatin, cyclophosphamide, dacarbazine, altretamine ifosfamide, melphalan, nitrogen mustard, oxaliplatin, thiotepa	Bond with DNA, RNA, and protein molecules leading to impaired DNA replication, RNA transcription, and cell functioning; all resulting in cell death	Cell cycle—nonspecific	Bone marrow suppression, nausea, vomiting, cystitis (cyclophosphamide, ifosfamide), stomatitis, alopecia, gonadal suppression, renal toxicity (cisplatin), and development of secondary malignancies
Nitrosoureas			
Carmustine, lomustine or CCNU, semustine, streptozocin	Similar to alkylating agents; cross the blood–brain barrier	Cell cycle—nonspecific	Delayed and cumulative myelosuppression, especially thrombocytopenia; nausea, vomiting, pulmonary, hepatic, and renal damage
Topoisomerase I Inhibitors			
Irinotecan Topotecan ***Topoisomerase II Inhibitors*** Etoposide Teniposide	Induce breaks in the DNA strand by binding to enzyme topoisomerase, preventing cells from dividing	Cell cycle—specific (S phase)	Bone marrow suppression, diarrhea, nausea, vomiting, flulike symptoms (topotecan), rash (etoposide), hepatotoxicity (teniposide)
Antimetabolites			
5-Azacytidine, capecitabine, cytarabine, edatrexate fludarabine, 5-fluorouracil (5-FU), gemcitabine, hydroxyurea, cladribine, 6-mercaptopurine, methotrexatepentostatin, 6-thioguanine	Interferes with the biosynthesis of metabolites or nucleic acids necessary for RNA and DNA synthesis; inhibits DNA replication and repair	Cell cycle—specific (S phase)	Nausea, vomiting, diarrhea, bone marrow suppression, stomatitis, renal toxicity (methotrexatepentostatin), hepatotoxicity (6-thioguanine), hand-foot syndrome (capecitibine)
Antitumor Antibiotics			
Bleomycin, dactinomycin, daunorubicin, doxorubicin, epirubicin, idarubicin, mitomycin,	Interfere with DNA synthesis by binding DNA;	Cell cycle—nonspecific	Bone marrow suppression, nausea, vomiting, alopecia, anorexia, cardiac toxicity

mitoxantrone, plicamycin	prevent RNA synthesis		(daunorubicin, doxorubicin), red urine (doxorubicin, idarubicin, epirubicin), pulmonary fibrosis (bleomycin)
Mitotic Spindle Inhibitors			
Plant alkaloids: vinblastine, vincristine, vinorelbine	Arrest metaphase by inhibiting mitotic tubular formation (spindle); inhibit DNA and protein synthesis	Cell cycle—specific (M phase)	Bone marrow suppression (mild with vincristine), peripheral neuropathies, nausea and vomiting
Taxanes: paclitaxel, docetaxel	Arrest metaphase by inhibiting tubulin depolymerization	Cell cycle—specific (M phase)	Hypersensitivity reactions, bone marrow suppression, alopecia, peripheral neuropathies, mucositis
Epothilones: ixabepilone	Alters microtubules and inhibits mitosis	Cell cycle—specific (M phase)	Peripheral neuropathies, bone marrow suppression, hypersensitivity reactions, hepatic impairment
Hormonal Agents			
Androgens and antiandrogens, estrogens and antiestrogens, progestins and antiprogestins, aromatase inhibitors, luteinizing hormone-releasing hormone analogues, steroids	Bind to hormone receptor sites that alter cellular growth; block binding of estrogens to receptor sites (antiestrogens); inhibit RNA synthesis; suppress cytochrome P450 system	Cell cycle—nonspecific	Hypercalcemia, jaundice, increased appetite, masculinization, feminization, sodium and fluid retention, nausea, vomiting, hot flashes, vaginal estrogen dryness
Miscellaneous Agents			
Asparaginase, procarbazine	Inhibits protein, DNA, and RNA synthesis	Varies	Anorexia, nausea, vomiting, bone marrow suppression, hepatotoxicity, hypersensitivity reaction, pancreatitis
Arsenic trioxide	Causes fragmentation of DNA resulting in cell death; in acute promyelocytic leukemia, it		Nausea, vomiting, electrolyte imbalances, fever, headache, cough, dyspnea, electrocardiogram abnormalities

	corrects protein changes and changes malignant T–cells into normal white blood cells.

DNA, deoxyribonucleic acid; RNA, ribonucleic acid.

Adapted from Comerford, K. C., & Durkin, M. T. (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer; Neuss, M. N., Gilmore, T. R., Belderson, K., et al. (2017). 2016 updated American Society of Clinical Oncology/Oncology Nursing Society chemotherapy administration safety standards, including standards for pediatric oncology. *Oncology Nursing Forum*, *44*(1), 31–43.

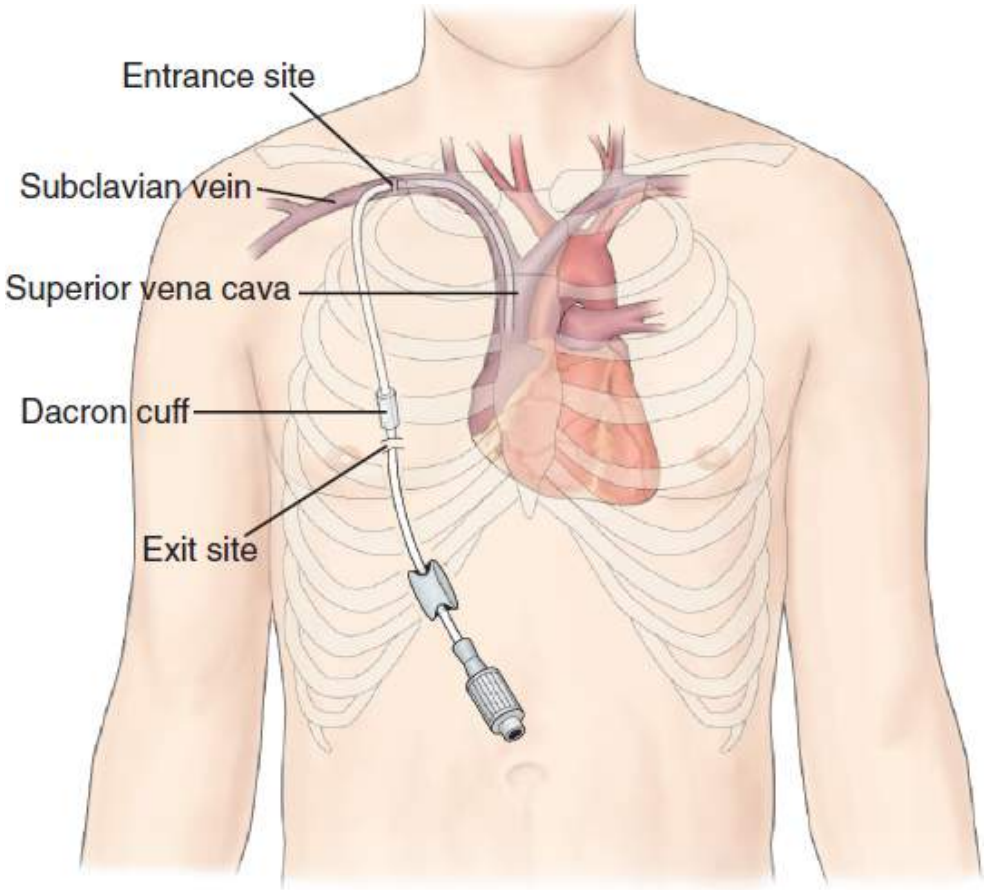

Figure 12-3 • Right atrial catheter. The right atrial catheter is inserted into the subclavian vein and advanced until its tip lies in the superior vena cava just above the right atrium. The proximal end is then tunneled from the entry site through the subcutaneous tissue of the chest wall and brought out through an exit site on the chest. The Dacron cuff anchors the catheter in place and serves as a barrier to infection.

Most immediate HSRs are immunoglobulin E (IgE)-mediated reactions—an allergic reaction (Olsen et al., 2019). Examples of agents that may cause an

allergic, IgE-mediated response include carboplatin, oxaliplatin, and L-asparaginase. However, some HSRs, such as anaphylactoid reactions, are non–IgE-mediated (nonallergic) and a result of cytokine release syndrome (CRS). Rituximab and cetuximab are examples of agents associated with non–IgE-mediated (nonallergic) HSRs. When signs and symptoms of HSR occur, the medication should be discontinued immediately, and emergency procedures initiated. Many institutions have developed specific protocols for responding to HSRs, including standing orders for administration of emergency medications (Roselló, Blasco, García Fabregat, et al., 2017). (See Chapter 33 for further discussion of allergic reactions.)

For some chemotherapeutic agents, especially if they are essential in the treatment plan, desensitization procedures may be possible, and the patient is retreated with the agent at reduced dosages or slower infusion rates. Premedication regimens are used for certain chemotherapy agents to prevent or minimize reactions.

Toxicity

Toxicity associated with chemotherapy can be acute or chronic. Cells with rapid growth rates (e.g., epithelium, bone marrow, hair follicles, sperm) are very susceptible to damage, and the effects may manifest in virtually any body system.

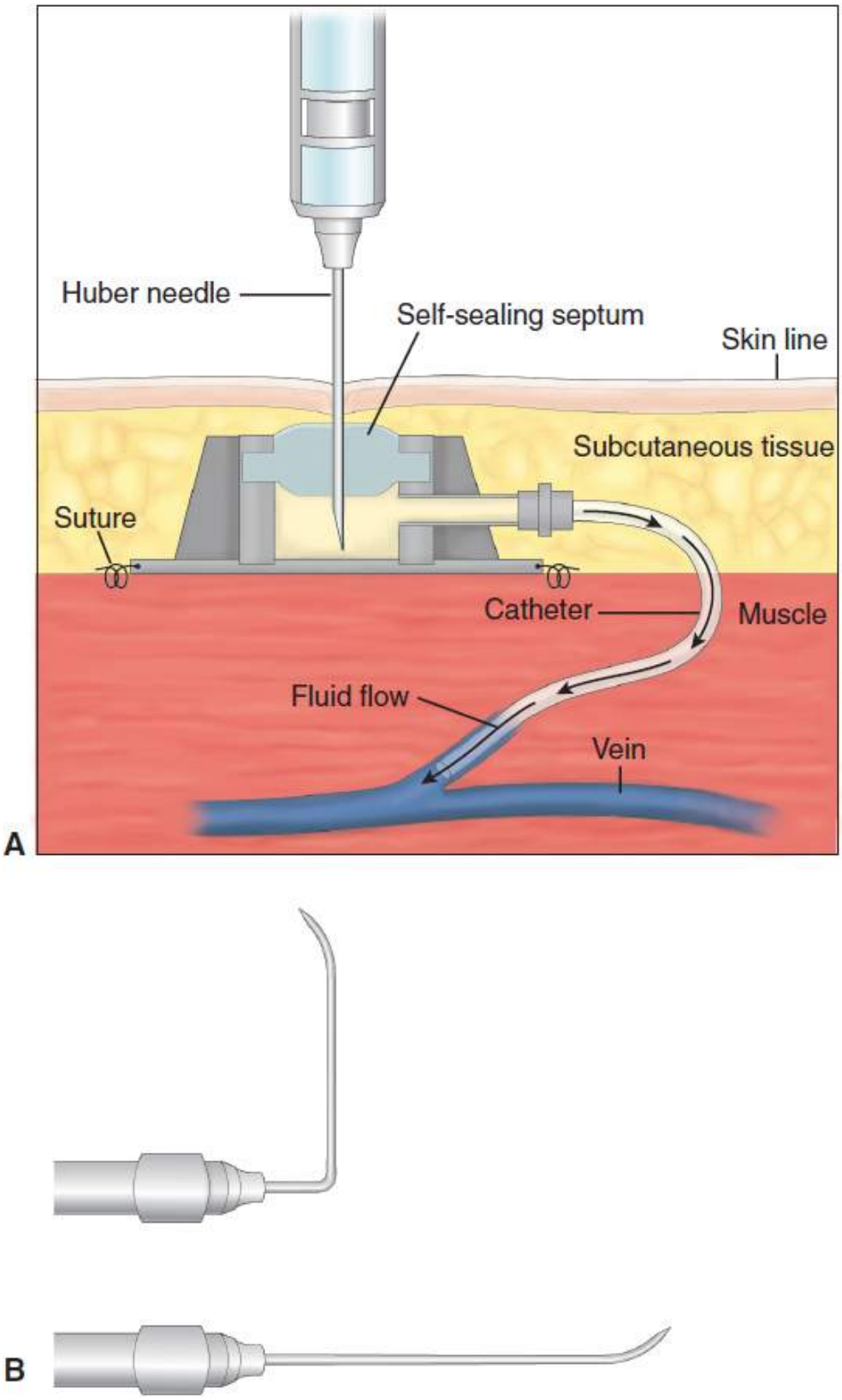

Figure 12-4 • Implanted vascular access device. **A.** A schematic diagram of an implanted vascular access device used for administration of medications, fluids, blood products, and nutrition. The self-sealing septum permits repeated puncture by Huber needles without damage or leakage. **B.** Huber needles used to enter the

implanted vascular port. The 90-degree needle is used for top-entry ports for continuous infusions.

Gastrointestinal System

The most common side effects of chemotherapy are nausea and vomiting, which may persist for 24 to 48 hours; delayed nausea and vomiting may occur up to 1 week after administration. The experience of chemotherapy-induced nausea and vomiting (CINV) may affect quality of life, psychological status, nutrition, fluid and electrolyte status, functional ability, compliance with treatment, and utilization of health care resources (Natale, 2018). Comorbidities, the underlying malignancy, other treatment modalities, and medications, as well as symptoms (e.g., pain), may contribute to CINV. Acute CINV is experienced in the first 24 hours after chemotherapy with a maximal intensity after 5 to 6 hours; delayed CINV occurs 24 hours posttreatment and may last as many as 7 days with a maximal intensity 48 to 72 hours after drug administration (anticipatory nausea and vomiting, occurring prior to administration of chemotherapy, may be a conditioned response triggered by a stimulus such as the smell of the infusion setting, the sight of the nurse, or the outpatient center waiting room) (Olsen et al., 2019).

Several mechanisms are responsible for the occurrence of nausea and vomiting, including activation of multiple receptors found in the vomiting center of the medulla, the chemoreceptor trigger zone, the gastrointestinal tract, the pharynx, and the cerebral cortex. Activation of neurotransmitter receptors in these areas is thought to induce CINV. Stimulation may originate through peripheral, autonomic, vestibular, or cognitive pathways. The primary neuroreceptors known to be implicated in CINV are 5-hydroxytryptamine (5-HT or serotonin) and dopamine receptors (Olsen et al., 2019).

The approach for managing CINV is based on the knowledge of the probability of emesis of the chemotherapy agents used. Algorithms are used to prevent and treat CINV based on national guidelines that consider this classification of chemotherapy agents (NCCN, 2019g).

Corticosteroids, phenothiazines, sedatives, and histamines are helpful, especially when used in combination with serotonin blockers to provide antiemetic protection (NCCN, 2019g). In order to manage delayed nausea and vomiting, antiemetic medications may be combined and are given for the first week at home after chemotherapy. Nonpharmacologic approaches such as relaxation techniques, imagery, acupressure, or acupuncture can help decrease stimuli contributing to symptoms and may be most helpful for patients with anticipatory nausea and vomiting. Small, frequent meals, bland foods, and comfort foods may reduce the frequency or severity of symptoms.

Stomatitis is commonly associated with some chemotherapy agents because of the rapid turnover of epithelium that lines the oral cavity. The entire gastrointestinal tract is susceptible to mucositis. Antimetabolites and antitumor

antibiotics are the major culprits in mucositis and other gastrointestinal symptoms, which can be severe in some patients.

Hematopoietic System

Many chemotherapy agents cause some degree of **myelosuppression** (depression of bone marrow function), resulting in leukopenia (decreased WBCs), **neutropenia** (decreased granulocytes), anemia (decreased red blood cells [RBCs]), thrombocytopenia (decreased platelets), and increased risk of infection and bleeding (Olsen et al., 2019). Depression of these cells is the usual reason for limiting the dose of the chemotherapy. Myelosuppression is predictable; for most agents, patients usually reach the point at which blood counts are lowest 7 to 14 days after chemotherapy has been given. During these 2 weeks, nurses anticipate associated toxicities, especially a fever associated with neutrophil count less than 1,500 cells/mm^3. Frequent monitoring of blood cell counts is essential, and patients are educated about strategies to protect against infection, injury, and blood loss, particularly while counts are low.

Other agents—colony-stimulating factors (granulocyte colony-stimulating factor [G-CSF] and granulocyte-macrophage colony-stimulating factor [GM-CSF])—can be given after chemotherapy to stimulate the bone marrow to produce WBCs, especially neutrophils, at an accelerated rate, thus decreasing the duration of neutropenia. G-CSF and GM-CSF decrease the episodes of infection and the need for antibiotics and allow for more timely treatment cycles of chemotherapy with less need to reduce the dosage. Erythropoietin (EPO) stimulates RBC production, thus decreasing the symptoms of treatment-induced chronic anemia and reducing the need for blood transfusions. Interleukin 11 (IL-11) (oprelvekin) stimulates the production of megakaryocytes (precursors to platelets) and can be used to prevent and treat severe thrombocytopenia but has had limited use because of toxicities, such as HSR; capillary leak syndrome; pulmonary edema; atrial arrhythmias; and nausea, vomiting, and diarrhea (Olsen et al., 2019).

Renal System

Some chemotherapy agents can cause renal dysfunction by damaging the blood vessels or filtering structures of the kidneys (Olsen et al., 2019). Clinical manifestations of renal dysfunction from conventional chemotherapy can range from the asymptomatic elevation of serum electrolytes and creatinine levels to acute kidney injury (Merchan, Jhaveri, Berns, et al., 2017). Cisplatin, methotrexate, and mitomycin are particularly toxic to the kidneys (Olsen et al., 2019). Damage to the kidneys may also result in impaired water secretion, leading to syndrome of inappropriate secretion of antidiuretic hormone (SIADH). Rapid tumor cell lysis after chemotherapy results in increased urinary excretion of uric acid, which can cause renal damage. In addition, intracellular contents are released into circulation, resulting in hyperkalemia,

hyperphosphatemia, and hypocalcemia and obstructive nephropathy. (See later discussion of tumor lysis syndrome.)

The monitoring of laboratory values, including blood urea nitrogen (BUN), serum creatinine, creatinine clearance, and serum electrolytes is essential (Olsen et al., 2019). Adequate hydration and diuresis to prevent formation of uric acid crystals and administration of allopurinol may be used to prevent renal toxicity. Amifostine has demonstrated an ability to minimize renal toxicities associated with cisplatin, cyclophosphamide, and ifosfamide therapy.

Hemorrhagic cystitis is a bladder toxicity that can result from cyclophosphamide and ifosfamide, and alkylating agent (e.g., busulfan and thiotepa) therapy (Olsen et al., 2019). Hematuria can range from microscopic to frank bleeding with symptoms ranging from transient irritation during urination, dysuria, and suprapubic pain to life-threatening hemorrhage. Protection of the bladder focuses on aggressive IV hydration, frequent voiding, and diuresis.

Cardiopulmonary System

Several chemotherapy agents are associated with cardiac toxicity. Anthracyclines (e.g., daunorubicin, doxorubicin) are known to cause irreversible cumulative cardiac toxicities when total dosage reaches 400 mg/m^2 (Henriksen, 2018). If these agents are given in the presence of thoracic radiation therapy or other agents with cardiotoxicity potential, the cumulative dose limit is lower. Patients at increased risk for the development of cardiac toxicities include: extreme ages >65 years or <18 years, female gender, African American race, chest radiation, kidney failure, and preexisting cardiac disease (including hypertension) (Henriksen, 2018). Dexrazoxane has been used on a limited basis as a cardio-protectant when doxorubicin is needed in individuals who have already received a cumulative dose limit and continuation of therapy is deemed beneficial. Patients with known cardiac disease (e.g., heart failure) are treated with lower doses or agents not known to be associated with cardiac toxicity. Cardiac ejection fraction (volume of blood ejected from the heart with each beat) and other signs of heart failure must be monitored closely.

Bleomycin, carmustine, busulfan, mitomycin C, and paclitaxel/docetaxel, among other agents, have toxic effects on lung function, such as alveolar damage, bronchospasm, pneumonitis, and pulmonary fibrosis (Olsen et al., 2019). Therefore, patients are monitored closely for changes in pulmonary function, including pulmonary function test results. Patients with known lung disease are treated with alternative agents not known to cause pulmonary toxicity. When pulmonary toxicity occurs, the agent is discontinued and patients are treated with steroids and other supportive therapies.

Capillary leak syndrome with resultant pulmonary edema is an effect of cytarabine, mitomycin C, cyclophosphamide, and carmustine (Olsen et al., 2019). Subtle onset of dyspnea and cough may progress rapidly to acute respiratory distress and subsequent respiratory failure. Patients who are at significant risk for capillary leak syndrome are monitored closely.

Reproductive System

Testicular and ovarian function can be affected by chemotherapeutic agents, resulting in possible infertility (Olsen et al., 2019). Women may develop problems with ovulation or early menopause, whereas men may develop temporary or permanent azoospermia (absence of spermatozoa). Because treatment may damage reproductive cells, banking of sperm is often recommended for men before treatment is initiated (Oktay, Harvey, Partridge, et al., 2018). Options available for women prior to initiation of chemotherapy include cryopreservation (freezing) of oocytes, embryos, or ovarian tissue. Patients and their partners are informed about potential changes in reproductive function resulting from chemotherapy. In addition, many chemotherapy agents are known or thought to be teratogenic. Therefore, patients are advised to use reliable methods of birth control while receiving chemotherapy and not to assume that infertility has resulted (Olsen et al., 2019).

Neurologic System

Chemotherapy-induced neurotoxicity, a potentially dose-limiting toxicity, can affect the central, peripheral, and autonomic nervous systems (Olsen et al., 2019). Neurotoxicity characterized by metabolic encephalopathy can occur with ifosfamide, high-dose methotrexate, and cytarabine. With repeated doses, the taxanes and plant alkaloids, especially vincristine, can cause cumulative peripheral nervous system damage with sensory alterations in the feet and hands. These sensations can be described as tingling, pricking, or numbness of the extremities; burning or freezing pain; sharp, stabbing, or electric shock–like pain; and extreme sensitivity to touch. If unreported by patients or undetected, progressive motor axon damage can lead to loss of deep tendon reflexes, with muscle weakness, loss of balance and coordination, and paralytic ileus.

Some chemotherapy agents (e.g., paclitaxel and gemcitabine) can cause severe peripheral neuropathies that may lead to diminished quality of life and functional abilities and result in dose reductions, a change in chemotherapy regimen, or early cessation of treatment (Haryani, Fetzer, Wu, et al., 2017). Although often reversible, these side effects may take many months to resolve or persist indefinitely. Along with the usual paresthesias of the hands and feet, oxaliplatin has a unique and frightening neurotoxicity presentation that is often precipitated by exposure to cold and is characterized by pharyngolaryngeal dysesthesia consisting of lip paresthesia, discomfort or tightness in the back of the throat, inability to breathe, and jaw pain (Olsen et al., 2019).

Quality and Safety Nursing Alert

Patients receiving oxaliplatin must be instructed to avoid drinking cold fluids or going outside with hands and feet exposed to cold temperatures to avoid exacerbation of these symptoms for 3 to 4 days after therapy (Olsen et al., 2019). Cisplatin may cause peripheral neuropathies and hearing loss due to damage to the acoustic nerve.

Cognitive Impairment

Many patients with cancer have trouble with remembering dates, multitasking, managing numbers and finances, organization, face or object recognition, inability to follow directions, feeling easily distracted, and motor and behavioral changes. Although not completely understood, these are viewed as symptoms of cognitive impairment. Cognitive impairment is a multidimensional concept involving a decline in information-handling processes in several domains, including attention and concentration, executive function, information processing speed, language, motor function, visuospatial skill, learning, and memory (Jansen, 2017). Commonly referred to by patients as "chemo brain" or "chemo fog," cognitive impairment has been associated with both cancer and cancer treatments, including surgery, radiation, chemotherapy, and targeted agents. The symptoms may be subtle or profound with potential negative effects on functional abilities, employment, independence, quality of life, and psychosocial status. Comorbidities, age, medications, pain, impaired nutrition, anemia, fatigue, fluid and electrolyte disturbances, organ dysfunction, infection, and hormonal imbalances are factors that may contribute to the experience of cognitive impairment and make it difficult to fully understand. Underlying mechanisms of cognitive impairment in patients with cancer being explored include neurotoxic effects, oxidative stress, hormonal changes, immune dysregulation, cytokine release, clotting, genetic predisposition, and accelerated aging processes (Jansen, 2017).

Fatigue

Cancer-related fatigue has been defined as an unusual, persistent, and subjective sense of tiredness that is not proportional to recent activity and interferes with usual functioning (NCCN, 2019f). Fatigue is a distressing side effect for most patients that greatly affects quality of life, during treatment and for months after treatment. The health care team works together to identify effective pharmacologic and nonpharmacologic approaches for fatigue management.

Nursing Management

Nurses play an important role in assessing and managing many of the problems experienced by patients receiving chemotherapy. Chemotherapy agents affect

both normal and malignant cells; therefore, their effects are often widespread, affecting many body systems.

Laboratory and physical assessments of metabolic indices and the dermatologic, hematologic, hepatic, renal, cardiovascular, neurologic, and pulmonary systems are critical in evaluating the body's response to chemotherapy. These assessments are performed prior to, during, and after a course of chemotherapy to determine optimal treatment options, evaluate the patient's response, and monitor toxicity. Patients are monitored for long-term effects of chemotherapy after active treatment has been completed during the period of survivorship (see Chart 12-4).

Assessing Fluid and Electrolyte Status

Anorexia, nausea, vomiting, altered taste, mucositis, and diarrhea put patients at risk for nutritional and fluid and electrolyte disturbances. Therefore, it is important for the nurse to assess the patient's nutritional and fluid and electrolyte status on an ongoing basis and to identify creative ways to encourage an adequate fluid and dietary intake.

Assessing Cognitive Status

Nurses should assess patients routinely for indications of cognitive impairment. Prior to the initiation of treatment, patients and families should be informed about the possibility of cognitive impairment. Nursing assessment plays an important role in determining the need for referral for neurocognitive evaluation and intervention (Jansen, 2017).

Chart 12-4

Potential Long-Term Complications of Cancer Chemotherapy

- Abnormalities in senses of taste, smell, and touch
- Abnormal balance, tremors, or weakness
- Avascular necrosis
- Cardiovascular toxicity (coronary artery disease, myocardial infarction, congestive heart failure, valvular heart disease, peripheral arterial disease)
- Decreased libido
- Dental caries
- Dry mouth
- Dysphagia
- Dyspnea on exertion
- Growth retardation in children
- Herpes infections (zoster and varicella)
- Hypothyroidism
- Immune dysfunction
- Infertility
- Osteoporosis
- Pericarditis (acute or chronic)
- Pneumococcal sepsis
- Pneumonitis (acute or chronic)
- Secondary cancers:
  - Acute myeloid leukemia
  - Myelodysplastic syndromes
  - Non-Hodgkin lymphomas
  - Solid tumors (especially bone and soft tissue, lung, breast)
  - Thyroid cancer
  - Thymic hyperplasia

Adapted from Yarbro, C. H., Wujcik, D., & Gobel, B. H. (2018). *Cancer nursing: Principles and practice*. Burlington, MA: Jones & Bartlett Publishers.

Modifying Risks for Infection and Bleeding

Suppression of the bone marrow and immune system is expected and frequently serves as a guide in determining appropriate chemotherapy dosage but increases the risk of anemia, infection, and bleeding disorders. Nursing assessment and care address factors that would further increase the patient's risk. The nurse's role in decreasing the risk of infection and bleeding is discussed further in the Nursing Care of the Patient with Cancer section.

Administering Chemotherapy

Nurses must be aware of chemotherapy and other agents most associated with HSRs, strategies for prevention, signs and symptoms characteristic of HSRs, and the appropriate early and time-sensitive interventions for preventing progression to anaphylaxis. Nurses provide patient and family education that emphasizes two

key points: the importance of adhering to prescribed self-administered premedication before presenting to the infusion center and recognizing and reporting the signs and symptoms to the nurse once the infusion has started. Patients and families are also educated about signs and symptoms that may occur at home following discharge from the infusion area that may warrant medication administration or immediate transport to the emergency department for further assessment and treatment.

The local effects of the chemotherapeutic agent are also of concern. The patient is observed closely during administration of the agent because of the risk and consequences of extravasation. Prevention of extravasation is essential and relies on vigilant nursing care (Neuss et al., 2017). Selection of peripheral veins, skilled venipuncture, and careful administration of medications are essential. Peripheral administration is limited to short duration (less than 1 hour; IV push or bolus) infusions using only a soft, plastic catheter placed in the forearm area (Olsen et al., 2019). Continuous infusion of vesicants that takes longer than 1 hour or are given frequently are given only via a central line, such as a right atrial silastic catheter, implanted venous access device, or PICC. These long-term venous access devices promote safety during medication administration and reduce problems with repeated access to the circulatory system (see Figs. 12-3 and 12-4). Indwelling or subcutaneous venous access devices require consistent nursing care. Complications include infection and thrombosis (Voog, Campion, Du Rusquec, et al., 2018).

Indications of extravasation during administration of vesicant agents include the following:

- Absence of blood return from the IV catheter
- Resistance to flow of IV fluid
- Burning or pain, swelling, or redness at the site

Quality and Safety Nursing Alert

If extravasation is suspected, the medication administration is stopped immediately.

An extravasation kit should be readily available with emergency equipment and antidote medications, as well as a quick reference for how to properly manage an extravasation of the specific vesicant agent used (although evidence-based data regarding effective antidotes are limited) (Neuss et al., 2017; Olsen et al., 2019). Nurses should refer to their organization's policy and procedures for reporting, managing, and documenting extravasation. Safety standards require the availability of defined extravasation management procedures, including antidote order sets and accessibility of antidotes in all settings where vesicant chemotherapy is given (Neuss et al., 2017). Recommendations and guidelines for managing vesicant extravasation, which vary with each agent, have been issued

by individual medication manufacturers, pharmacies, and the ONS (Neuss et al., 2017; Olsen et al., 2019).

Difficulties or problems with administration of chemotherapeutic agents are brought to the attention of the primary provider promptly so that corrective measures can be taken to minimize local tissue damage.

The nurse evaluates the patient receiving neurotoxic chemotherapy, communicates findings with the medical oncologist, provides education to patients and families, and makes appropriate referrals for complete neurologic evaluation and occupational or rehabilitative therapies.

Preventing Nausea and Vomiting

Nurses are integral to the prevention and management of CINV. They collaborate with other members of the oncology care team to identify factors contributing to the experience of CINV and select effective antiemetic regimens that maximize currently available therapies. Nurses provide education for patients and families regarding antiemetic regimens and care for delayed CINV that may continue at home after the chemotherapy infusion has completed (NCCN, 2019g).

Managing Cognitive Changes

Although several approaches have been explored, no evidence-based guidelines for the prevention, treatment, or management of cognitive impairment have been established. Examples of nonpharmacologic approaches that nurses recommend to patients include exercise, natural restorative environmental intervention (walking in nature or gardening), and cognitive training programs (Jansen, 2017). Nurses should assist patients to address factors, such as fluid and electrolyte imbalances, nutrition deficits, fatigue, pain, and infection to minimize their contribution to cognitive impairment.

Managing Fatigue

Fatigue is a common side effect of chemotherapy. Nurses assist patients to explore the role that the underlying disease processes, combined treatments, other symptoms, and psychosocial distress play in the patient's experience of fatigue. In addition, nurses work with the patient and other team members to identify effective approaches for fatigue management (NCCN, 2019h).

Protecting Caregivers

Nurses involved in handling chemotherapeutic agents may be exposed to low doses of the agents by direct contact, inhalation, or ingestion (Menonna-Quinn, Polovich, & Marshall, 2019). Skin and eye irritation, nausea, vomiting, nasal mucosal ulcerations, infertility, low-birth-weight babies, congenital anomalies, spontaneous abortions, and mutagenic substances in urine have been reported in nurses preparing and handling chemotherapy agents. The Occupational and

Safety Health Administration (OSHA), the ONS, hospitals, and other health care agencies have developed specific precautions for health care providers involved in the preparation and administration of chemotherapy and for handling materials exposed to body fluids of those who have received these hazardous agents (see Chart 12-5) (Neuss et al., 2017; Olsen et al., 2019). Nurses must be familiar with their institutional policies and procedures regarding personal protective equipment, handling and disposal of chemotherapy agents and supplies, and management of accidental spills or exposures. Emergency spill kits should be readily available in any treatment area where chemotherapy is prepared or given. Precautions must also be taken when handling any bodily fluids or excreta from the patient, as many agents are excreted unaltered in urine and feces. Nurses in all treatment settings have a responsibility to educate patients, families, caregivers, assistive personnel, and housekeepers concerning precautions.

Hematopoietic Stem Cell Transplantation

HSCT has been used to treat several malignant and nonmalignant diseases for many years (Yarbro et al., 2018). In adults, HSCT is most commonly used to treat certain hematologic malignancies (e.g., malignant myeloma, acute leukemia, non-Hodgkin lymphoma), and less commonly some solid tumors (e.g., germ cell tumors, breast cancer, neuroblastomas).

The process of obtaining hematopoietic stem cells (HSCs) has evolved over the years (Yarbro et al., 2018). Historically, HSCs were obtained in the operating room by harvesting large amounts of bone marrow tissue from a donor under general anesthesia. However, peripheral blood stem cell collection using the process of apheresis now accounts for the vast majority of HSCT procedures (Yarbro et al., 2018). The cells collected are specially processed and reinfused into the patient. This method of collecting HSCs is a safe and a more cost-effective means of collection than the process of harvesting of marrow. Stem cells can also be collected from umbilical cord blood harvested from the placenta of newborns at birth that is cryopreserved and stored for later use (Yarbro et al., 2018).

Types of Hematopoietic Stem Cell Transplantation

Types of HSCT are based on the source of donor cells and the treatment (conditioning) regimen used to prepare the patient for stem cell infusion and eradicate malignant cells (Yarbro et al., 2018). These include:

- *Allogeneic HSCT* (AlloHSCT): From a donor other than the patient (may be a related donor such as a family member or a matched unrelated donor from the National Bone Marrow Registry or Cord Blood Registry)
- *Autologous:* From the patient

- *Syngeneic:* From an identical twin
- *Myeloablative:* Consists of giving patients high-dose chemotherapy and, occasionally, total-body irradiation
- *Nonmyeloablative:* Also called *mini-transplants;* does not completely destroy bone marrow cells

Chart 12-5

Safety in Handling Chemotherapy for Health Care Providers

- When preparing (compounding, reconstituting) chemotherapy for administration, use the following safety equipment to prevent exposure through inhalation, direct contact, and ingestion:
  - Class II or III biologic safety cabinet (BSC)
  - Closed-system transfer devices
  - Puncture and leak-proof containers, IV bags
  - Needleless systems (e.g., IV tubing and syringes)
- If BSC is not available when preparing chemotherapy for administration, use the following safety equipment to minimize exposure:
  - Surgical N-95 respirator to provide respiratory and splash protection
  - Eye and face protection (both face shield and goggles) working at or above eye level or cleaning a spill
- When preparing or administering chemotherapy or handling linens and other materials contaminated with chemotherapy or blood and body fluids of patients receiving chemotherapy, wear the following for personal protection:
  - Double layer of powder-free gloves specifically designated for chemotherapy handling (the inner glove is worn under the gown cuff and the outer glove is worn over the cuff)
  - Long sleeve, disposable gowns (without seams or closures that can allow drugs to pass through) made of polyethylene-coated polypropylene or other laminate materials
- Linens contaminated with chemotherapy or blood and body fluids of patients receiving chemotherapy should be placed in the following:
  - Closed-system, puncture- and leak-proof containers labeled “hazardous: chemotherapy contaminated linens”
  - Above referenced container maintained in the infusion center soiled utility room for outpatient settings
  - Above referenced container maintained in the patient room or soiled utility room for inpatient settings
- Chemotherapy preparation equipment (e.g., syringes, tubing, empty vials, etc.), gowns, and gloves should be disposed of in:
  - Closed-system, puncture- and leak-proof containers labeled “hazardous: chemotherapy contaminated waste”
- Wash hands with soap and water after removing gloves used to prepare or administer chemotherapy or clean contaminated linens and other materials
- “Spill kits” with the appropriate gowns, gloves, disposable absorbent materials for cleansing large areas, and hazard sign should be kept in all areas where chemotherapy is prepared and given
- Implement a quality improvement program addressing safe chemotherapy handling that includes the following:
  - Standard operating policies and procedures for:
    - Chemotherapy handling, preparation, and disposal

    - Handling and disposal of chemotherapy spills
    - Handling and disposal of blood and body fluids and contaminated materials of patients receiving chemotherapy
- Conduct competency-based education, training, and performance evaluations regarding chemotherapy safety procedures at orientation and at subsequent regular intervals
- Medical monitoring program to identify indicators of exposure
- Root cause analysis for all chemotherapy spills and exposure incidents

Adapted from National Institute for Occupational Safety and Health. (2008). Personal protective equipment for health care workers who work with hazardous drugs. Retrieved on 7/11/2019 at: www.cdc.gov/niosh/docs/wp-solutions/2009-106/pdfs/2009-106.pdf?id=10.26616/NIOSHPUB2009106; Olsen, M. M., LeFebvre, K. B., & Brassil, K. (Eds.) (2019). *Chemotherapy and immunotherapy guidelines and recommendations for practice*. Pittsburgh, PA: Oncology Nursing Society.

AlloHSCTs are used primarily for diseases of the bone marrow and are dependent on the availability of a human leukocyte antigen–matched donor, which greatly limits the number of possible transplants. An advantage of AlloHSCT is that the transplanted cells should not be immunologically tolerant of a patient's malignancy and should cause a lethal **graft-versus-tumor effect** in which the donor cells recognize the malignant cells and act to eliminate them.

AlloHSCT may involve either myeloablative (high-dose) or nonmyeloablative (mini-transplant) chemotherapy (Yarbro et al., 2018). In ablative AlloHSCT, the recipient receives high doses of chemotherapy and possibly total-body irradiation to completely eradicate (ablate) the bone marrow and any malignant cells and help prevent rejection of the donor stem cells. The collected HSCs that are infused IV into the recipients travel to sites in the body where they produce bone marrow and establish themselves through the process of engraftment. Once engraftment is complete (8 to 10 days, sometimes longer), the new bone marrow becomes functional and begins producing RBCs, WBCs, and platelets. In nonablative AlloHSCT, the chemotherapy doses are lower and aimed at destroying malignant cells (without completely eradicating the bone marrow), thus suppressing the recipient's immune system to allow engraftment of donor stem cells. The lower doses of chemotherapy, associated with less organ toxicity and infection, can be used for older patients or those with underlying organ dysfunction for whom high-dose chemotherapy would be prohibitive (Yarbro et al., 2018). After engraftment, it is hoped that the donor cells will create a graft-versus-tumor effect. Before engraftment, patients are at high risk for infection, sepsis, and bleeding. Side effects of the high-dose chemotherapy and total-body irradiation can be acute and chronic (Negrin, 2018; Yarbro et al., 2018). Acute side effects include headache, alopecia, nausea, vomiting, mucositis, diarrhea, fluid and electrolyte imbalances, and acute kidney injury. Chronic side effects include infertility; pulmonary, cardiac, liver, and kidney

dysfunction; osteoporosis and avascular bone necrosis; diabetes; and secondary malignancies.

During the first 30 days after the conditioning regimen, AlloHSCT patients are at risk for developing hepatic sinusoidal obstructive syndrome (HSOS) (previously referred to as veno-oclusive disease) related to chemotherapy-induced inflammation of the sinusoidal epithelium (Negrin & Bonis, 2019). Inflammation causes embolization of RBCs, resulting in destruction, fibrosis, and occlusion of the sinusoids. Clinical manifestations of HSOS may include weight gain, hepatomegaly, increased bilirubin, and ascites. Although various approaches have been used to treat HSOS, evidence-based strategies have not emerged. The use of peripheral stem cells, specific chemotherapy dosing, and nonmyeloablative regimens have been associated with a decreased incidence (Negrin, 2018; Yarbro et al., 2018).

Graft-versus-host disease (GVHD), a major cause of morbidity and mortality in 30% to 50% of the allogeneic transplant population, occurs when the donor lymphocytes initiate an immune response against the recipient's tissues (e.g., skin, gastrointestinal tract, liver) during the beginning of engraftment (Yarbro et al., 2018). The donor cells view the recipient's tissues as foreign or immunologically different from what they recognize as "self" in the donor. To prevent GVHD, patients receive immunosuppressant drugs, such as cyclosporine, methotrexate, tacrolimus, or mycophenolate mofetil.

GVHD may be acute, occurring within the first 100 days, or chronic, occurring after 100 days (Yarbro et al., 2018). Clinical manifestations of acute GVHD include diffuse rash progressing to blistering and desquamation similar to second-degree burns; mucosal inflammation of the eyes and the entire gastrointestinal tract with subsequent diarrhea that may exceed 2 L per day; and biliary stasis with abdominal pain, hepatomegaly, and elevated liver enzymes progressing to obstructive jaundice. The first 100 days or so after AlloHSCT is crucial for patients; the immune system and blood-making capacity (hematopoiesis) must recover sufficiently to prevent infection and hemorrhage.

Autologous HSCT (AuHSCT) is considered for patients with disease of the bone marrow who do not have a suitable donor for AlloHSCT or for patients who have healthy bone marrow but require bone marrow–ablative doses of chemotherapy to cure an aggressive malignancy (Yarbro et al., 2018). The most common malignancies treated with AuHSCT include lymphoma and multiple myeloma. However, the use of AuHSCT has gained increasing acceptance in treating neuroblastoma, Ewing sarcoma, and germ cell tumors. Stem cells are collected from the patient and preserved for reinfusion; if necessary, they are treated to kill any malignant cells within the marrow, called *purging.* The patient is then treated with ablative chemotherapy and, possibly, total-body irradiation to eradicate any remaining tumor. Stem cells are then reinfused. Until engraftment occurs in the bone marrow sites of the body, there is a high risk of infection, sepsis, and bleeding. Acute and chronic toxicities from chemotherapy and radiation therapy may be severe. The risk of HSOS is also present after

autologous transplantation. No immunosuppressant medications are necessary after AuHSCT, because the patient does not receive foreign tissue. A disadvantage of AuHSCT is the risk that tumor cells may remain in the bone marrow despite high-dose chemotherapy (conditioning regimens).

Syngeneic transplants result in less incidence of GVHD and graft rejection; however, there is also less graft-versus-tumor effect to fight the malignancy. For this reason, even when an identical twin is available for marrow donation, another matched sibling or even an unrelated donor may be the most suitable donor to combat an aggressive malignancy (Yarbro et al., 2018).

Nursing Management

Nursing care of the patient undergoing HSCT is complex and demands a high level of skill. The success of HSCT is greatly influenced by nursing care throughout the transplantation process.

Implementing Care Before Treatment

All patients must undergo extensive evaluations before HSCT to assess the current clinical status of the disease. Nutritional assessments, extensive physical examinations, organ function tests, and psychological evaluations are conducted. Blood work includes assessing past infectious antigen exposure (e.g., hepatitis virus, cytomegalovirus, herpes simplex virus, human immunodeficiency virus, syphilis). The patient's social support systems and financial and insurance resources are also evaluated. Informed consent and patient education about the procedure and care before and after HSCT are vital.

Providing Care During Treatment

Skilled nursing care is required during the treatment phase of HSCT when high-dose chemotherapy (conditioning regimen) and total-body irradiation are given. The acute toxicities of nausea, diarrhea, mucositis, and hemorrhagic cystitis require close monitoring and symptom management by the nurse.

Nursing management during stem cell infusion consists of monitoring the patient's vital signs and blood oxygen saturation; assessing for adverse effects, such as fever, chills, shortness of breath, chest pain, cutaneous reactions, nausea, vomiting, hypotension or hypertension, tachycardia, anxiety, and taste changes; and providing strategies for symptom control, ongoing support, and patient education. During stem cell infusion, patients may experience adverse reactions to the cryoprotectant dimethylsulfoxide (DMSO) used to preserve the harvested stem cells. Less common toxicities include neurologic and renal impairment (Yarbro et al., 2018).

Quality and Safety Nursing Alert

Until engraftment of the new marrow occurs, the patient undergoing HSCT is at high risk for death from sepsis and bleeding.

A cluster of symptoms referred to as engraftment syndrome may occur during the neutrophil recovery phase in both allogeneic and autologous transplants. Clinical features of this syndrome vary widely but may include noninfectious fever associated with skin rash, weight gain, diarrhea, and pulmonary infiltrates, with improvement noted after the initiation of corticosteroid therapy rather than antibiotic therapy (Mutahar & Al-Anazi, 2017). Until engraftment is well established, the patient requires support with blood products and hematopoietic growth factors.

Potential infections may be bacterial, viral, fungal, or protozoan in origin. During the first 30 days following transplant, the patient is most at risk for developing reactivations of viral infections, including herpes simplex, EBV, cytomegalovirus, and varicella zoster. Mucosal denudement poses a risk for *Candida* (yeast) infection locally and systemically. Pulmonary toxicities offer the opportunity for fungal infections such as *Aspergillus*. Renal complications arise from the nephrotoxic chemotherapy agents used in the conditioning regimen or those used to treat infection (amphotericin B, aminoglycosides). A neutropenic diet is usually prescribed for patients to decrease the risk of exposure to foodborne infections from bacteria, yeast, molds, viruses, and parasites (Yarbro et al., 2018).

Tumor lysis syndrome and acute tubular necrosis are also potential complications after HSCT. Nursing assessment for signs of these complications is essential for early identification and treatment. GVHD requires skillful nursing assessment to detect early effects on the skin, liver, and gastrointestinal tract. HSOS resulting from the conditioning regimens used can result in fluid retention, jaundice, abdominal pain, ascites, tender and enlarged liver, and encephalopathy. Pulmonary complications, such as pulmonary edema, interstitial pneumonia, and other pneumonias, often complicate recovery.

Providing Care After Treatment

Nursing care following HSCT includes care of recipients and donors. These are discussed in the following sections.

Caring for Recipients

Ongoing nursing assessment during follow-up visits is essential to detect late effects of therapy after HSCT, which may occur 100 days or more after the procedure (Yarbro et al., 2018). Late effects include infections (e.g., varicella-zoster infection), restrictive pulmonary abnormalities, and recurrent pneumonias. Infertility often results due to total-body irradiation, chemotherapy, or both as components of the ablative regimen. Chronic GVHD can involve the skin, liver,

intestine, esophagus, eyes, lungs, joints, and vaginal mucosa. Cataracts may also develop after total-body irradiation.

There is a high potential of psychological distress following an HSCT, which has been associated with delayed recovery, mortality, and increased rates of complications, such as GVHD (Hermioni, Christina, Melanie, et al., 2019). Thus, psychosocial assessments by nursing staff must be ongoing and a priority. In addition to the multiple physical and psychological stressors affecting patients at each phase of the transplantation experience, the nature of the treatment and patient experience can place extreme emotional, social, financial, and physical demands on family, friends, and donors. Nurses assess the family and other caregivers' needs and provide education, support, and information about resources.

Caring for Donors

Like HSCT recipients, donors also require nursing care. They may experience mood alterations, decreased self-esteem, and guilt from feelings of failure if the transplantation fails. Family members must be educated and supported to reduce anxiety and promote coping during this difficult time. In addition, they must also be assisted to maintain realistic expectations of themselves as well as of the patient.

Immunotherapy and Targeted Therapy

Immunotherapy

Immunotherapy involves the use of medications or biochemical mediators to stimulate or suppress components of the immune system to kill cancer cells (ACS, 2019g). Over the past decade, advances in the understanding of the immune system and about its interaction with cancer have led to significant advances in immunotherapy. This has dramatically changed how patients with cancer are treated and has resulted in improvements in overall survival for many forms of cancer. There are several types of immunotherapy currently being used to treat cancer, including nonspecific immunotherapies, monoclonal antibodies, checkpoint inhibitors, cancer vaccines, and chimeric antigen receptor (CAR) T–cell therapy. Many immunotherapies are targeted therapies. Targeted therapies are discussed later in this chapter.

Nonspecific Immunotherapy

Nonspecific immunotherapy does not target the cancer cell directly, but rather boosts the immune system to enhance cancer cell destruction alone or along with other cancer treatments, such as chemotherapy or radiation therapy (ACS, 2019f). Common nonspecific immunotherapy agents include bacille Calmette-

Guérin (BCG) and cytokines (interferon, interleukins, and colony-stimulating factors).

BCG is one of the earliest immunotherapy agents used to treat cancer. BCG is a live attenuated strain of *Mycobacterium bovis*, which is closely related to the bacterium that causes tuberculosis in people. BCG is most commonly used to treat localized bladder cancer (ACS, 2019h). When instilled into the bladder, BCG serves as an antigen to stimulate an immune response. The intention is that the stimulated immune system will then eradicate malignant cells. Common toxicities associated with BCG therapy include mild flulike symptoms (e.g., fever, chills, malaise), bladder burning/discomfort, urinary frequency, and blood tinged urine, which typically last 2 to 3 days after treatment (ACS, 2019h).

The most commonly used nonspecific immunotherapy agents are cytokines. **Cytokines** are messenger substances that may be released by a cell to create an action at that site or may be carried by the bloodstream to a distant site before being activated; they are also called *biochemical* or *inflammatory mediators.* These substances are produced primarily by cells of the immune system to enhance or suppress the production and functioning of other components of the immune system and thus can be used to treat cancer or the adverse effects of some cancer treatments. Cytokines are grouped into families, such as interferons (IFNs), interleukins (ILs), and colony-stimulating factors. Colony-stimulating factors were described earlier in this chapter for their supportive role in myelosuppressive treatment modalities. (Refer to Chapter 31 for more detailed discussion of the immune system.)

IFNs are cytokines with antiviral, antitumor, and immunomodulatory (inhibition or stimulation of the immune system) properties. Multiple antitumor effects of IFNs include antiangiogenesis, direct destruction of tumor cells, inhibition of growth factors, and disruption of the cell cycle (Yarbro et al., 2018). IFNs are used on a limited basis for the treatment of some solid and hematologic cancers. Similar to IFNs, ILs have immunomodulatory effects on other components of the immune response. IL-2, an interleukin made in a laboratory, has been approved as a treatment option for advanced kidney cancer and metastatic melanoma in adults.

Adverse effects such as fever, myalgia, nausea, and vomiting, as seen with IFN and IL-2 therapy, may not be life-threatening. However, other adverse effects with these therapies (e.g., capillary leak syndrome, pulmonary edema, hypotension) may become life-threatening. These severe toxicities have restricted the use of IFN and IL-2 clinically and have prompted clinicians to seek alternative anticancer therapies (Waldmann, 2018).

Monoclonal Antibodies (MoAbs)

MoAbs, another type of immunotherapy, have become available through technologic advances, enabling investigators to grow and produce targeted antibodies for specific malignant cells. Theoretically, this type of specificity allows MoAbs to destroy the cancer cells and spare normal cells. The specificity

of MoAbs is dependent on identifying key antigen proteins on the surface (outside) of tumors that are not present on normal tissues. When the MoAb attaches to the cell surface antigen, an important signal transduction pathway for communication between the malignant cells and the extracellular environment is blocked. The results may include an inability to initiate apoptosis, reproduce, or invade surrounding tissues.

The production of MoAbs involves injecting tumor cells that act as antigens into mice. B-cell lymphocytes in the spleen of the mouse produce immunoglobulin (antibodies) made in response to the injected antigens. Antibody-producing B-cells are combined with a cancer cell that can grow indefinitely in culture medium and continue producing more antibodies.

The combination of spleen cells and the cancer cells is referred to as a hybridoma. From hybridomas that continue to grow in the culture medium, the desired antibodies are harvested, purified, and prepared for diagnostic or therapeutic use (see Fig. 12-5). Advances in genetic engineering have led to the production of MoAbs with combinations of mouse and human components (*chimeric MoAbs*) or all-human components (*human MoAbs*). MoAbs made with human genes have greater immunologic properties and are less likely to cause allergic and infusion reactions (Norris, 2019).

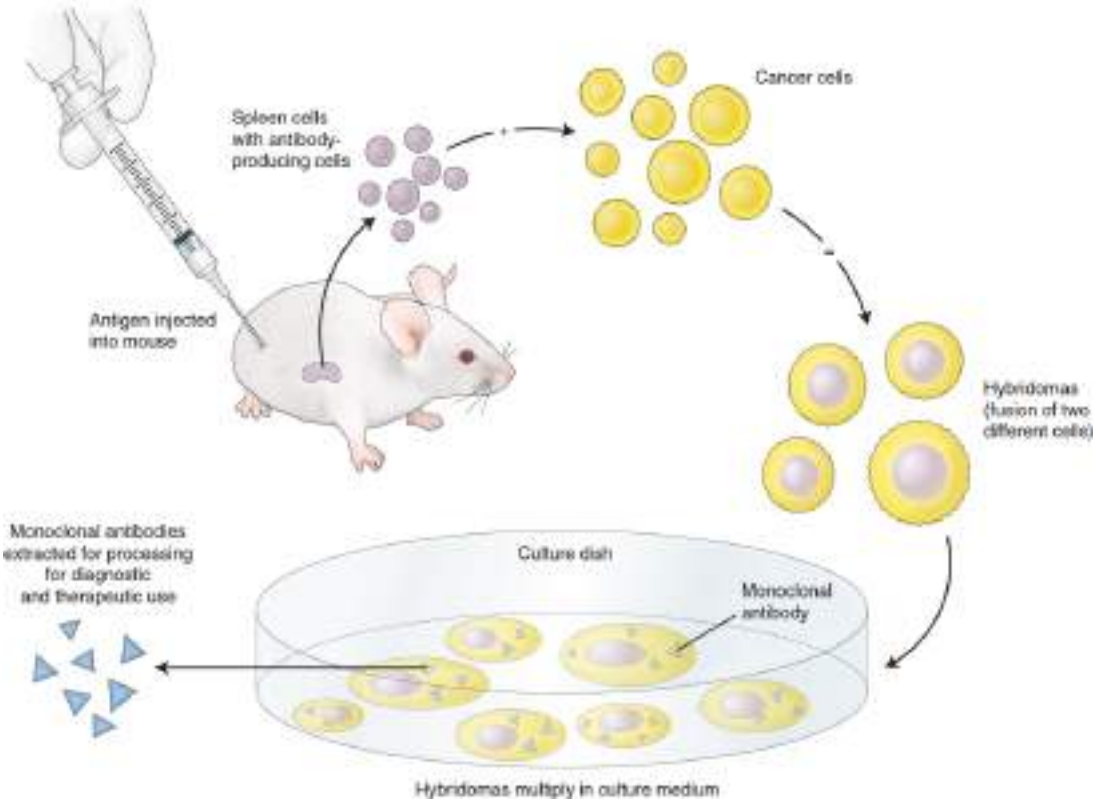

Figure 12-5 • Antibody-producing spleen cells are fused with cancer cells. This process produces cells called *hybridomas.* These cells, which can grow indefinitely in a culture medium, produce antibodies that are harvested, purified, and prepared for diagnostic or treatment purposes.

MoAbs (with names usually ending in -mab) are large particles that work on extracellular molecules, which are usually administered intravenously. Several MoAbs are used for the treatment in cancer using various extracellular (on the cell membrane) and intracellular targets. Trastuzumab targets the HER2 protein, an error of gene overexpression found in breast and other cancers (ACS, 2019g). Rituxumab is a MoAb that binds specifically with the CD20 antigen expressed by non-Hodgkin lymphoma and B-cell chronic lymphocytic leukemia.

Some MoAbs are used alone (termed naked MoAbs), whereas others are used in combination with agents that facilitate their antitumor actions (termed conjugated MoAbs). Ibritumomab tiuxetan, a MoAb conjugated with a radioactive isotope, is used in the treatment of certain types of lymphoma (ACS, 2019g). MoAbs are also used as aids in diagnostic evaluation of both primary and metastatic tumors through radiologic imaging and laboratory techniques (Olsen et al., 2019). For example, the process of immunohistochemistry uses a MoAb tagged with a stain that binds with the protein of interest, providing a visual stain for the presence or absence of the protein (Bishop, Cole, Zhang, et al., 2018). This type of test is used to identify the presence of estrogen and progesterone receptors on breast cancer cells to see if the cells will be responsive

to hormonal agents. Immunohistochemistry testing is also used to detect several proteins associated with hereditary nonpolyposis colon cancers. MoAbs are used to assist in the diagnosis of ovarian, colorectal, breast, and prostate cancers and some types of leukemia and lymphoma. MoAbs are also used in purging residual tumor cells from peripheral stem cell collections for patients who are undergoing HSCT after high-dose cytotoxic therapy. Researchers continue to explore the development and use of MoAbs, either alone or in combination with other substances such as radioactive materials, chemotherapy agents, toxins, and hormones.

MoAbs are associated with both common and unique toxicities (ACS, 2019g). Common toxicities associated with MoAbs include flulike symptoms (e.g., chills, weakness, malaise) headache, nausea and vomiting, diarrhea, rash, proteinuria, hypothyroidism, hypertension, and hepatoxicity. Although mild to moderate allergic and infusion reactions are more commonly associated with chimeric MoAbs, severe HSRs have been seen with MoAb infusions. Other toxicities are specific to the substance attached to the MoAbs.

Checkpoint Inhibitors

The immune system uses inhibitory and acceleratory pathways and immune checkpoints to regulate the antitumor response (ACS, 2019g; Bayer, Amaya, Baniewicz, et al., 2017). Checkpoints are specific proteins on T–cells that need to be blocked (or inactivated) to initiate an immune response against cancer cells. Cancer cells use different mechanisms to avoid recognition by the immune system, thus allowing them to grow unchecked. Immune checkpoint inhibitors block proteins that diminish immune system function and prevent T lymphocytes from identifying and destroying cancer cells. When these mechanisms are blocked, the “brakes are off” and T–cells are released, allowing the immune system to identify and mount an immune response against cancer cells (this is termed an antitumor response).

Recently, special type of MoAbs were developed that block specific checkpoints on T–cells to enhance cancer cell surveillance and destruction by the immune system. These MoAbs are called check point inhibitors. Three classes of checkpoint inhibitors have been approved by the FDA for the treatment of cancer, including cytotoxic T-lymphocyte antigen-4 (CTLA-4), anti-programmed cell death protein 1 (PD-1) receptor, and anti-programmed cell death ligand 1(PD-L1) (Olsen et al., 2019). The CTLA-4 is an intracellular protein within resting T lymphocytes. CTLA receptors on certain T–cells prevent the overactivation of the immune response; thus, blocking this receptor allows for a persistent T–cell antitumor response (Bayer et al., 2017). An example of an immune check point inhibitor that blocks CTLA-4 is ipilimumab. Ipilimumab is currently approved for some forms of melanoma, colorectal cancer, and kidney cancer.

PD-1 is a checkpoint protein on activated T–cells that when bound to another protein called PD-L1 prevents the immune system from mounting a response

against normal cells (Olsen et al., 2019). PD-L1 is also located on some cancer cells, which disrupts immune surveillance and the antitumor response, thus allowing cancer cells to grow unchecked. Immune checkpoint inhibitors that block PD-1 (e.g., nivolumab and pembrolizumab) and PD-L1 (e.g., atezolizumab, avelumab, durvvalumab) are used to treat a wide range of cancers, including: melanoma of the skin, non–small cell lung cancer, kidney cancer, bladder cancer, head and neck cancers, and Hodgkin lymphoma.

Immune checkpoint inhibitors exhibit a different toxicity profile from other anticancer therapies. Thus, the unique toxicities associated with immune checkpoint inhibitors are termed "immune-related adverse events" (irAes). These irAes are thought to be related to an inflammatory response to immune-related activity that can affect any organ or organ system; however, the exact etiology is not fully known (Olsen et al., 2019). IrAes often present with a delayed onset and the severity of toxicities can range from mild to potentially life-threatening. The most common irAes include dermatologic (e.g., rash and pruritus); gastrointestinal (e.g., diarrhea and colitis); pulmonary (e.g., pneumonitis); renal (e.g., nephritis); endocrine (e.g., hypophysitis [inflammation of the pituitary gland], thyroiditis, hyper- and hypothyroidism) toxicities. Prompt recognition of immune-related toxicities is essential to prevent treatment delays and to ensure prompt initiation of effective management strategies, which often include the use of anti-inflammatory medications, such as corticosteroids (Olsen et al., 2019).

Cancer Vaccines

Cancer vaccines mobilize the body's immune response to prevent or treat cancer. These vaccines contain either portions of cancer cells alone or portions of cells in combination with other substances (adjuvants) that can augment or boost immune responses. *Autologous* vaccines are made from the patient's own cancer cells, which are taken from tumor tissue obtained during biopsy or surgical intervention. The cancer cells are killed and prepared for injection back into the patient. *Allogeneic* vaccines are made from cancer cell lines that are immortalized cells that were originally obtained from other people who had a specific type of cancer. These cancer cells are grown in a laboratory and eventually killed and prepared for injection.

Prophylactic vaccines prevent disease. Three vaccines have been approved by the FDA for the prevention of HPV. HPV2 (Cervarix), recommended for use in females only, protects against HPV types 16 and 18 that are responsible for about 70% of all cervical cancers (ACS, 2019g). HPV4 (Gardasil) provides protection against four HPV types (6, 11, 16, and 18) and is recommended for use in both genders. HPV9 (Gardasil-9), recommended for both males and females, protects against nine HPV types associated with cervical, anal, vaginal, and vulvar cancers. HPV9 also protects against genital warts. All of the HPV vaccines are given as a series of three doses over 6 months. Although the role of HPV vaccines in prevention of oropharyngeal cancers related to HPV16 has not

been fully established, there are preliminary data to suggest effectiveness (Wang, Dickie, Sutavani, et al., 2018).

Vaccines are also used to treat existing disease. Therapeutic vaccines kill existing cancer cells and inhibit further cancer development. Sipuleucel-T (ACS, 2019g) is indicated for men with metastatic prostate cancer that is no longer responding to hormone therapy. It is the only therapeutic vaccine currently FDA approved. Therapeutic vaccines do not cure cancer but are associated with improved patient survival.

Chimeric Antigen Receptor (CAR) T–Cell Immunotherapy

A new addition to the treatment of cancer with immunotherapy is chimeric antigen receptor (CAR) T–cell therapy. CAR T–cell is a type of targeted immunotherapy that uses tumor-specific antigen recognition to target specific malignancies. CAR T–cell therapy involves the use of genetically modified T–cells to kill cancer cells (Lamprecht & Dansereau, 2019; Olsen et al., 2019). For example, in CART-19 therapy, cluster of differentiation (CD)–19 is the target antigen. This antigen is commonly overexpressed in acute lymphoblastic leukemia and certain types of non-Hodgkin lymphoma (Bayer et al., 2017). The only two CAR T–cell immunotherapy agents currently FDA-approved both target CD19 (tisagenlecleucel and axicabtagene ciloleucel). Tisagenlecleucel is approved to treat adults with relapsed or refractory non-Hodgkin lymphoma and young adults (up to 25 years old) with relapsed or refractory acute lymphoblastic leukemia. Axicabtagene and ciloleucel are approved to treat certain types of relapsed or refractory B-cell lymphoma (Olsen et al., 2019).

The process of making CAR genetically modified T–cells begins with collecting T–cells. T–cells may be collected from the patient (autologous) or collected from a healthy donor (allogeneic) using leukapheresis. The T–cells are sent to the laboratory where they are genetically altered by adding a specific chimeric antigen receptor. This process takes several weeks to make enough CAR T–cells needed for therapy. When there are enough CAR T–cells (based on the patient's body weight), the cells are infused to the patient in a procedure similar to a blood transfusion (Lamprecht & Dansereau, 2019). A few days before a CAR T–cell infusion, the patient may be given chemotherapy to reduce the number of other immune cells to make room for the new CAR T–cells to expand and proliferate. Once infused, the CAR T–cells will continue to grow (up to a year or more postinfusion) while binding with tumor-specific antigen to kill cancer cells.

The two most common toxicities related to CAR T–cell therapy are CRS and neurologic toxicities (Anderson & Latchford, 2019). CRS, also referred to as cytokine storm, is the most common toxicity of CAR T–cell therapy and is experienced to some degree by most patients. During therapy, the infused CAR T–cells and other immune cells stimulate the release of inflammatory cytokines resulting in a systemic inflammatory response, which usually occurs within a few days of treatment. Clinical manifestations of CRS most commonly include

fever (hallmark sign), tachycardia, chills, myalgias, arthralgias, and fatigue. Although, if the CRS is severe, hypotension, dyspnea, hypoxia, respiratory distress, coagulopathies, and end-organ toxicities may occur (Anderson & Latchford, 2019). Neurologic toxicities can range from a headache and mild confusion to cerebral edema or intracranial hemorrhage. Although the exact etiology of neurologic toxicities related to CAR T–cell therapy is not yet known, it has been postulated that increased vascular permeability, increased cytokine levels, and the ability of the cells to cross the blood–brain barriers may be factors (Anderson & Latchford, 2019). Other toxicities seen with CAR T–cell therapy include tumor lysis syndrome, myelosuppression (neutropenia, anemia, and thrombocytopenia), and hypogammaglobulinemia.

Targeted Therapies

Normal cell growth is regulated by well-defined communication pathways between the environment surrounding the cell and the internal cell environment, the nucleus, and the intracellular cytoplasm. The cell membrane contains important protein receptors that respond to signals transmitted from the external cell environment and transmit that signal to the internal cell environment using enzymatic pathways called *signal transduction pathways.* Although normal cells have transduction pathways, scientific advances have led to the recognition that cancer, at the cellular level, is characterized by deregulated cell signaling transduction pathways (both intra- and extracellular pathways), as well as altered cell membrane receptors and proteins that play an important role in tumor initiation, growth, and spread (Norris, 2019). This improved understanding of cancer cell behavior has allowed scientists to develop molecular-based therapies, called targeted therapies.

Targeted therapies involve the use of agents to kill or prevent the spread of cancer cells by targeting a specific part of the cell, with less negative effects on healthy cells than conventional chemotherapy. These agents specifically target (like a lock and key mechanism) receptors, proteins, signal transduction pathways, and other processes to prevent the continued growth of cancer cells (NCI, 2019d). Targeted therapies allow for cancer treatment to be "personalized" to the unique molecular basis of the patient's cancer. To determine if a patient would benefit from a targeted therapy, the patient's cancer cells must be evaluated in the laboratory to determine if they have enough of the target molecule for the therapy to be effective. Thus, not all patients with the same type of cancer may benefit from the same targeted treatment. New unique molecular targets are regularly being identified, resulting in the discovery of many new targeted agents over the past decade (Olsen et al., 2019).

There are two main types of targeted therapies: monoclonal antibodies (previously discussed in the immunotherapy section) and small molecule drugs. Small molecule drugs (with names usually ending in -nib) target specific molecules on the inside of the cancer cells and are usually administered orally.

Targeted therapies are further classified in accordance with their mechanism of action (or the unique molecule targeted) (Olsen et al., 2019). There is a good amount of overlap in the mechanism of action of these agents because many targeted therapies work via complex pathways and have more than one target molecule. An overview of common categories of targeted therapies including tyrosine kinase inhibitors, EGFR inhibitors, vascular endothelial growth factor/receptor inhibitors, multikinase inhibitors, and proteasome inhibitors are discussed below using small molecule drugs as exemplars.

Tyrosine kinase inhibitors block a group of enzymes called tyrosine kinases, which regulate many cellular functions including signaling cellular growth and division (Olsen et al., 2019). Overexpression (too much) of tyrosine kinase is found in some cancer cells. Blocking these enzymes may prevent cancer cell growth. An example of a tyrosine kinase inhibitor is imatinib mesylate, which is used to treat cancers with an overexpression of BCR-ABL, such as chronic myeloid leukemias, acute lymphoblastic leukemias, and gastrointestinal stromal tumors (Comerford & Durkin, 2020).

Epidermal growth factor receptor (EGFR) inhibitors block a specific surface protein called epidermal growth factor (EGF), which is present on both normal and cancer cells. The overexpression of EGF in cancer cells promotes division and growth; thus, blocking EGFR can result in decreased cancer cell proliferation (Olsen et al., 2019). For example, erlotinib blocks the tyrosine kinase domain of the EGF protein to reduce cancer cell growth. Elotinib is approved to treat advanced non–small cell lung cancer and advanced pancreatic cancer in combination with chemotherapy (Comerford & Durkin, 2020).

Vascular endothelial growth factor/receptor inhibitors (VEGFRIs) are agents that block vascular endothelial growth factor, which is produced by cells to stimulate **angiogenesis** (the growth of new blood vessels). As such, VEGFRIs inhibit angiogenesis, which prevents cancer cells from receiving adequate amounts of oxygen and nutrients needed for growth. VEGFRIs are used to treat various types of cancer, including soft tissue sarcomas, and thyroid, lung, kidney, and colorectal cancers. For example, axitinib is a VEGFRI approved to treat advanced renal cell carcinoma (kidney cancer) after failure of one prior systemic therapy (Comerford & Durkin, 2020; Olsen et al., 2019).

Multikinase inhibitors (MKIs) inhibit several intracellular and extracellular (surface) kinases that play a role in cellular growth and metastatic processes to reduce cancer cell growth and replication (Comerford & Durkin, 2020; Olsen et al., 2019). Sorafenib is an example of an MKI that inhibits several kinase receptor pathways (e.g., c-KIT, PDGFR, RAF, RET, VEGFR-1, VEGFR-2, VEGFR-3). Sorafenib is used to treat several different cancer types including liver, kidney, and thyroid cancers.

Proteasome inhibitors inhibit proteasome cellular complexes, that prevent certain enzymes from making proteins (Comerford & Durkin, 2020; Olsen et al., 2019). Proteasome helps maintain intracellular homeostasis by regulating proteins that facilitate cell division and prevent cell death. Thus, blocking

proteasome interferes with cell division and enhances cancer cell death. An example of a proteasome inhibitor is bortezomib, which is approved to treat multiple myeloma and certain types of lymphoma (e.g., mantle cell lymphoma).

Common toxicities that occur with targeted therapies include mucositis, nausea, vomiting, diarrhea, abdominal pain, electrolyte and fluid imbalances, skin rash, impaired wound healing, hypertension, and myelosuppression (decreased red blood cells, WBCs, and platelets) (Comerford & Durkin, 2020; Olsen et al., 2019). Peripheral neuropathy can also occur with some proteasome inhibitors. More serious complications of targeted therapy include cardiotoxicity (e.g., brotezomib) and hepatoxicity (e.g., sorafenib).

Nursing Management

Patients receiving immunotherapy and targeted therapy have many of the same needs as patients undergoing other conventional cancer treatments. However, manipulation and stimulation of the immune system also creates unique challenges (Bayer et al., 2017; Olsen et al., 2019). Nurses must be aware of the adverse effects of these therapies and recognize the signs and symptoms of serious reactions to emergently institute appropriate interventions and supportive care. Nurses monitor patients for the impact of adverse effects on performance status and quality of life so that appropriate measures can be implemented to improve patient outcomes. The nurse must also assist in planning and evaluating patient care, and assess the need for education, support, and additional resources for both the patient and the family.

Patient education is important, as many of the toxicities are not only a source of physical discomfort, but they may also affect quality of life and patient adherence to treatment (Olsen et al., 2019; Yarbro et al., 2018). Key points of education related to immunotherapy and targeted therapy include providing information about (Bayer et al., 2017; Olsen et al., 2019; Yarbro et al., 2018):

- prescribed treatment(s) and associated toxicities to allow for prompt recognition of potentially treatment-limiting (e.g., peripheral neuropathy) and life-threatening (i.e., heart and liver failure) toxicities;
- the importance of reporting new symptoms or the exacerbation of existing symptoms promptly to the health care provider;
- how and when to contact the primary provider and seek the assistance of emergency medical services; and
- how to provide self-care during and after treatment.

Patient and family education should also include attention to general standards of care relevant to all anticancer treatment (such as principles of infection control, hand hygiene, nutrition and hydration, safe sexual practices, good skin care) and instructions to notify the health care provider about any newly prescribed or over-the-counter medications, including herbs, vitamins, and dietary supplements (Bayer et al., 2017).

Promoting Home, Community-Based, and Transitional Care

The nurse educates patients about self-care and assists in providing for continuing care. Some cancer immunotherapy and targeted therapies can be given subcutaneously (e.g., trastuzumab and denosumab) by the patient or family members at home. As needed, the home health nurse educates the patient and family how to administer these agents and monitors the use of appropriate technique as well as safe disposal of sharps and contaminated materials. The nurse also provides education about toxicities and helps the patient and family identify strategies to manage common side effects of immunotherapy and targeted therapy.

The use of oral medications to treat cancer has risen greatly in the past several years, especially with advances in targeted therapies, many of which are given by mouth. Since 2015, more than 50 oral anticancer medications were approved by FDA and it is estimated between 25% and 35% of all anticancer therapies being developed are orally administered (Dusetzina, Huskamp, Winn, et al., 2018; Kays, 2018). The rising use of oral therapies shifts the responsibility for delivery of treatment to patients and families in the home setting. Treatment approaches with newer mechanisms of action and associated toxicities, as well as the transition of responsibility to patients and families, increase the need for nurses to identify factors affecting adherence and to develop strategies to address adherence barriers (see Table 12-8).

TABLE 12-8 Strategies for Promoting Adherence to Oral Antineoplastic Agents

Assess for factors that may interfere with adherence to oral antineoplastic agents; develop plan of care that identifies and addresses specific assessment findings.

Barriers to Adherence	Strategies for Promoting Adherence
Sociodemographic Factors • Limited financial resources • Competing priorities for financial resources • Joblessness • Limited or no insurance • Racial or ethnic disparities • Lower level of education • Poor health literacy • Illiteracy • Non–English speaking • Lack of transportation • Lack of or limited social support • Rural residence	• Refer to financial counseling through health care facility, local nonprofit health/oncology support/advocacy, or other nonprofit community advocacy organizations. • Refer to social worker for referrals as described above and/or for disability applications through employer or Social Security Administration, Medicaid, or Medicare applications. • Explore patient assistance programs for costs of health care, copays, medications, household costs, transportation services (costs or availability), and home care available through nonprofit organizations, oncology support/advocacy or other nonprofit community advocacy organizations, religious institutions, philanthropic organizations, pharmaceutical industry–sponsored programs, health care institution–specific programs; assist with financial documentation and application procedures as needed. • Explore assistance programs for other priorities competing for financial resources (e.g., for utility costs, gas, child care, food). • Assist patient to identify family, friends, or other available supports to assist with activities of daily living, household responsibilities, errands, shopping, meals, transportation or other responsibilities; assist with delegation of needs and schedules of availability if needed. • Assess preferred method of learning (e.g., verbal, visual, written materials); tailor instructional materials to patient needs, including language. • Include family, significant other, and friends in education whenever feasible. • Use return demonstration of behaviors and devices used to support adherence. • Provide contact information that spans 24 h for questions or problems. • Contact patient by phone or other means (e-mail, texting, video conference, telehealth) to assess for concerns in between follow-up visits to provider. • Encourage patient to use adherence reminders, such as pill boxes, medication calendars, checklists, medication diaries, alarms on cell phone or other devices/timers; explore availability of programmed telephone reminder services, text messages from family member, friend, or other caregiver; review diary at each visit. • Instruct patient to bring pill bottles to each follow-up visit; perform pill counts to monitor adherence. • Send postcard reminder to patient weekly (or less often) or 1 wk prior to due date for medication refill.

	• Refer to home care for continued education and follow-up on adherence. • Identify local pharmacies that supply oral medications for cancer therapies. Instruct patients to contact nurse if the pharmacy cannot fill the prescription within 24 h. • Remind patients to anticipate need for adequate supply of medications prior to travel or vacation.
Age • Older adults; especially those >75 yrs	• Ensure that printed education materials and instructions are printed in black using at least 14-point sans serif font such as Arial or Calibri. • Use illustrated education materials. • Review and revise adherence strategies if patient status declines or changes. • Explore availability of alarmed medication box.
Beliefs • Oral medications less effective or important than IV treatments • Fatalism about disease outcomes	• Provide education regarding oral versus IV medications. • Discuss goals of care and ongoing assessment of response to treatment.
Comorbidities • Preexisting chronic disease • Vision or hearing impairments	• Communicate with primary care and other providers involved in care of patient regarding current cancer disease status and treatment; collaborate with other providers for ongoing management of nononcology issues or exacerbation of issues that may impact cancer treatment adherence. • Collaborate with appropriate resources to assist with special needs and assistive devices for vision or hearing impairments.
Polypharmacy • Multiple medications for comorbidities or cancer treatment and symptom management	• Review all medications prescribed by oncology physicians and other providers involved in care of patient for preexisting chronic disease. • Assess patient use of over-the-counter medications and other agents. • Consult with pharmacist to identify medications and other agents that may be contraindicated or that may interfere with antineoplastic regimen. • Collaborate with all providers prescribing medications in order to simplify or reduce number of required medications if possible.

	• Provide patient, family, or other caregiver education regarding specific instructions when multiple medications are required. • Provide written checklist for patient to utilize daily to check off each medication when taken. • Check if patient prescriptions allow for refills; prescriptions should be for a finite period of time that concludes with next scheduled visit.
Psychiatric, Psychological, or Cognitive Concerns • Psychiatric disease • Depression • Cognitive impairments • Anxiety	• Avoid initial education regarding oral medications at the same time of first provider visit; have patient and other learners return for another appointment to see nurse for education and follow-up with subsequent visit if deemed to be at high risk for adherence challenges. • Discuss with provider the necessity for referral to psychiatrist to evaluate need for psychotropic medications. • Refer patient for professional mental health counseling as needed. • Identify additional supports for care and education as discussed earlier.
Disease Factors • Symptoms such as pain, nausea, fatigue, skin rashes, etc. • Impaired mobility	• Proactively assess and manage symptoms related to underlying disease or treatments. • Provide patient, family, or other caregivers education about expected side effects and management strategies. • Instruct patient to premedicate with antiemetic as prescribed 30 min prior to taking oral antineoplastic agent if needed for nausea or vomiting. • Identify additional supports for care as discussed earlier. • Assess need for referral to home physical or occupational therapy to address impaired mobility and need for assistive devices.
Communication Issues • Patient–Clinician • Clinician–Clinician	• Establish rapport and allow patients, families, and other caregivers time and opportunity to ask questions. • Do not assume adherence to oral antineoplastic agents; emphasize the value and importance of adherence and assess potential barriers consistently throughout course of treatment at each follow-up visit. • Communicate with primary provider regarding current cancer disease status, treatment and information regarding antineoplastic agents, such as drug–drug interactions, expected toxicities, and toxicities requiring prompt intervention.

IV, intravenous.

Adapted from Olsen, M. M., LeFebvre, K. B., & Brassil, K. (Eds.). (2019). *Chemotherapy and immunotherapy guidelines and recommendations for practice*. Pittsburgh, PA:

The nurse collaborates with physicians, social workers, third-party payers, and pharmaceutical companies to help the patient obtain reimbursement or support for the cost of oral cancer therapies and other required medications (Dusetzina et al., 2018). The nurse also reminds the patient about the importance of keeping follow-up appointments with the primary provider and assesses the patient's need for symptom management related to the underlying diseases or adverse effects of treatment. Home health nurses maintain communication with the primary provider regarding patient adherence and tolerance of treatment so that changes in care can be implemented in a timely fashion.

Complementary, Alternative, and Integrative Health Therapies

Integrative health care is viewed as a comprehensive, interdisciplinary approach to preventing and treating illness and promoting health that brings together complementary, alternative, and conventional therapies. The use of an integrative approach to health and wellness has grown within mainstream health care settings in the United States, particularly within oncology care (National Center for Complementary and Integrative Health [NCCIH], 2018).

Individuals use complementary approaches to prevent and treat cancer, although there are no data to support efficacy. Patients also use complementary approaches to manage symptoms related to cancer and associated treatments; some approaches are supported by clinical research while others are not. It is estimated that as many as 67% of people diagnosed with cancer use some form of complementary medicine (Wanchai, Armer, Smith, et al., 2017). However, many patients do not routinely communicate complementary practices to their health care providers because they usually are not asked about its use; they withhold the information, fearing that their provider would not approve, or they feel that the use of these approaches will not affect the conventional treatment they are receiving.

Although many complementary modalities can be a source of comfort and emotional support for patients, assessment of complementary therapy use is important for patient safety. Patients often perceive vitamins and dietary supplements as harmless, natural products that have no side effects or potential toxicities. In patients receiving any conventional therapies, the use of herbs or botanicals may interfere with drug metabolism, decrease or increase desired effects, or contain elements of uncertain pharmacologic capacities (NCCIH, 2018). Deep tissue massage and other manipulative therapies are contraindicated in patients with open wounds, radiodermatitis, thrombocytopenia, VTE, and coagulation disorders, and in those taking anticoagulants. See Chapter 4 for more information on complementary, alternative, and integrative health therapies.

COVID-19 Considerations

The novel coronavirus disease 2019 (COVID-19) pandemic began in Wuhan, China, in late 2019. Since that time, several risks for both severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and pathogenesis to COVID-19 have been posed (see Chapter 66). Epidemiologic findings from early data in China suggest that having cancer could be an important risk factor for becoming infected with SARS-CoV-2 as well as increasing the risk of mortality from COVID-19 (Deng, Yin, Chen, et al., 2020). Many cancer clinicians and researchers worldwide recognized during the early days of the pandemic that there was an urgent need to identify idiosyncratic risks and treatment issues that revolve around managing adults with both COVID-19 and cancer. As a result, the COVID-19 and Cancer Consortium (CCC19) was established (see Resources section for link to CCC19). An early cohort study sponsored by CCC19 of 928 patients from the United States, Canada, and Spain with either a history of cancer or active malignancy identified prognostic factors for mortality and severe COVID-19 (Kuderer, Choueiri, Shah, et al., 2020). Overall 13% of the patients died (Kuderer et al., 2020), a higher mortality rate than the 5.6% case fatality rate for all adult patients in the United States with COVID-19 (Johns Hopkins University & Medicine Coronavirus Resource Center, 2020). The researchers identified the following factors as associated with an increase in 30-day mortality: older age, male sex, a history of smoking, having two or more comorbidities, having an active cancer, and having received azithromycin plus hydroxychloroquine during treatment for COVID-19 (Kuderer et al., 2020). The four most common presenting symptoms of COVID-19 in these patients included fever, cough, fatigue or malaise, and dyspnea; the same as for all patients with COVID-19 (Kuderer et al., 2020). There was no association between having recently had surgery and either having severe COVID-19 or dying, suggesting that surgery indicated for patients with cancer should not be postponed due to pandemic concerns (Kuderer et al., 2020). CCC19 will continue to analyze registry data of patients with COVID-19 and cancer and publicize noteworthy findings as they become available, to facilitate optimal management of patients with COVID-19 and cancer (Kuderer et al., 2020).

Nursing Care of the Patient with Cancer

The outlook for patients with cancer has greatly improved because of scientific and technologic advances. However, as a result of the underlying disease or various treatment modalities, patients with cancer may experience a variety of secondary problems such as reduced WBC counts, infection, bleeding, skin and nutritional problems, pain, fatigue, and psychological stress. Chart 12-6 provides a nursing care plan for the patient with cancer.

Maintaining Tissue Integrity

Some of the most frequently encountered disturbances of tissue integrity include stomatitis, skin and tissue reactions to radiation therapy, cutaneous toxicities associated with targeted therapy, alopecia, and metastatic skin lesions.

Stomatitis

Mucositis, a common side effect of radiation and some types of chemotherapy, refers to an inflammatory process involving the mucous membranes of the oral cavity and the gastrointestinal tract. **Stomatitis**, a form of mucositis, is an inflammatory process of the mouth, including the mucosa and tissues surrounding the teeth. Stomatitis is characterized by changes in sensation, erythema (mild redness), and edema or, if severe, by painful ulcerations, bleeding, and secondary infection. Stomatitis commonly develops within 3 to 14 days after patients receive certain chemotherapeutic agents (e.g., 5-fluorouracil and doxorubicin), immunotherapies (e.g., IL-2 and nivolumab); and targeted therapies (e.g., temsirolimus and everolimus). Stomatitis affects up to 100% of patients undergoing high-dose chemotherapy with HSCT, 90% of patients with malignancies of the head and neck receiving radiotherapy, and up to 40% of patients receiving standard-dose chemotherapy (Eilers, Asakura, Blecher, et al., 2017; Olsen et al., 2019). Stomatitis may be worse in patients with head and neck cancers who receive combined modality therapy of both radiation and chemotherapy. When severe, stomatitis can lead to interruptions, delays, and modifications in the course of treatment, all of which may contribute to less desirable patient outcomes. Severe oral pain can significantly affect swallowing, nutritional intake, speech, quality of life, coping abilities, and willingness to adhere to treatment regimens. In addition, stomatitis may lead to more frequent health care visits, hospitalizations, and increased health care costs (Berger, Schopohl, Bollig, et al., 2018). Stomatitis and mucositis are attributed to a cascade of molecular processes and submucosal endothelial cell destruction that begin almost immediately after the initiation of radiation and certain types of chemotherapy, prior to the development of signs and symptoms. Mucositis develops because of a sequence of related and interacting biologic events, culminating in injury and apoptosis of basal epithelial cells, leading to the loss of epithelial renewal, atrophy, and ulceration. Gram-positive and gram-negative organisms can invade the ulcerated tissue and result in infection.

Nursing assessment begins with an understanding of the patient's usual practices for oral hygiene and identification of individuals at risk for stomatitis. Oral cavity assessment is performed daily or at each patient visit (Olsen et al., 2019). Risk factors and comorbidities associated with stomatitis include poor oral hygiene, general debilitation, existing dental disease, prior irradiation to the head and neck region, impaired salivary gland function, the use of other medications that dry mucous membranes, myelosuppression, tobacco use, previous cancer treatment with a stomatotoxic agent or radiation therapy, diminished renal function, impaired nutritional status, and both older (>65 years) and younger (<20 years) ages (Olsen et al., 2019). The patient is also assessed for dehydration, infection, pain, and nutritional impairment resulting from mucositis.

Optimal evidence-based prevention and treatment approaches for stomatitis remain limited but continue to be studied across disciplines (Bowen, Gibson, Coller,

et al., 2019; Eilers et al., 2017). Most clinicians agree that maintenance of good oral hygiene, including brushing, flossing, rinsing, and dental care, is necessary to minimize the risk of oral complications associated with cancer therapies.

Palifermin, an IV-administered synthetic form of human keratinocyte growth factor, is beneficial in the prevention and management of stomatitis in patients with hematologic malignancies who are preparing for HSCT and in those undergoing chemotherapy for head and neck cancer (Bowen et al., 2019; Eilers et al., 2017). Palifermin promotes epithelial cell repair and accelerated replacement of cells in the mouth and gastrointestinal tract. Careful timing of administration and monitoring are essential for effectiveness and to detect adverse effects. Other approaches recommended for practice include cryotherapy (topical application of oral ice during infusions), consistent oral hygiene, low-level laser therapy, and sodium bicarbonate mouth rinses (Bowen et al., 2019; Eilers et al., 2017; Olsen et al., 2019). Additional aspects of care are discussed in Chart 12-6: nursing care plan for patients with cancer.

Chart 12-6 **PLAN OF NURSING CARE**

The Patient with Cancer

NURSING DIAGNOSIS: Risk for infection associated with inadequate defenses related to myelosuppression secondary to radiation or antineoplastic agents
GOAL: Prevention of infection

Nursing Interventions	Rationale	Expected Outcomes
1. Assess patient for evidence of infection. a. Check vital signs every 4 hours. b. Monitor white blood cell (WBC) count and differential each day. c. Inspect all sites that may serve as entry ports for pathogens (IV sites, wounds, skin folds, bony prominences, perineum, and oral cavity). 2. Report fever (≥38.3°C [101°F] or ≥38°C [100.4°F] for >1 hour) (see Table 12-10), chills, diaphoresis, swelling, heat, pain, erythema, exudate on any body surfaces. Also report change in respiratory or mental status, urinary frequency or burning, malaise, myalgias, arthralgias, rash, or diarrhea. 3. Obtain cultures and sensitivities as indicated before initiation of antimicrobial treatment (wound exudate, sputum, urine, stool, blood). 4. Initiate measures to minimize infection.	1. Signs and symptoms of infection may be diminished in the immunocompromised host. Prompt recognition of infection and subsequent initiation of therapy will reduce morbidity and mortality associated with infection. 2. Early detection of infection facilitates early intervention. 3. Tests identify the organism and indicate the most appropriate antimicrobial therapy. The use of inappropriate antibiotics enhances proliferation of additional flora and encourages growth of antibiotic-resistant organisms. 4. Exposure to infection is reduced. a. Preventing contact with pathogens helps prevent infection. b. Hands are significant source of contamination. c. Incidence of rectal and perianal abscesses and subsequent	• Demonstrates normal temperature and vital signs • Exhibits absence of signs of inflammation: local edema, erythema, pain, and warmth • Exhibits normal breath sounds on auscultation • Takes deep breaths and coughs every 2 hours to prevent respiratory dysfunction and infection. • Exhibits absence of pathogens on cultures • Avoids contact with others with infections • Avoids crowds • All personnel carry out hand hygiene after each voiding and bowel movement. • Excoriation and trauma of

a. Discuss with patient and family:
   1. Placing patient in private room if absolute WBC count <1000/mm^3.
   2. Importance of patient avoiding contact with people who have known or recent infection or recent vaccination.

b. Instruct all personnel in careful hand hygiene before and after entering room.

c. Avoid rectal or vaginal procedures (rectal temperatures, examinations, suppositories; vaginal tampons).

d. Use stool softeners to prevent constipation and straining.

e. Assist patient in practice of meticulous personal hygiene.

f. Instruct patient to use electric razor.

g. Encourage patient to ambulate in room unless contraindicated.

h. Provide patient and family education on food hygiene and safe food handling.

i. Each day change water pitcher, systemic infection is high. Manipulation may cause disruption of membrane integrity and enhance progression of infection.

d. Minimizes trauma to tissues

e. Prevents skin irritation

f. Minimizes skin trauma

g. Minimizes chance of skin breakdown and stasis of pulmonary secretions

h. No evidence supports dietary restrictions of avoiding raw or fresh fruit and vegetables for patients who are neutropenic. General precautions regarding food handling and storage are recommended.

i. Stagnant water is a source of infection.

5. Hospital-acquired sepsis is closely associated with IV catheters.
   a. Incidence of infection is increased when catheter is in place >72 hours.
   b. Chlorhexidine is effective against many gram-positive

skin are avoided.

- Trauma to mucous membranes is avoided (avoidance of rectal thermometers, suppositories, vaginal tampons, perianal trauma).
- Uses evidence-based procedures and techniques if participating in management of invasive lines or catheters
- Uses electric razor
- Is free of skin breakdown and stasis of secretions
- Adheres to dietary and environmental precautions
- Exhibits no signs of sepsis or septic shock
- Exhibits normal vital signs, cardiac output, and arterial pressures when monitored

denture cleaning fluids, and respiratory equipment containing water. 5. Assess IV sites every day for evidence of infection. a. Change peripheral short-term IV sites every other day. b. Cleanse skin with chlorhexidine before arterial puncture or venipuncture. c. Change central venous catheter dressings every 48 hours. d. Change all solutions and infusion sets every 72–96 hours. e. Follow Infusion Nursing Society guidelines for care of peripheral and central venous access devices. 6. Avoid intramuscular injections. 7. Avoid insertion of urinary catheters; if catheters are necessary, use aseptic technique. 8. Educate patient or family member to administer granulocyte (or granulocyte-macrophage) colony-stimulating factor when prescribed. 9. Advise patient to avoid exposure to animal excreta, discuss dental procedures with primary provider, avoid	and gram-negative pathogens. c. Allows observation of site and removes source of contamination. d. Once introduced into the system, microorganisms can grow in infusion sets despite replacement of container and high flow rates. e. Infusion Nursing Society collaborates with other nursing subspecialties in determining guidelines for IV access care. 6. Reduces risk for skin abscesses. 7. Rates of infection greatly increase after urinary catheterization. 8. Granulocyte colony-stimulating factor decreases the duration of neutropenia and the potential for infection. 9. Minimizes exposure to potential sources of infection and disruption of skin integrity	• Demonstrates ability to administer colony-stimulating factor • Has bowel movements at regular intervals without constipation or straining • Patient hygiene is maintained. • Absence of IV catheter–related infection • Absence of skin abscesses • Absence of urinary catheter–related infection

vaginal douche, and avoid vaginal or rectal manipulation during sexual contact during the period of neutropenia.		
NURSING DIAGNOSIS: Risk for impaired skin integrity: erythematous and wet desquamation reactions to radiation therapy **GOAL:** Maintenance of skin integrity		
Nursing Intervention	**Rationale**	**Expected Outcomes**
1. In erythematous areas: a. Avoid the use of soaps, cosmetics, perfumes, powders, lotions, and ointments; non–aluminum-based deodorant may be used on intact skin. b. Use only lukewarm water to bathe the area. c. Avoid rubbing or scratching the area. d. Avoid shaving the area with a straight-edged razor. e. Avoid applying hot-water bottles, heating pads, ice, and adhesive tape to the area. f. Avoid exposing the area to sunlight or cold weather. g. Avoid tight clothing in the area. Use cotton clothing. h. Topical agents such as Aquaphor,	1. Care to the affected areas must focus on preventing further skin irritation, drying, and damage. a. These substances may cause pain and additional skin irritation and damage. b. Avoiding water of extreme temperatures and soap minimizes additional skin damage, irritation, and pain. c. Rubbing, scratching, or both will lead to additional skin irritation, damage, and increased risk of infection. d. The use of razors may lead to additional irritation and disruption of skin integrity and increased risk of infection. e. Avoiding extreme temperatures minimizes	• Avoids use of soaps, powders, and other cosmetics on site of radiation therapy • States rationale for special care of skin • Exhibits minimal change in skin • Avoids trauma to affected skin region (avoids shaving, constricting and irritating clothing, extremes of temperature, and the use of adhesive tape) • Reports change in skin promptly • Demonstrates proper care of blistered or open areas

radiacare gel, aloe vera, or biafine may be used, and low- or medium-potency corticosteroid cream may be given if pruritus is present.

2. If wet desquamation occurs:

   a. Do not disrupt any blisters that have formed.

   b. Avoid frequent washing of the area.

   c. Report any blistering.

   d. Use prescribed creams or ointments; topical antibacterial creams may help to dry a wet wound (e.g., Silvadene cream).

   e. If area weeps, apply a nonadhesive absorbent dressing.

   f. If the area is without drainage, moisture and vapor-permeable dressings, such as hydrocolloids and hydrogels on noninfected areas, have been used in many settings.

   g. Consult with wound-ostomy-continence nurse (WOCN) and primary provider if eschar forms.

additional skin damage, irritation, burns, and pain.

   f. Sun exposure or extreme cold weather may lead to additional skin damage and pain.

   g. Allows air circulation to affected area

   h. May aid healing; however, evidence supporting the benefits of topical agents is lacking.

2. Open weeping areas are susceptible to bacterial infection. Care must be taken to prevent introduction of pathogens.

   a. Disruption of skin blisters disrupts skin integrity and may lead to increased risk of infection.

   b. Frequent washing may lead to increased irritation and skin damage, with increased risk of infection.

   c. Blistering of skin represents progression of skin damage.

   d. Anecdotally believed to decrease irritation and inflammation of the area and promote healing; although a variety of products are used in many settings, there are

- Exhibits absence of infection of blistered and opened areas.
- Wound is free of development of eschar

few randomized controlled trials with evidence to support one product or intervention over another.

e. Easier to remove and associated with less pain and trauma when drainage dries and adheres to dressing.

f. May promote healing; however, randomized controlled clinical trial support is lacking in the setting of moist desquamation. Hydrocolloid dressings may enhance comfort.

g. Eschar must be removed to promote healing and prevent infection. WOCNs have expertise in the care of wounds.

NURSING DIAGNOSIS: Impaired oral mucous membrane integrity: stomatitis
GOAL: Maintenance of intact oral mucous membranes

Nursing Intervention	Rationale	Expected Outcomes
1. Assess oral cavity daily using the same assessment criteria or rating scale. 2. Identify individuals at increased risk for stomatitis and related complications. 3. Instruct patient to report oral burning, pain, areas of redness, open lesions on oropharyngeal mucosa and lips, pain associated with swallowing, or decreased tolerance to temperature extremes of food. 4. Encourage and assist as needed in oral hygiene.	1. Provides baseline for later evaluation; maintains consistency in assessment findings 2. Patient and treatment variables are associated with the incidence and severity of stomatitis as well as related complications such as delayed healing and infection. 3. Identification of initial stages of stomatitis will facilitate prompt interventions, including modification of treatment as prescribed by primary provider. 4. Patients who are having discomfort or pain, or other symptoms related to the disease and treatment, may require encouragement and assistance in performing oral hygiene. Oral hygiene is maintained to prevent complications of	• States rationale for frequent oral assessment and hygiene • Factors associated with the incidence, severity, and complications are identified prior to initiation of cancer treatment • Oral mucosal assessment is conducted at baseline and on an ongoing basis • Oral hygiene practices are initiated prior to development of stomatitis. • Identifies signs and symptoms of stomatitis to report to nurse or primary provider • Participates in recommended oral hygiene regimen • Avoids mouthwashes with alcohol • Brushes teeth and mouth with soft toothbrush • Uses lubricant to keep lips soft and nonirritated • Avoids hard-to-chew, spicy, hot foods or other irritating foods

	stomatitis, such as infection.	• Maintains adequate hydration
Nursing Intervention	**Rationale**	**Expected Outcomes**
Preventive		
1. Advise patient to avoid irritants such as commercial mouthwashes, alcoholic beverages, and tobacco. 2. Brush with soft toothbrush using nonabrasive toothpaste for 90 seconds after meals and at bedtime; allow toothbrush to air dry before storing; floss at least once daily or as advised by the clinician; patients who have not previously flossed regularly should not initiate flossing during stomatoxic treatment; rinse mouth four times a day with a bland rinse (normal saline, sodium bicarbonate, or saline and sodium bicarbonate); avoid irritating foods (acidic, hot, rough, and spicy); use water-based moisturizers to protect lips. 3. Consider use of oral ice chips during stomatoxic chemotherapy infusions. 4. Consider use of low-level laser therapy.	1. Alcohol content of mouthwashes and tobacco smoke will dry oral tissues and potentiate breakdown. 2. Limits trauma and removes debris. Patients who have not previously flossed regularly should not initiate flossing during stomatoxic treatment due to potential for injury to the oral mucosa and increased susceptibility to infection. 3. Oral cryotherapy has demonstrated reduced oral mucositis incidence, severity, and pain; improved quality of life; and minimizes chances of complications of oral mucositis 4. Low-energy level laser therapy has demonstrated decreased severity, duration, and pain associated with stomatitis.	• Exhibits clean, intact oral mucosa • Exhibits no ulcerations or infections of oral cavity • Exhibits no evidence of bleeding • Reports absent or decreased oral pain • Reports no difficulty swallowing • Exhibits healing (reepithelialization) of oral mucosa within 5–7 days (mild stomatitis)

5. Consider administration of palifermin as prescribed for patients receiving high-dose chemotherapy. 6. Maintain adequate hydration. 7. Provide written instruction and education to patients on the above items.	5. Palifermin, a recombinant keratinocyte growth factor (KGF) that stimulates the growth of cells lining the mouth and intestinal tract, has been shown to decrease the severity and duration of stomatitis. 6. Maintenance of hydration prevents mucosal drying and breakdown. 7. Written information reinforces patient education and provides the patient and family with a source.	
Mild stomatitis (generalized erythema, limited ulcerations, small white patches: *Candida*) 1. Use normal saline mouth rinses every 1–4 hours. 2. Use soft toothbrush or toothette. 3. Remove dentures except for meals; be certain that dentures fit well. 4. Apply water-soluble lip lubricant. 5. Avoid foods that are spicy or hard to chew and those with extremes of temperature.	1. Assists in removing debris, thick secretions, and bacteria 2. Minimizes trauma 3. Minimizes friction and discomfort 4. Promotes comfort 5. Prevents local trauma	• Exhibits healing of oral tissues within 10–14 days (severe stomatitis) • Exhibits no bleeding or oral ulceration • Consumes adequate fluid and food • Exhibits absence of dehydration and weight loss • Exhibits no evidence of infection
Severe stomatitis		

(confluent ulcerations with bleeding and white patches covering >25% of oral mucosa)		
1. Obtain tissue samples for culture and sensitivity tests of areas of infection. 2. Assess ability to chew and swallow; assess gag reflex. 3. Use oral rinses (may combine in solution saline, anti-*Candida* agent, such as mycostatin, and topical anesthetic agent [described later]) as prescribed, or place patient on side and irrigate mouth; have suction available. 4. Remove dentures. 5. Use toothette or gauze soaked with solution for cleansing. 6. Use water-soluble lip lubricant. 7. Provide liquid or pureed diet. 8. Monitor for dehydration. 9. Minimize discomfort. a. Consult primary provider for use of topical anesthetic, such as dyclonine and diphenhydramine, or viscous lidocaine. b. Administer systemic analgesics as prescribed.	1. Assists in identifying need for antimicrobial therapy 2. Patient may be in danger of aspiration 3. Facilitates cleansing and provides for safety and comfort 4. Prevents trauma from ill-fitting dentures 5. Limits trauma and promotes comfort 6. Promotes comfort and minimizes loss of skin integrity 7. Ensures intake of easily digestible foods without chewing 8. Decreased oral intake and ulcerations potentiate fluid deficits 9. Promotes healing a. Alleviates pain and increases sense of well-being; promotes participation in oral hygiene and nutritional intake b. Adequate management of pain related to	a. Adheres to oral care regimen b. Exhibits healing of oral tissues within 10–14 days (severe stomatitis) • Consumes adequate fluid and food • Exhibits absence of dehydration and weight loss • Exhibits no evidence of infection • Reports absent or decreased discomfort or pain

c. Perform mouth care as described.	severe stomatitis can facilitate improved quality of life, participation in other aspects of activities of daily living, oral intake, and verbal communication. c. Promotes removal of debris, healing, and comfort	

NURSING DIAGNOSIS: Impaired skin integrity associated with rash
GOALS: Maintenance of skin integrity

Nursing Intervention	Rationale	Expected Outcomes
Prevention		
1. Instruct patients to avoid sunlight through use of protective clothing, use of sun screen with SPF of 30 with physical blockers (zinc oxide, titanium dioxide), or avoidance of direct sun exposure. 2. Maintain adequate oral hydration. 3. Avoid long hot showers or baths, harsh soaps and laundry detergents, perfumes, and nonhypoallergenic cosmetics. 4. Apply emollients; apply hydrocortisone 1% cream with moisturizer at least twice daily; administer doxycycline 100 mg	1. Many agents are associated with photosensitivity; sunburn would intensify inflammation associated with rash and potentiate loss of skin integrity 2. Prevents skin dryness related to dehydration 3. Prevents skin irritation, dryness, flaking, and inflammation 4. Minimizes dryness, flaking, and disruption of skin integrity	• Sun exposure will be limited; no development of sun burn • Absence of dehydration • Participates in skin care regimen as instructed • Absence of dryness, flaking

twice per day or minocycline, as prescribed		
Treatment		
1. Apply topical treatment as prescribed: clindamycin 1%, fluocinonide 0.05% cream twice a day, or alclometasone 0.05% cream twice a day 2. For severe papulopustular rash: Administer systemic treatment as prescribed: doxycycline 100 mg twice per day; minocycline 100 mg daily; or isotretinion at low doses of 20–30 mg per day 3. Assess for development of infection: obtain cultures of pustules and administer appropriate antibiotics as prescribed by the physician	1. Recommended as treatment to minimize skin disruption and prevent infection by Multinational Association of Supportive Care in Cancer (MASCC) 2. Recommended as treatment to minimize skin disruption and prevent infection by Multinational Association of Supportive Care in Cancer (MASCC) 3. Prompt recognition and treatment of infection are necessary to prevent bacteremia, sepsis, and further patient compromise	• Rash severity does not interfere with level of comfort and adherence to targeted therapy as prescribed; absence of local or systemic infection • Rash severity does not interfere with level of comfort and adherence to targeted therapy as prescribed; absence of local or systemic infection • Local infection is controlled; absence of sepsis

NURSING DIAGNOSIS: Impaired tissue integrity: alopecia
GOAL: Maintenance of tissue integrity; coping with hair loss

Nursing Intervention	Rationale	Expected Outcomes
1. Discuss potential hair loss and regrowth with patient and family; advise that hair loss may occur on body parts other than the head. 2. Explore potential impact of hair loss on self-image, interpersonal relationships, and sexuality. 3. Prevent or minimize hair loss through the following: a. Use scalp cooling (hypothermia), if appropriate. b. Cut long hair before treatment. c. Use mild shampoo and conditioner, gently pat dry, and avoid excessive shampooing. d. Avoid electric curlers, curling irons, dryers, clips, barrettes, hair sprays, hair dyes, hair extensions, weaves, braids, dreadlocks, hair straightening products, and permanent waves. e. Avoid excessive combing or brushing; use wide-toothed comb. 4. Prevent trauma to scalp. a. Use sunscreen or wear hat when in the	1. Provides information so that patient and family can begin to prepare cognitively and emotionally for loss 2. Facilitates coping and maintenance of interpersonal relationships 3. Retains hair as long as possible. a. Decreases hair follicle uptake of chemotherapy (not used for patients with leukemia or lymphoma because tumor cells may be present in blood vessels or scalp tissue) b. Minimizes hair loss due to the weight and manipulation of hair 4. Preserves tissue integrity a. Assists in maintaining skin integrity b. Prevents ultraviolet light exposure 5. Minimizes change in appearance a. Wig that closely resembles hair color and style is	• Identifies alopecia as potential side effect of treatment • Identifies positive and negative feelings and threats to self-image • Verbalizes meaning that hair and possible hair loss have for them • States rationale for modifications in hair care and treatment • Uses mild shampoo and conditioner, and shampoos hair only when necessary • Avoids hair dryer, curlers, sprays, and other stresses on hair and scalp • Wears hat or scarf over

sun. 5. Suggest ways to assist in coping with hair loss. a. Purchase wig or hairpiece before hair loss. b. If hair loss has occurred, take photograph to wig shop to assist in selection. c. Begin to wear wig before hair loss. d. Contact the American Cancer Society for donated wigs or a store that specializes in this product. e. Wear hat, scarf, or turban. 6. Encourage patient to wear own clothes and retain social contacts. 7. Explain that hair growth usually begins again once therapy is completed.	more easily selected if hair loss has not begun. b. Facilitates adjustment c. Enables patient to be prepared for loss and facilitates adjustment d. Provides options to patient and assists with financial burden if necessary e. Conceals loss and protects scalp 6. Assists in maintaining personal identity 7. Reassures patient that hair loss is usually temporary	hair when exposed to sun • Takes steps to deal with possible hair loss before it occurs; purchases wig or hairpiece if desired • Maintains hygiene and grooming • Interacts and socializes with others

NURSING DIAGNOSIS: Impaired nutritional status associated with nausea and vomiting

GOAL: Patient experiences less nausea and vomiting associated with therapies; weight loss is minimized

Nursing Intervention	Rationale	Expected Outcomes
1. Assess the patient's previous experiences and expectations of nausea and vomiting, including causes and interventions used.	1. Identifies patient concerns, misinformation, and potential strategies for intervention; also gives patient sense of empowerment and control.	• Identifies previous triggers of nausea and vomiting
2. Adjust diet before and after drug administration according to patient preference and tolerance.	2. Each patient responds differently to food after chemotherapy. A diet containing foods that relieve or prevent nausea or vomiting is most helpful.	• Exhibits decreased apprehension and anxiety
3. Prevent unpleasant sights, odors, and sounds in the environment.	3. Unpleasant sensations can stimulate the nausea and vomiting center.	• Identifies previously used successful interventions for nausea and vomiting
4. Use distraction, music therapy, biofeedback, self-hypnosis, relaxation techniques, and guided imagery before, during, and after chemotherapy.	4. Decreases anxiety, which can contribute to nausea and vomiting. Psychological conditioning may also be decreased.	• Reports decrease in nausea
5. Administer prescribed antiemetics, sedatives, and corticosteroids before chemotherapy and afterward as needed.	5. Administration of antiemetic regimen before onset of nausea and vomiting limits the adverse experience and facilitates control. Combination drug therapy reduces nausea and vomiting through various triggering mechanisms.	• Reports decrease in incidence of vomiting
6. Ensure adequate fluid hydration before, during, and after drug administration; assess intake and output.	6. Adequate fluid volume dilutes drug levels, decreasing stimulation of vomiting receptors.	• Consumes adequate fluid and food when nausea subsides
7. Encourage frequent oral hygiene.		• Demonstrates use of distraction, relaxation, and imagery when indicated
		• Exhibits normal skin turgor and

8. Provide pain-relief measures, if necessary. 9. Consult with dietician as needed. 10. Assess and address other contributing factors to nausea and vomiting, such as other symptoms, constipation, gastrointestinal irritation, electrolyte imbalance, radiation therapy, medications, and central nervous system metastasis.	7. Reduces unpleasant taste sensations 8. Increased comfort increases physical tolerance of symptoms. 9. Interdisciplinary collaboration is essential in addressing complex patient needs. 10. Multiple factors may contribute to nausea and vomiting.	moist mucous membranes • No additional weight loss

NURSING DIAGNOSIS: Impaired nutritional status associated with anorexia, cachexia, or malabsorption

GOAL: Maintenance of nutritional status and of weight within 10% of pretreatment weight

Nursing Intervention	Rationale	Expected Outcomes
1. Assess and address factors that interfere with oral intake or are associated with increased risk of decreased nutritional status. 2. Initiate appropriate referrals for interdisciplinary collaboration to manage factors that interfere with oral intake. 3. Educate patient to avoid unpleasant sights, odors, and sounds in the environment during mealtime. 4. Suggest foods that are preferred and well tolerated by the patient, preferably high-calorie and high-protein foods. Respect ethnic and cultural food preferences. 5. Encourage adequate fluid intake, but limit fluids at mealtime.	1. Multiple patient or treatment-related factors are associated with increased risk of impaired nutritional intake, such as radiation to the head, neck, and thorax; stomatoxic or emetogenic chemotherapy; prior oral, head, and neck surgery; mucositis; impaired swallowing or dysphagia; poor dentition; cough or dyspnea. 2. Other disciplines may be more appropriate for assessment and management of issues such as swallowing impairments (speech therapy), fatigue and decreased physical ability (physical and occupational therapy), nutritional assessment and determination of patient needs (nutritionist), cough and dyspnea (respiratory therapy), poor dentition (dental medicine), depression/anxiety (social worker, psychologist, or psychiatrist). 3. Anorexia can be stimulated or increased with noxious stimuli.	• Factors associated with increased risk for impaired nutritional intake are identified • Factors associated with increased risk of impaired nutritional intake are identified and addressed, whenever possible, through interdisciplinary collaboration • Patient and family identify minimal nutritional requirements • Maintains or increases weight and body cell mass as per goals identified by nutritionist • Reports decreasing anorexia and increased interest in eating • Demonstrates normal skin turgor

6. Suggest smaller, more frequent meals. 7. Promote relaxed, quiet environment during mealtime with increased social interaction as desired. 8. If patient desires, serve alcoholic beverages at mealtime with foods. 9. Consider cold foods, if desired. 10. Encourage nutritional supplements and high-protein foods between meals. 11. Encourage frequent oral hygiene, particularly prior to meals. 12. Address pain and other symptom management needs. 13. Increase activity level as tolerated. 14. Decrease anxiety by encouraging verbalization of fears and concerns; use relaxation techniques and guided imagery at mealtime. 15. Instruct patient and family about body alignment and proper positioning at mealtime. 16. Collaborate with dietician to provide nutritional	4. Foods preferred, well tolerated, and high in calories and protein maintain nutritional status during periods of increased metabolic demand. 5. Fluids are necessary to eliminate wastes and prevent dehydration. Increased fluids with meals can lead to early satiety. 6. Smaller, more frequent meals are better tolerated because early satiety is less likely to occur. 7. A quiet environment promotes relaxation. Social interaction at mealtime may foster appetite, divert focus on food, and promote enjoyment of eating. 8. Alcoholic beverages may stimulate appetite and add calories. 9. Cold, high-protein foods are often more tolerable and less odorous than hot foods. 10. Supplements and snacks add protein and calories to meet nutritional requirements. 11. Oral hygiene may stimulate appetite and increase saliva production. 12. Pain and other symptoms impair appetite and nutritional intake. 13. Increased activity promotes appetite. 14. Relief of anxiety may increase appetite.	• Identifies rationale for dietary modifications; patient and family verbalize strategies to minimize nutritional deficits • Participates in calorie counts and diet histories • Uses relaxation techniques and guided imagery before meals • Exhibits laboratory and clinical findings indicative of adequate nutritional intake: normal serum levels of protein, albumin, transferrin, iron, blood urea nitrogen (BUN), creatinine, vitamin D, electrolytes, hemoglobin, hematocrit, and lymphocytes; normal urinary creatinine levels • Consumes diet containing required nutrients • Carries out oral hygiene before meals

counseling; instruct patient and family regarding enteral tube feedings of commercial liquid diets, elemental diets, or other foods as prescribed. 17. Collaborate with dietician or nutrition support team to instruct patient and family regarding home parenteral nutrition with lipid supplements as prescribed. 18. Administer appetite stimulants as prescribed by primary provider. 19. Encourage family and friends not to nag or cajole patient about eating. 20. Assess and address other contributing factors to nausea, vomiting, and anorexia such as electrolyte imbalance, radiation therapy, medications, and central nervous system metastasis.	15. Proper body position and alignment are necessary to aid chewing and swallowing. 16. Nutritional counseling may improve outcomes. Tube feedings may be necessary in the severely debilitated patient who has a functioning gastrointestinal system but is unable to maintain adequate oral intake. 17. Parenteral nutrition with supplemental fats supplies needed calories and proteins to meet nutritional demands, especially in the nonfunctional gastrointestinal system. 18. Although the mechanism is unclear, medications such as megestrol acetate have been noted to improve appetite in patients with cancer and human immunodeficiency virus infection. 19. Pressuring patient to eat may cause conflict and unnecessary stress. 20. Multiple factors contribute to anorexia and nausea.	• Reports decreased pain or other symptoms; symptoms do not interfere with oral intake • Reports decreasing episodes of nausea and vomiting • Participates in increasing levels of activity as measured by assessment of performance status • Family and friends do not focus efforts on encouraging food intake • States rationale for use of tube feedings or parenteral nutrition • Demonstrates ability to manage enteral feedings or parenteral nutrition, if prescribed • Maintains body position and alignment needed to facilitate chewing and swallowing

NURSING DIAGNOSIS: Fatigue
GOAL: Decreased fatigue level

Nursing Intervention	Rationale	Expected Outcomes
1. Assess patient and treatment factors that are associated with or increase fatigue (e.g., anemia, fluid and electrolyte imbalances, pain, anxiety, etc.)	1. Multiple factors are associated with or contribute to cancer-related fatigue. Although fatigue is common in patients receiving chemotherapy or radiation therapy, there are several factors that can be modified or addressed, such as dehydration, electrolyte abnormalities, organ impairment, anemia, impaired nutrition, pain and other symptoms, depression, anxiety, impaired mobility, and dyspnea	• Factors contributing to fatigue are assessed and managed whenever possible • Exhibits acceptable serum value levels for nutritional indices (see Imbalanced Nutrition) • Reports decreased pain or other symptoms • Consumes diet with recommended nutritional intake • Achieves or maintains appropriate weight and body mass • Maintains adequate hydration • Reports decreasing levels of fatigue • Adopts healthy lifestyle practices • Rests when fatigued
2. Institute interventions to address factors contributing to fatigue (e.g., correct electrolyte imbalance, manage pain, collaborative management of anemia, administer prescribed antidepressants, anxiolytics, hypnotics, or psychostimulants, as indicated)	2. Addressing factors contributing to fatigue assists in managing fatigue (e.g., lowered hemoglobin and hematocrit predispose patient to fatigue due to decreased oxygen availability especially in a setting of impaired mobility that requires increased energy expenditure).	
3. Encourage balance of rest and exercise; avoiding extended periods of inactivity. At minimum, promote patient's normal sleep habits.	3. Sleep helps to restore energy levels. Prolonged napping during the day may interfere with sleep habits.	
4. During active treatment, rearrange daily schedule and organize activities to conserve energy expenditure; encourage patient to ask for others' assistance with	4. Reorganization of activities can reduce energy losses and stressors.	

necessary chores, such as housework, child care, shopping, and cooking. During periods of profound fatigue, consider reduced job workload, if necessary and possible, by reducing number of hours worked per week. 5. Encourage protein, fat, and calorie intake at least equal to that recommended for the general public. 6. Encourage the use of relaxation techniques and guided imagery. 7. Encourage participation in planned exercise programs involving aerobic, resistance, and flexibility training based on individual limitations and safety measures. a. Minimum exercise for survivors depending on individual capabilities ranges from 10 minutes of light exercise, yoga, or stretching daily to 30 minutes of moderate to vigorous of activity	5. Protein and calorie depletion decreases activity tolerance; preventing malnutrition, achieving and maintaining recommended weight and body mass assist in management of fatigue. 6. Promotion of relaxation and psychological rest limits contribution to physical fatigue. 7. Various approaches to exercise programs have demonstrated increases in endurance and stamina and lower fatigue. 8. Many providers fail to discuss the role of exercise and healthy lifestyle practices for patients during and after cancer treatment. Patients may be more likely to utilize the benefits of exercise in addressing fatigue if they receive a formal prescription. 9. Creates community partnerships, a nonclinical environment of support, fosters increased awareness of survivorship needs, and provides referral sources that can reach more survivors. 10. A CET designs and administers fitness assessments and exercise programs specific to an	• Reports adequate sleep • Requests assistance with activities appropriately • Uses relaxation exercises and imagery to decrease anxiety and promote rest • Reports no breathlessness during activities • Reports improved ability to relax and rest • Exhibits improved mobility and decreased fatigue • Fatigue does not interfere with ability to participate in activities of daily living or pleasure

8.	Collaborate with other cancer providers to encourage them to give patients a prescription to exercise and explain role of exercise in cancer treatment.	individual's cancer diagnosis, treatment, current recovery status; possesses basic understanding of cancer diagnoses, treatments, and potential adverse effects.	
9.	Partner with community organizations (e.g., YMCA) to develop and offer cancer survivor specific rehab/exercise programs.		
10.	Collaborate with physical and occupational therapy or refer to American College of Sports Medicine (ACSM) Certified Cancer Exercise Trainer (CET) to identify safe and appropriate activities.		

NURSING DIAGNOSIS: Chronic pain
GOAL: Relief of pain and discomfort

Nursing Intervention	Rationale	Expected Outcomes
1. Use pain scale to assess pain and discomfort characteristics: location, quality, frequency, duration, etc., at baseline and on an ongoing basis. 2. Assure patient that you know the pain is real and will assist them in reducing it. 3. Assess prior pain experiences and previous management strategies the patient found successful. 4. Assess other factors contributing to patient's pain: fear, fatigue, other symptoms, psychosocial distress, etc. 5. Provide education to patient and family about prescribed analgesic regimen. 6. Address myths or misconceptions and lack of knowledge about the use of opioid analgesics.	1. Provides baseline for assessing changes in pain level and evaluation of interventions 2. Fear that pain will not be considered real increases anxiety and reduces pain tolerance. 3. Helps to individualize pain management approaches and identify potential challenges or approaches that should not be utilized because of safety or other issues 4. Provides data about factors that decrease the patient's ability to tolerate pain and increase pain level 5. Analgesics tend to be more effective when given early in pain cycle, around the clock at regular intervals, or when given in long-acting forms; breaks the pain cycle; premedication with analgesics is used for activities that cause increased pain or breakthrough pain. 6. Barriers to adequate pain management involve patients' fear of side effects, fatalism about the possibility of achieving pain control,	• Reports decreased level of pain and discomfort on pain scale • Reports less disruption in activity and quality of life from pain and discomfort • Reports decrease in other symptoms and psychosocial distress • Adheres to analgesic regimen as prescribed • Barriers to adequately addressing pain do not interfere with strategies for managing pain. • Takes an active role in administration of analgesia • Identifies additional effective pain-relief strategies • Uses previously employed successful pain-relief strategies appropriately • Identifies or utilizes nonpharmacologic pain-relief strategies and

7. Collaborate with patient, primary provider, and other health care team members when changes in pain management are necessary. 8. Consult with palliative care providers or team throughout the cancer continuum. 9. Explore nonpharmacologic and complementary strategies to relieve pain and discomfort: distraction, imagery, relaxation, cutaneous stimulation, acupuncture, etc.	fear of distracting providers from treating the cancer, belief that pain is indicative of progressive disease, and fears about addiction. Professional health providers also have demonstrated limited knowledge about evidence-based approaches to pain. 7. New methods of administering analgesia must be acceptable to patient, primary provider, and health care team to be effective; patient's participation decreases the sense of powerlessness. 8. Palliative care specialists provide expertise and contribute to symptom management regardless of stage of disease or treatment within the cancer continuum, not only during end-stage disease. Palliative care can improve quality of life, length of survival, symptom burden, mood, and efficient utilization of health services. 9. Increases the number of options and strategies available to patient that serve as adjuncts to pharmacologic interventions.	reports successful decrease in pain • Reports that decreased level of pain permits participation in other activities and events and quality of life

NURSING DIAGNOSIS: Grief associated with loss; altered role functioning
GOAL: Appropriate progression through grieving process

Nursing Intervention	Rationale	Expected Outcomes
1. Encourage verbalization of fears, concerns, and questions regarding disease, treatment, and future implications. 2. Explore previous successful coping strategies. 3. Encourage active participation of patient or family in care and treatment decisions. 4. Visit family and friends to establish and maintain relationships and physical closeness. 5. Encourage ventilation of negative feelings, including projected anger and hostility, within acceptable limits. 6. Allow for periods of crying and expression of sadness. 7. Involve spiritual advisor as desired by the patient and family. 8. Refer patient and family to professional counseling as indicated to alleviate	1. An increased and accurate knowledge base decreases anxiety and dispels misconceptions. 2. Provides frame of reference and examples of coping. 3. Active participation maintains patient independence and control. 4. Frequent contacts promote trust and security and reduce feelings of fear and isolation. 5. This allows for emotional expression without loss of self-esteem. 6. These feelings are necessary for separation and detachment to occur. 7. This facilitates the grief process and spiritual care. 8. Goal is to facilitate the grief process or adaptive methods of coping. 9. Grief work is variable. Not every person uses every phase of the grief process, and the time spent in dealing with each phase varies with every person. To complete grief work, this variability must be allowed.	The patient and family: • Progress through the phases of grief as evidenced by increased verbalization and expression of grief. • Identify resources available to aid coping strategies during grieving. • Use resources and supports appropriately. • Discuss the future openly with each other. • Discuss concerns and feelings openly with each other. • Use nonverbal expressions of concern for each other. • Develop positive or adaptive coping mechanisms for processing of grief.

pathologic or nonadaptive grieving.

9. Allow for progression through the grieving process at the individual pace of the patient and family.

NURSING DIAGNOSIS: Disturbed body image and situational low self-esteem associated with changes in appearance, function, and roles
GOAL: Improved body image and self-esteem

Nursing Intervention	Rationale	Expected Outcomes
1. Assess patient's feelings about body image and level of self-esteem. 2. Identify potential threats to patient's self-esteem (e.g., altered appearance, decreased sexual function, hair loss, decreased energy, role changes). Validate concerns with patient. 3. Encourage continued participation in activities and decision making. 4. Encourage patient to verbalize concerns. 5. Individualize care for the patient. 6. Assist patient in self-care when fatigue, lethargy, nausea, vomiting, and other symptoms prevent independence. 7. Assist patient in selecting and using cosmetics, scarves, hair pieces, hats, and clothing that increase their sense of attractiveness. 8. Encourage patient and partner to share	1. Provides baseline assessment for evaluating changes and assessing effectiveness of interventions. 2. Anticipates changes and permits patient to identify importance of these areas to them. 3. Encourages and permits continued control of events and self. 4. Identifying concerns is an important step in coping with them. 5. Prevents or reduces depersonalization and emphasizes patient's self-worth. 6. Physical well-being improves self-esteem. 7. Promotes positive body image. 8. Provides opportunity for expressing concern, intimacy, affection, and acceptance.	• Identifies concerns of importance • Takes active role in activities • Maintains participation in decision making • Verbalizes feelings and reactions to losses or threatened losses • Participates in self-care activities • Permits others to assist in care when they are unable to be independent • Exhibits interest in appearance, maintains grooming, and uses aids (cosmetics, scarves, etc.) appropriately if desired • Participates with others in conversations and social events and activities • Verbalizes concern about sexual partner or significant others • Explores alternative ways of expressing concern and affection • The patient and significant other can maintain level of intimacy and express affection and acceptance

concerns about altered sexuality and sexual function and to explore alternatives to their usual sexual expression. 9. Refer to collaborating specialists as needed.	9. Interdisciplinary collaboration is essential in meeting patient needs.	

COLLABORATIVE PROBLEM: Potential complication: risk for bleeding problems
GOAL: Prevention of bleeding

Nursing Intervention	Rationale	Expected Outcomes
1. Monitor for factors increasing risk of bleeding (thrombocytopenia, elevated INR/PT/PTT, decreased fibrinogen or other clotting factors, use of medications affecting platelets or other clotting indices) 2. Assess for and educate patient/family about signs and symptoms of bleeding: a. Petechiae or ecchymosis (bruising) b. Decrease in hemoglobin or hematocrit c. Prolonged bleeding from invasive procedures, venipunctures,	1. The underlying cancer, antineoplastic agents or other medications may interfere with normal mechanisms of clotting. 2. Early detection promotes early intervention. a. Petechiae and ecchymosis indicate injury to microcirculation and larger vessels. b. Decreased hemoglobin or hematocrit may indicate blood loss. c. Prolonged bleeding may indicate	• Signs and symptoms of bleeding are identified • Exhibits no blood in feces, urine, or emesis • Exhibits no bleeding of gums or injection/venipuncture sites • Exhibits no ecchymosis (bruising) or petechiae • Patient and family identify ways to prevent bleeding • Uses recommended measures to reduce risk of bleeding (uses soft toothbrush, shaves with electric razor only) • Exhibits normal vital signs • Reports that environmental hazards have been reduced or removed • Maintains hydration

minor cuts or scratches d. Frank or occult blood in any body fluids e. Bleeding from any body orifice f. Altered mental status g. Hypotension; tachycardia	abnormal clotting indices. d. Occult blood in body fluids indicates bleeding. e. Indicates blood loss f. Altered mental status may indicate decreased cerebral tissue oxygenation or bleeding. g. Hypotension or tachycardia may indicate blood loss.	• Reports absence of constipation • Avoids substances interfering with clotting • Absence of tissue destruction • Exhibits normal mental status and absence of signs of intracranial bleeding • Avoids medications that interfere with clotting (e.g., aspirin) • Absence of epistaxis and cerebral bleeding
3. Instruct patient and family about ways to minimize risk of bleeding. a. Use soft toothbrush for mouth care. b. Avoid commercial mouthwashes. c. Use electric razor for shaving. d. Use emery board for nail care. e. Avoid foods that are difficult to chew. f. Keep lips moisturized with water-based lubricant g. Maintain fluid intake of at least 3 L per 24 hours unless contraindicated h. Use stool softeners or increase bulk in diet. i. Recommend use of water-based lubricant before	3. Patient can participate in self-protection. a. Prevents trauma to oral tissues b. Contain high alcohol content that will dry oral tissues c. Prevents trauma to skin d. Reduces risk of trauma to nail beds e. Prevents oral tissue trauma f. Prevents skin from drying g. Prevents skin and oral tissue membranes from drying h. Prevents trauma to rectal	

sexual intercourse.

4. Initiate measures to minimize bleeding. Draw all blood for lab work with one daily venipuncture for hospitalized patients.
   a. Avoid taking temperature rectally or administering suppositories and enemas.
   b. Avoid intramuscular injections; use smallest needle possible.
   c. Apply direct pressure to injection and venipuncture sites for at least 5 minutes.
   d. Avoid bladder catheterizations; use smallest catheter if catheterization is necessary.
   e. Avoid medications that will interfere with clotting (e.g., aspirin).
   f. Recommend use of water-based lubricant before sexual intercourse.
   g. Platelet transfusions as prescribed; administer prescribed diphenhydramine

mucosa from straining
   i. Prevents friction and tissue trauma

4. Measures are taken to minimize bleeding
   a. Minimizes blood loss
   b. Bleeding may occur from intramuscular injection sites, particularly if large bore needles are used
   c. Bleeding may occur if direct pressure is not applied for a long enough time period
   d. Prevents trauma to urethra
   e. Minimizes risk of bleeding
   f. Helps prevent bleeding from small skin tears
   g. Platelet count <20,000/mm^3 (0.02 × 1012/L) is associated with increased risk of spontaneous bleeding. Allergic reactions to blood products are associated with antigen–

hydrochloride or hydrocortisone sodium succinate to prevent reaction to platelet transfusion. h. Supervise activity when out of bed. i. Caution against forceful nose blowing.	antibody reaction that causes platelet destruction h. Reduces risk of falls i. Prevents trauma to nasal mucosa and increased intracranial pressure

Adapted from Corbitt, N., Harrington, J., Kendall, T. (2017). Putting evidence into practice: Prevention of bleeding. Retrieved on 7/23/2019 at: www.ons.org/pep/bleeding; Eilers, J. G., Asakura, Y., Blecher, C. S., et al. (2017). Putting evidence into practice: Mucositis. Retrieved on 7/7/2019 at: www.ons.org/pep/mucositis; Gosselin, T., Beamer, L., Ciccolini, K., et al. (2017). Putting evidence into practice: Radiodermatitis. Retrieved on 7/29/2019 at: www.ons.org/pep/radiodermatitis; Miaskowski, C. A., Brant, J. M., Caldwell, P., et al. (2017). Putting evidence into practice: Chronic pain. Retrieved on 7/19/2019 at: www.ons.org/pep/chronic-pain; Mitchell, S. A., Albrecht, T. A., Omar Alkaiyat, M., et al. (2017). Putting evidence into practice: Fatigue. Retrieved on 7/2/2019 at: www.ons.org/pep/fatigue; Thorpe, D. M., Conley, S. B., Drapek, L., et al. (2017). Putting evidence into practice: Anorexia. Retrieved on 7/28/2019 at: www.ons.org/pep/anorexia; Williams, L., Ciccolini, K., Johnson, L. A., et al. (2017). Putting evidence into practice: Skin reactions. Retrieved on 7/23/2019 at: www.ons.org/pep/skin-reactions; and Wilson, B. J., Ahmed, F., Crannell, C. E., et al. (2017). Putting evidence into practice: Preventing infection – general. Retrieved on 7/5/2019 at: www.ons.org/pep/prevention-infection-general

Radiation-Associated Impairment of Skin Integrity

Although advances in radiation therapy have resulted in decreased incidence and severity of skin impairments, patients may still develop radiodermatitis, formerly called radiation dermatitis, associated with pain, irritation, pruritus, burning, skin sloughing without drainage (dry desquamation) or with drainage (wet desquamation), and diminished quality of life (Gosselin, Beamer, Ciccolini, et al., 2017; Olsen et al., 2019). Nursing care for patients with radiodermatitis includes maintenance of skin integrity, cleansing, promotion of comfort, pain reduction, prevention of additional trauma, prevention and management of infection, and promotion of a moist wound-healing environment (Olsen et al., 2019). In order to prevent impaired skin integrity, patients are advised to use moisturizer on the skin, avoid sun exposure to the area of treatment, and avoid tape or bandages and other sources of irritation or trauma. Although a variety of methods and products are used in clinical practice for patients with radiation-induced skin impairment, there is

limited evidence to support their value (Gosselin et al., 2017). Patients with skin and tissue reactions to radiation therapy require careful skin care to prevent further skin irritation, drying, and damage, as discussed in the nursing care plan (see Chart 12-6, Risk for impaired skin integrity: erythematous and wet desquamation reactions to radiation therapy).

Alopecia

The temporary or permanent thinning or complete loss of hair is a potential adverse effect of whole brain radiation therapy, various chemotherapies and targeted agents. Alopecia usually begins 1 to 3 weeks after the initiation of chemotherapy and radiation therapy; regrowth most often begins within 8 weeks after the last treatment (Olsen et al., 2019). Some patients who undergo radiation to the head may sustain permanent hair loss. The onset of gradually progressing alopecia and body hair loss associated with targeted therapies generally occurs 1 to 3 months after the start of treatment and may be patchy appearing as temporal or frontal hair loss (Barton-Burke, Ciccolini, Mekas, et al., 2017). This type of hair loss is usually reversible after the end of therapy and in some cases beginning sooner. Several targeted agents are associated with changes in hair growth rate, curliness, texture, and pigmentation. Although health care providers may view hair loss as a minor issue, for many patients it is a major assault on body image, challenging to self-esteem, and resulting in psychosocial distress and depression. Despite the significant psychosocial impact of alopecia, few studies have addressed methods to prevent or minimize the impact of alopecia. The use of cryotherapy to the head (scalp cooling) has been shown to be effective in reducing alopecia during chemotherapy administration (Ross & Fischer-Cartlidge, 2017; Rugo, Melin, & Voigt, 2017). However, due to reports of scalp metastasis and a lack of safety data, cryotherapy is not recommended for use in patients with hematologic malignancies (Rugo et al., 2017). Nurses provide information about hair loss and support the patient and family in coping with changes in body image. Patients are assisted to identify proactive choices that may empower them to improve responses to cancer and perceived lack of control as discussed in the nursing care plan (see Chart 12-6, Impaired tissue integrity: alopecia).

Malignant Skin Lesions

Skin lesions may occur with local extension or metastasis of the tumor into the epithelium and its surrounding lymph and blood vessels. Either locally invasive or metastatic cancer to the skin may result in erythema, discolored nodules, or progression to wounds involving edema, exudates, and tissue necrosis. The most extensive lesions involve ulceration (referred to as fungating lesions) with an overgrowth of malodorous microorganisms. These lesions are a source of considerable pain, discomfort, and embarrassment. Although skin lesions occur in various malignancies, they are most commonly associated with breast cancer.

Ulcerating skin lesions usually indicate advanced or disseminated disease that is unlikely to be eradicated but may be controlled or palliated through systemic treatment (chemotherapy and targeted therapy) or radiation therapy. Local care of

these lesions is a nursing priority. Nurses carefully assess malignant skin lesions for the size, appearance, condition of surrounding tissue, odor, bleeding, drainage, and associated pain or other symptoms, including evidence of infection. The potential for serious complications such as hemorrhage, vessel compression/obstruction, or airway obstruction, especially in head and neck cancer, should be noted so that the caregiver can be instructed in palliative measures to maintain patient comfort.

Nursing care (see Chart 12-6) also includes wound cleansing, reduction of superficial bacteria, control of bleeding, odor reduction, protection from further skin trauma, and pain management. The patient and family require emotional support, assistance, and guidance in providing wound care and addressing comfort measures at home.

Promoting Nutrition

Most patients with cancer experience some weight loss during their illness. Thus nurses need to promote good nutrition throughout treatment.

Nutritional Impairment

Anorexia, malabsorption, and cancer-related anorexia-cachexia syndrome (CACS) are some common nutritional problems. Impaired nutritional status may contribute to both physical and psychosocial consequences (see Chart 12-7). Nutritional concerns include decreased protein and caloric intake, metabolic or mechanical effects of the cancer, systemic disease, side effects of the treatment, or the patient's emotional status.

Chart 12-7

Potential Consequences of Impaired Nutrition in Patients with Cancer

- Anemia
- Decreased survival
- Immune incompetence and increased incidence of infection
- Delayed tissue and wound healing
- Fatigue
- Diminished functional ability
- Decreased capacity to continue antineoplastic therapy
- Increased hospital admissions
- Increased length of hospital stay
- Impaired psychosocial functioning

Anorexia

Among the many causes of anorexia in patients with cancer are alterations in taste, manifested by increased salty, sour, and metallic taste sensations, and altered responses to sweet and bitter flavors. Taste changes contribute to decreased appetite and nutritional intake and subsequently protein–calorie malnutrition. Taste

alterations may result from mineral (e.g., zinc) deficiencies, increases in circulating amino acids and cellular metabolites, or the administration of chemotherapeutic agents. Patients undergoing radiation therapy to the head and neck may experience "mouth blindness," which is a severe impairment of taste.

Anorexia may occur because patients develop early satiety after eating only a small amount of food. This sense of fullness occurs secondary to a decrease in digestive enzymes, abnormalities in the metabolism of glucose and triglycerides, and prolonged stimulation of gastric volume receptors, which convey the feeling of being full. Psychological distress (e.g., fear, pain, depression, isolation) throughout illness may also have a negative impact on appetite. Patients may develop an aversion to food because of nausea and vomiting associated with treatment.

Malabsorption

Some patients with cancer are unable to absorb nutrients from the gastrointestinal system as a result of tumor activity, cancer treatments, or both. Malignancy can affect gastrointestinal activity in several ways (e.g., impaired enzyme production, interference with both protein and fat digestion) that can lead to increased gastrointestinal irritation, peptic ulcer disease, and fistula formation.

Chemotherapy and radiation associated with mucositis cause damage to mucosal cells of the bowel, resulting in impaired nutrient absorption. Abdominal irradiation has been associated with sclerosis of intestinal blood vessels and fibrotic changes in the gastrointestinal tissue, both impacting nutrient absorption. Surgical intervention may change peristaltic patterns, alter gastrointestinal secretions, and reduce the absorptive surfaces of gastrointestinal mucosa, all of which contribute to malabsorption.

Cancer-Related Anorexia-Cachexia Syndrome

CACS is a complex biologic process that results from a combination of increased energy expenditure and decreased intake (Mattox, 2017; Olsen et al., 2019). This syndrome can occur in both the curative and palliative stages of treatment and care. Combined immunologic, neuroendocrine, and metabolic processes give rise to anorexia, unintentional weight loss, and increased metabolic demand with impaired metabolism of glucose and lipids. As this syndrome continues, altered metabolic processes and tumor responses lead to cytokine release, causing generalized systemic inflammation. The patient experiences continued weight loss and malnutrition characterized by loss of adipose tissue, visceral protein, and skeletal muscle mass. Patients with CACS complain of loss of appetite, early satiety, and fatigue. It is estimated that 50% of patients with cancer experience anorexia and cachexia; this percentage increases to as high as 86% in patients with advanced cancer at the end of life (Olsen et al., 2019). Protein losses are associated with the development of anemia, peripheral edema, and progressive debilitation. The signs and symptoms of cancer cachexia and progressive debilitation result in decreased quality of life, psychological distress, and anxiety for both patient and family as they respond to actual and perceived impending losses, fear, lack of control, and helplessness.

Nursing care is integral to an interdisciplinary approach that addresses the multiple factors contributing to impaired nutritional status in patients with cancer (see Chart 12-6).

General Nutrition Considerations

Assessment of the patient's nutritional status is conducted at diagnosis and monitored throughout the course of treatment and follow-up. Early identification of patients at risk for problems with intake, absorption, and cachexia, particularly during the early stages of disease, can facilitate timely implementation of specifically targeted interventions that attempt to improve quality of life, treatment outcomes, and survival (Krishnasamy, Yoong, Chan, et al., 2017). Current weight, weight loss, diet and medication history, patterns of anorexia, nausea and vomiting, diarrhea, and situations and foods that aggravate or relieve symptoms are assessed and addressed.

The type of cancer, stage, and treatment approaches are considered so that proactive measures to support nutrition can be identified. For example, patients with head and neck cancers who are treated with radiation therapy, or some combination of surgery, radiation, chemotherapy or targeted agents, are at high risk for inadequate oral intake and nutritional deficits. In many centers, these patients have a percutaneous endoscopic gastrostomy (PEG) tube placed for enteral nutrition prior to initiation of treatment and the onset of mucositis, weight loss, and other consequences of impaired oral intake. A speech therapy consult may be helpful for patients with oropharyngeal or laryngeal tumors or surgical interventions that are anticipated to effect swallowing, secretion management, speech, or respiratory function.

Whenever possible, every effort is made to maintain adequate nutrition through the oral route. Prokinetic agents such as metoclopramide are used to increase gastric emptying in patients with early satiety and delayed gastric emptying. Other pharmacologic interventions such as megestrol acetate or corticosteroids (on a short-term basis) may be used to improve appetite. Oral nutritional supplements are encouraged to meet nutritional needs and to maintain or improve weight gain and physical functioning. Approaches incorporate nutritional counseling, exercise, pharmacologic interventions to combat anorexia, and symptom management when feasible (NCCN, 2019g). If adequate nutrition cannot be maintained by oral intake, nutritional support via the enteral route may be necessary as discussed previously. When needed, the patient and family are taught to administer enteral nutrition in the home. Home health nurses assist with patient education and monitor the patient's symptoms and response to enteral nutrition.

When malabsorption is a problem, enzyme and vitamin replacement may be instituted. Additional strategies include changing the feeding schedule, using simple diets, and relieving diarrhea. If malabsorption is severe, or the cancer involves the upper gastrointestinal tract, parenteral nutrition may be necessary. However, patients receiving parenteral nutrition are at increased risk for complications, including catheter-related and systemic infection. The use of parenteral nutrition in patients with advanced or end-stage cancer is seldom used and controversial (Jatoi & Kelly, 2019). Parenteral nutrition can be given in several ways: by a long-term

venous access device such as a right atrial catheter (see Fig. 12-3), implanted venous port (see Fig. 12-4), or PICC (see Fig. 12-6). The nurse educates the patient and family to care for the venous access device and to administer parenteral nutrition. Home health nurses provide education and assist with or supervise parenteral nutrition administration in the home.

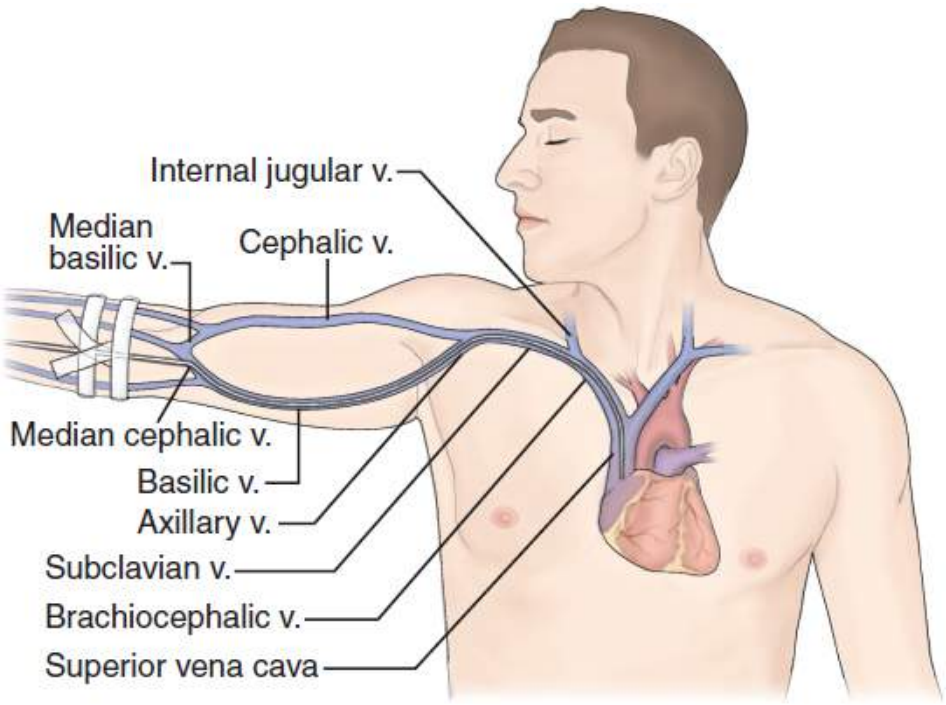

Figure 12-6 • A peripherally inserted central catheter is advanced through the cephalic or basilic vein to the axillary, subclavian, or brachiocephalic vein or the superior vena cava.

Relieving Pain

More than half of patients with cancer experience pain throughout the cancer trajectory. Moderate to severe pain is reported by approximately 28% of patients with cancer during treatment and as many as 52% of those with advanced disease (van den Beuken-van Everdingen, Hochstenbach, Joosten, et al., 2016). Although cancer pain may be acute, it is more frequently characterized as chronic. (See Chapter 9 for more information on pain.) As in other situations involving pain, the experience of cancer pain is influenced by physical, psychosocial, cultural, and spiritual factors.

Cancer can cause pain in various ways (see Table 12-9). Initially, pain is most often related to the underlying cancer process. Pain is also associated with various cancer treatments. Acute pain is linked with trauma from surgery. Occasionally, chronic pain syndromes, such as postsurgical neuropathies (pain related to nerve tissue injury), occur. Some chemotherapeutic agents cause tissue necrosis, peripheral neuropathies, and stomatitis—all potential sources of pain—whereas radiation therapy can cause pain secondary to skin, nervous tissue, or organ

inflammation. Patients with cancer may have other sources of pain, such as arthritis or migraine headaches, that are unrelated to the underlying cancer or its treatment.

The nurse assesses the patient for the source and site of pain as well as those factors that influence the patient's perception and experience of pain, such as fear and apprehension, fatigue, anger, and social isolation. Pain assessment scales are useful for assessing the patient's pain before and after pain-relieving interventions are instituted to assess the effectiveness of interventions. Other symptoms that contribute to the pain experience, such as nausea and fatigue, are assessed and addressed as well.

TABLE 12-9 Examples of Sources of Cancer Pain

Source	Descriptions	Underlying Cancer
Bone metastasis	Throbbing, aching	Breast, prostate, myeloma
Ischemia	Sharp, throbbing	Kaposi sarcoma
Lymphatic or venous obstruction	Dull, aching, tightness	Lymphoma, breast, Kaposi sarcoma
Nerve compression, infiltration	Burning, sharp, tingling	Breast, prostate, lymphoma
Organ obstruction	Dull, crampy, gnawing	Colon, gastric
Organ infiltration	Distention, crampy	Liver, pancreatic
Skin inflammation, ulceration, infection, necrosis	Burning, sharp	Breast, head and neck, Kaposi sarcoma

Adapted from van den Beuken-van Everdingen, M. H., Hochstenbach, L. M., Joosten, E. A., et al. (2016). Update on prevalence of pain in patients with cancer: Systematic review and meta-analysis. *Journal of Pain and Symptom Management*, *51*(6), 1070–1090; Yarbro, C. H., Wujcik, D., & Gobel, B. H. (2018). *Cancer nursing: Principles and practice*. Burlington, MA: Jones & Bartlett Publishers.

Today, most people expect pain to disappear or resolve quickly. Although it is often controllable, advanced cancer pain is commonly irreversible and not quickly resolved. For many patients, pain is often seen as a signal that cancer is advancing, and that death is approaching. As patients anticipate pain and anxiety increases, pain perception heightens, producing fear and further pain. Thus, chronic cancer pain can lead to a cycle progressing from pain to anxiety to fear and back to pain, especially when the pain is not adequately managed. Inadequate pain management is most often the result of misconceptions and insufficient knowledge about pain assessment and management on the part of patients, families, and health care providers (Scarborough & Smith, 2018). Chapter 9 provides information regarding factors contributing to the pain experience, pain perception, and tolerance as well as pharmacologic and nonpharmacologic nursing interventions addressing pain. The nursing care plan (see Chart 12-6) also provides strategies for nursing assessment and management of chronic pain. Analgesics are administered based on the patient's reported level of pain. A cancer pain algorithm, developed as a set of analgesic guiding principles, is given in Figure 12-7.

Pharmacologic and nonpharmacologic approaches, even those that may be invasive, are considered in managing cancer-related pain regardless of the patient's status along the cancer trajectory. The nurse assists the patient and family to take an active role in managing pain. The nurse provides education and support to correct fears and misconceptions about opioid use. Inadequate pain management leads to a diminished quality of life characterized by distress, suffering, anxiety, fear, immobility, isolation, and depression.

Decreasing Fatigue

Fatigue is one of the most frequent and distressing symptoms experienced by patients receiving cancer therapy. Patients report that fatigue persists and interferes with activities of daily living for months to years after the completion of treatment (Wang, Yang, Miao, et al., 2018). Fatigue rarely exists in isolation; patients typically experience other symptoms concurrently, such as pain, dyspnea, anemia, sleep disturbances, or depression. The relationship between sleep disturbances, fatigue, and depression (as well as other clinical factors) in older adults with cancer is an active area of research.

In assessing fatigue, the nurse distinguishes between *acute fatigue,* which occurs after an energy-demanding experience, and *cancer-related fatigue,* which is defined as "a distressing persistent, subjective sense of physical, emotional or cognitive tiredness or exhaustion related to cancer or cancer treatment that is not proportional to recent activity and interferes with usual functioning" (NCCN, 2019h). Acute fatigue serves a protective function, whereas cancer-related fatigue does not. The exact mechanisms of fatigue are not well understood and are multifactorial in nature.

Despite the commonly occurring experience of fatigue in patients with cancer, a reliable assessment tool has not been identified. The experience of fatigue is highly subjective, with patient descriptors varying greatly (NCCN, 2019h). The nurse assesses physiologic and psychological factors that can contribute to fatigue (see Chart 12-8).

Exercise is an effective approach to the management of cancer-related fatigue (Mitchell, Albrecht, Omar Alkaiyat, et al., 2017). Psychoeducational approaches, cognitive-behavioral therapy to address sleep, progressive muscle relaxation, yoga, and mindfulness meditation may be effective measures to facilitate fatigue management (Mitchell et al., 2017). Nurses assist patients with strategies to minimize fatigue or help the patient cope with fatigue as described in the nursing care plan (see Chart 12-6, Fatigue). Occasionally, pharmacologic interventions are utilized, including antidepressants for patients with depression, anxiolytics for those with anxiety, hypnotics for patients with sleep disturbances, and psychostimulants for some patients with advanced cancer or fatigue that does not respond to other interventions (NCCN, 2019h; Mitchell et al., 2017). See the Nursing Research profile in Chart 12-9.

Chart 12-8

Sources of Fatigue in Patients with Cancer

- Anxiety associated with fear, diagnosis, role changes, uncertainty of future
- Disturbed sleep pattern related to cancer therapies, anxiety, and pain
- Electrolyte imbalances due to vomiting, diarrhea
- Risk for impaired nutritional intake due to nausea, vomiting, cancer-related anorexia-cachexia syndrome
- Impaired physical mobility due to neurologic impairments, surgery, bone metastasis, pain, and analgesic use
- Impaired tissue integrity due to stomatitis, mucositis
- Ineffective breathing associated with cough and dyspnea
- Ineffective protection secondary to neutropenia, thrombocytopenia, anemia
- Pain, pruritus
- Uncertainty and education needs related to disease process, treatment

Adapted from the National Comprehensive Cancer Network (NCCN). (2019h). NCCN guidelines for supportive care: Cancer related fatigue – version 1.2019. Retrieved on 7/20/2019 at: www.nccn.org/professionals/physician_gls/pdf/fatigue.pdf

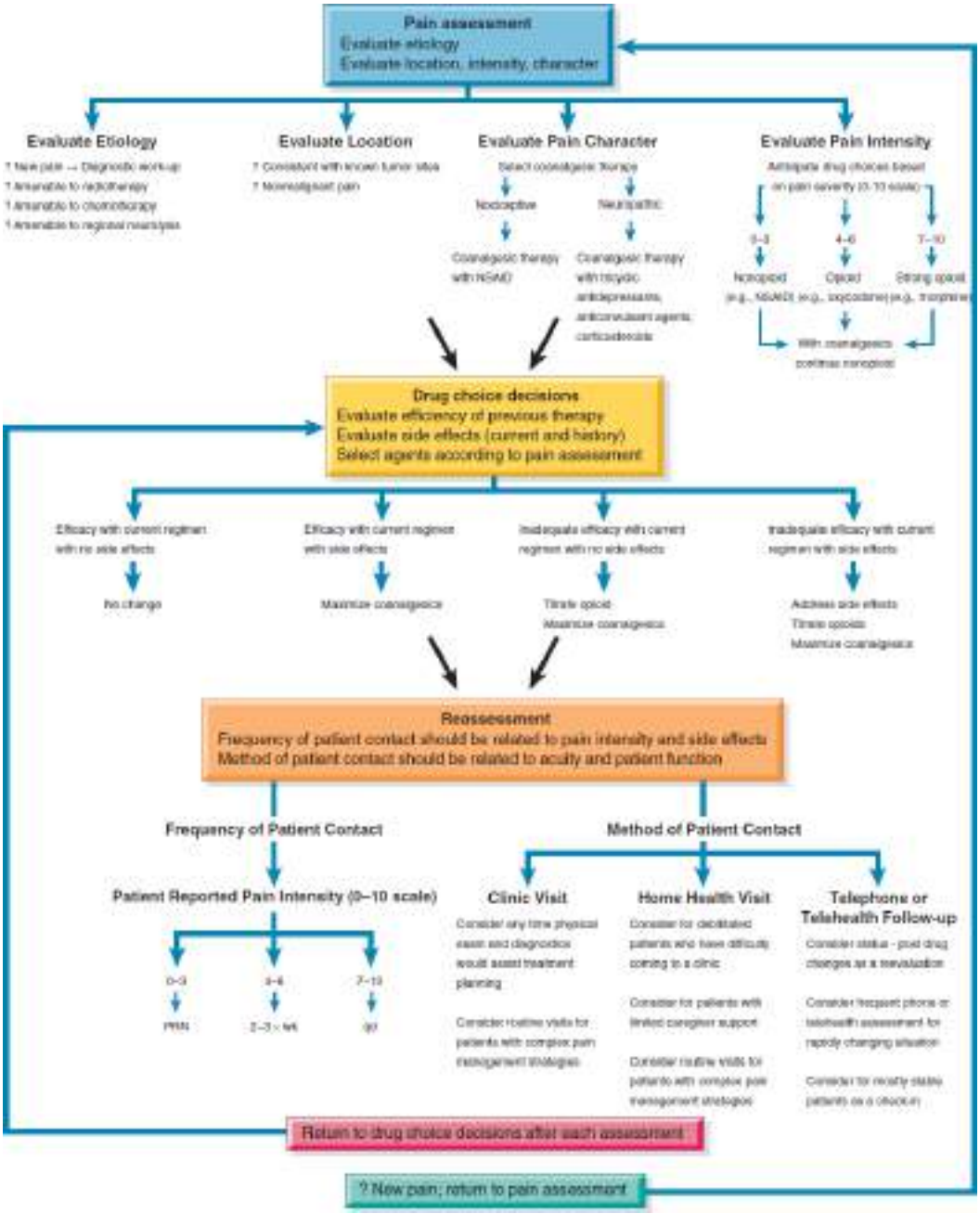

Figure 12-7 • The cancer pain algorithm (highest-level view) is a decision-tree model for pain treatment. NSAID; nonsteroidal anti-inflammatory drug; PRN, as needed; qd, once a day; wk, week. Adapted from DuPen, A. R., DuPen, S., Hansberry, J., et al. (2000). An educational implementation of a cancer pain algorithm for ambulatory care. *Pain Management Nursing, 1*(4), 118.

Chart 12-9 NURSING RESEARCH PROFILE

Poor Sleep and Fatigue in Women with Breast Cancer

Overcash, J., Tan, A., & Noonan, A. (2018). Factors associated with poor sleep in older women diagnosed with breast cancer. *Oncology Nursing Forum, 45*(3), 359–371.

Purpose

Breast cancer is the most common form of cancer in women. The risk for developing breast cancer increases with age, as does the incidence of poor quality of sleep. The purpose of this study was to determine the relationship among poor sleep and gait, grip (hand) strength, cognitive status, and symptoms (depression, pain, fatigue).

Design

Women with breast cancer (any stage) aged 69 years or older were recruited to participate in this descriptive, cross-sectional study for an outpatient cancer clinic in the midwestern region of the United States. Instruments used to collect data in this study included: the Timed Up and Go Test (gait), Jamar Hydraulic Hand Dynamometer (grip strength), the Mini-Cog (cognitive status), the Geriatric Depression Scale (depression), Numeric Pain Scale (pain), the Brief Fatigue Inventory (fatigue), and the Pittsburgh Sleep Quality Index (sleep).

Findings

Sixty women with breast cancer, with a mean age of 77.6 (range 69.0 to 93.0) years, participated in this study. Strong to moderate relationships were found between pain and fatigue (r = 0.58, p = 0.001); pain and depression (r = 0.40, p = 0.002); and depression and fatigue (r = 0.66, p = 0.001). Patients with greater severity of fatigue (OR = 1.57, 95% CI = 1.32 – 2.16]), depression (OR = 1.46, 95% CI = 1.07 – 1.99]), and pain (OR = 1.41, 95% CI = 1.04 – 1.92]) were found to be at significantly higher risk of having poor sleep. Fatigue was found to have the strongest association with poor sleep. Poor sleep was not significantly related to gait, grip strength, or cognitive status in this study (all p-values > 0.05).

Nursing Implications

Nurses need to be aware of the symptoms that can affect sleep in older women with breast cancer, both during and following treatment. In this study, fatigue was found to strongly relate to poor sleep, which suggests that nurses must assess for and develop strategies to address both symptom concerns. Nurses should encourage older women with breast cancer to engage in physical activity (exercise) as part of their daily routine, to decrease fatigue and enhance sleep. Given that fatigue, depression, pain, and poor sleep may contribute to an increased risk for falls in older adults, nurses must pay particular attention to safety when caring for women with breast cancer and their families.

Improving Body Image and Self-Esteem

The nurse identifies potential threats to the patient's body image and assesses the patient's ability to cope with the many bodily changes that may be experienced throughout the course of disease and treatment. Entry into the health care system

may be accompanied by depersonalization. Threats to self-concept occur as the patient faces the realization of illness, disfigurement, possible disability, and death. To accommodate treatments or because of the disease, many patients with cancer are forced to alter their lifestyles. Priorities and values change when body image is threatened. Disfiguring surgery, hair loss, cachexia, skin changes, altered communication patterns, and sexual dysfunction can threaten the patient's self-esteem and body image.

A creative and positive approach is essential when caring for patients with altered body image. Nursing strategies for addressing issues related to body image and self-esteem are included in the nursing care plan (see Chart 12-6). The nurse serves as an active listener and counselor to both the patient and the family. Possible influences of the patient's culture and age are considered when discussing concerns and potential interventions.

Addressing Sexuality

The physiologic processes associated with cancer; potential short- and long-term effects of cancer treatments; and psychosocial, emotional, and spiritual responses to the entire experience may lead patients to confront a variety of sexuality-based issues. Patients at the greatest risk of sexual dysfunction are those with tumors that involve the sexual or pelvic organs and those whose treatment affects the hormonal systems mediating sexual function (Olsen et al., 2019). Although sexuality is an important component of overall health, many nurses and other health professionals are hesitant to include sexuality in their discussions with patients (Almont, Farsi, Krakowski, et al., 2019). In offering a holistic approach to the care of patients with cancer, nurses should initiate discussions about sexuality and assess sexual health.

Infertility, a common consequence of cancer and cancer treatments, can be of concern to patients and their partners. The potential for impaired fertility is discussed and options reviewed for fertility preservation (Olsen et al., 2019). Fertility plans are discussed and determined prior to the initiation of any therapy that may compromise reproductive abilities.

Referrals are made as needed for specialized evaluation and interventions that are beyond the scope of nursing intervention.

Assisting in the Grieving Process

A cancer diagnosis need not indicate a fatal outcome. Many forms of cancer are curable, and others may be controlled for long periods of time similar to the course of other chronic diseases. Despite the tremendous advances in cancer treatment, many patients and their families still view cancer as a fatal disease that is inevitably accompanied by pain, suffering, debilitation, and emaciation. Grieving is a normal response to these fears and to actual or potential losses: loss of health, normal sensations, body image, social interaction, intimacy, independence, and usual social roles. Patients, families, and friends may grieve for the loss of quality time to spend with others, the loss of future and unfulfilled plans, and the loss of control over the patient's body and emotional reactions. Nurses continue to assess the patient and

family for positive or maladaptive coping behaviors, interpersonal communication, and evidence of the need for additional psychosocial support or interventions such as referral for professional counseling.

If the patient enters the terminal phase of disease, the nurse may assess that the patient and family members are at different stages of grief. In such cases, the nurse assists the patient and family to acknowledge and cope with their reactions and feelings. The nurse also empowers the patient and family to explore preferences for issues related to end-of-life care, such as withdrawal of active disease treatment, desire for the use of life-support measures, and symptom management approaches. Oncology nurses respectfully support the patient's spiritual or religious views and facilitate contact with their preferred clergy member, if desired. In addition, nurses consider the patient's cultural beliefs and practices when addressing issues related to grief. After the death of a patient with cancer, home health or hospice nurses follow up with surviving family members for bereavement counseling to facilitate expression and coping with feelings of loss and grief. (See Chapter 13 for further discussion of end-of-life issues.)

Management of Psychosocial Distress

Despite advances in cancer care, patients experience varying levels of psychosocial distress related to actual or potential losses, fear of the unknown, symptoms due to cancer or cancer treatments, changes in usual family and social roles, financial concerns, and a sense of loss of control. Psychosocial distress is defined as a multifactorial unpleasant emotional experience of a psychological (cognitive, behavioral, emotional), social, or spiritual nature that may interfere with the ability to cope effectively with cancer, its physical symptoms and its treatment (NCCN, 2019i). Distress occurs along a continuum, ranging from common normal feelings of vulnerability, sadness, and fears to problems that can become disabling, such as depression, anxiety, panic, social isolation, and existential and spiritual crisis. Distress that is not addressed can have a significant impact on the overall well-being, interpersonal relationships, cognitive abilities, and adherence to treatment regimens, leading to poor outcomes.

Nurses need to screen patients for psychosocial distress during the cancer experience. Patients are supported in managing various sources and levels of distress. Referral to mental health providers may be helpful to address specific concerns (NCCN, 2019i).

Monitoring and Managing Potential Complications

Nurses need to pay particular attention to monitoring for and helping manage complications such as infection, septic shock, bleeding, and thrombocytopenia.

Infection

For patients in all stages of cancer, the nurse assesses factors associated with the development of infection. Although infection-associated morbidity and mortality have greatly decreased, prevention and prompt treatment of infection are essential

in patients with cancer (Olsen et al., 2019). Often, more than one predisposing factor is present in patients with cancer. The nurse monitors laboratory studies to detect early changes in WBC counts. Common sites of infection, such as the pharynx, skin, perianal area, urinary, and respiratory tracts, are assessed on a regular basis. However, the typical signs of infection (swelling, redness, drainage, and pain) may not occur in myelosuppressed patients because of decreased circulating WBCs and a diminished local inflammatory response. Fever may be the only sign of infection (NCCN, 2019j). The nurse monitors the patient for sepsis, particularly if invasive catheters or long-term IV catheters are in place.

WBC function is often impaired in patients with cancer. Among the five types of WBCs (neutrophils [granulocytes], lymphocytes, monocytes, basophils, and eosinophils), neutrophils serve as the body's primary initial defense against invading organisms. Comprising 60% to 70% of the body's WBCs, neutrophils act by engulfing and destroying infective organisms through phagocytosis. Both the total WBC count and the concentration of neutrophils are important in determining the patient's ability to fight infection. A decrease in circulating WBCs is referred to as leukopenia. The terms granulocytopenia and neutropenia refer to a decrease in neutrophils.

A differential WBC count identifies the relative numbers of WBCs and permits tabulation of polymorphonuclear neutrophils (PMNs) or segmented neutrophils (mature neutrophils, reported as "polys," PMNs, or "segs") and immature forms of neutrophils (reported as bands, metamyelocytes, and "stabs"). The absolute neutrophil count (ANC) is calculated by the following formula:

$$\text{ANC} = (\text{segmented neutrophils [\%]} + \text{band [\%]}) \times \text{WBC count (cell/mm}^3\text{)}$$

$$\text{Example: } (25\% \text{ seg} + 25\% \text{ bands}) \times 6000 \text{ WBC cell/mm}^3 = 3000 \text{ ANC}$$

Neutropenia, an abnormally low ANC, is associated with an increased risk of infection. The risk of infection rises as the ANC decreases. As the ANC declines below 1500 cells/mm^3, the risk of infection rises. An ANC less than 500 cells/mm^3 reflects a severe risk of infection (NCCN, 2019j). The ***nadir*** is the lowest ANC following chemotherapy, targeted therapy, or radiation therapy that suppresses bone marrow function. Severe neutropenia may necessitate delays in administration of myelosuppressive therapies or treatment dose adjustments, although the use of the hematopoietic growth factors (e.g., colony-stimulating factors; see previous discussion) has reduced the severity and duration of treatment-associated neutropenia as well as infection-related morbidity and early death (NCCN, 2019j). The administration of these growth factors assists in maintaining treatment schedules, drug dosages, treatment effectiveness, and quality of life.

Patients with febrile neutropenia are assessed for factors that increase the risk of infection and for sources of infection through cultures of blood, sputum, urine, stool, IV and urinary or other catheters, and wounds, if appropriate (see Table 12-10). In addition, a chest x-ray is usually obtained to assess for pulmonary infection.

Defense against infection is compromised in many ways. The integrity of the skin and mucous membranes is challenged by multiple invasive diagnostic procedures, by the adverse effects of all cancer treatment modalities, and by the detrimental effects of immobility. Impaired nutrition as a result of CACS, nausea, vomiting, diarrhea, and the underlying disease alters the body's ability to combat invading organisms. Medications such as antibiotics disturb the balance of normal flora, allowing the overgrowth of normal flora and pathogenic organisms. Other medications can also alter the immune response (see Chapter 31). Cancer itself may lead to defects in cellular and humoral immunity. Advanced cancer may cause obstruction of hollow viscera (e.g., intestines), blood, and lymphatic vessels, creating a favorable environment for proliferation of pathogenic organisms. In some patients, tumor cells infiltrate bone marrow and prevent normal production of WBCs.

TABLE 12-10 Assessment of Neutropenic Fever in Patients with Cancer

Fever Criteria	Neutropenia Criteria
• Any one-time temperature of 38.3°C (101°F) or • Any temperature of ≥38°C (100.4°F) or ≥1 h	• <500 neutrophils/mcL or • <1000 neutrophils/mcL and predicted to decline to ≤500 neutrophils/mcL over the next 48 h

Assessment Targets for Neutropenic Fever Evaluation

Infection Risk Factors	Physical Assessment	Diagnostic Procedures	Microbiologic Cultures
• Chronic comorbid illnesses • Underlying hematologic malignancies • Immunosuppression related to factors other than neutropenia (e.g., immunosuppressive therapy following allogeneic HSCT or hypogammaglobulinemia [decreased gammaglobulin production]) • Solid tumors causing obstructions of the bronchial tree, ureters, colon, or biliary ducts • Advanced or refractory underlying malignancy • Prolonged duration of neutropenia • Age ≥65 yrs • Limited mobility or debilitation • Medications (e.g., corticosteroids such as prednisone) • Antibiotic therapy or prophylaxis • Recent surgery for diagnosis or treatment • Chemotherapy or targeted therapy received within the last 7–10 days • Prior treatment with multiple types of chemotherapy regimens • Recent radiation therapy; especially to areas	• Skin, pressure points, wounds • Surgical or biopsy incision sites • IV access or reservoir sites • Drainage catheter sites • Tracheostomy site • Lungs and sinuses • Perivaginal and perirectal area • Alimentary canal, abdomen • Neurologic assessment • Vital signs	• Diagnostic imaging as appropriate to identify abscesses, fistulas, pneumonia, obstruction, etc. • Complete blood count/differential • Serum chemistries, liver function tests • Renal function tests • Pulse oximetry or arterial blood gases • Lumbar puncture for CSF analysis	• Blood (peripheral and central venous access if applicable) • Urine (especially with indwelling catheter) • Skin wounds, lesions, incision sites, catheter exit sites • Catheter tips when feasible • Drainage from catheters • Stool, diarrhea • Sputum • CSF

associated with bone marrow reserves • Prior documented infections • Impaired skin integrity • Invasive drainage or urinary catheters • Peripheral or central venous access devices • Exposures (travel, others with infection, blood administration, pets) • Diarrhea • Poor nutritional status • Recent lumbar puncture or indwelling Ommaya reservoir™ (long-term intraventricular catheter for administration of chemotherapy into CSF and ventricles)	

CSF, cerebrospinal fluid; HSCT, hematopoietic stem cell transplantation; IV, intravenous.
Adapted from National Comprehensive Cancer Network (NCCN). (2019j). NCCN clinical practice guidelines in oncology: Prevention and treatment of cancer-related infection—version 1.2019. Retrieved on 7/14/2019 at: www.nccn.org/professionals/physician_gls/pdf/infections.pdf; Palmore, T. N., Parta, M., Cuellar-Rodriguez, J., et al. (2018). Infections in the cancer patient. In DeVita, V. T., Lawrence, T. S., Rosenberg, S. A. (Eds.). *Cancer: Principles & practice of oncology* (11th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Nurses are in a key position to assist in preventing and identifying symptoms of infection, as discussed in the nursing care plan (see Chart 12-6). Clinical practice guidelines developed by the ONS, the Infusion Nurses Society (INS), the NCCN, and the ASCO are used to guide prevention and management of infection. Interventions to prevent infection and alternative patient education formats for infection-related instruction are high nursing research priorities.

Gram-positive bacteria (*Streptococcus,* enterococci, and *Staphylococcus* species) and gram-negative organisms (*Escherichia coli, Klebsiella pneumoniae, Enterobacter,* and *Pseudomonas aeruginosa*) are the most frequently isolated causes of infection. Fungal organisms, such as *Candida albicans,* also contribute to the incidence of serious infection. Viral infections in immunocompromised patients are caused most often by herpes simplex, respiratory syncytial, parainfluenza, and influenza A and B viruses.

Fever is reported promptly as it is an important sign of infection in patients when associated with neutropenia (Olsen et al., 2019). Patients with neutropenic fever (see Table 12-10) are assessed for infection and reported promptly (NCCN, 2019j). Antibiotics may be prescribed after cultures of wound drainage, exudates, sputum, urine, stool, or blood are obtained. Careful consideration is given to the underlying malignancy, prior antineoplastic treatment, ANC, comorbidities, and other patient-

related factors prior to the identification of the most appropriate antibiotic therapy. Evidence-based guidelines are available for prevention and treatment of cancer-related infections (NCCN, 2019j). Patients with neutropenia are treated with broad-spectrum antibiotics before the infecting organism is identified because of the increased risk of mortality associated with untreated infection. Broad-spectrum antibiotic therapy targets the most likely major pathogenic organisms. It is important for these medications to be given and taken promptly as scheduled to achieve adequate blood levels. Once the offending organism is identified, more specific antimicrobial therapy is prescribed as appropriate. Nurses provide education for patients and families regarding prevention of infection, signs and symptoms to report, and the importance of adherence to prescribed antimicrobial therapy.

Septic Shock

The nurse assesses the patient frequently for signs and symptoms of infection and inflammation throughout the trajectory of cancer care. Sepsis and septic shock are life-threatening complications that must be prevented or detected and treated promptly. Although all patients with cancer are at risk, patients who are neutropenic or who have hematologic malignancies are at the greatest risk. Patients with signs and symptoms of impending sepsis and septic shock require immediate hospitalization and aggressive treatment in the intensive care setting. See Chapter 11 for discussion of sepsis and septic shock.

Bleeding and Thrombocytopenia

Platelets are essential for normal blood clotting and coagulation (hemostasis). **Thrombocytopenia**, a decrease in the circulating platelet count, is the most common cause of bleeding in patients with cancer and is usually defined as a platelet count less than 100,000/mm^3 (0.1×10^{12}/L). The risk of bleeding increases when the platelet count decreases below 50,000/mm^3 (0.05×10^{12}/L). At platelet counts lower than 10,000/mm^3 (0.02×10^{12}/L), the risk for spontaneous bleeding is increased (Olsen et al., 2019).

Thrombocytopenia often results from bone marrow depression after certain types of chemotherapy and radiation therapy and with tumor infiltration of the bone marrow. In some cases, platelet destruction is associated with hypersplenism (enlarged spleen) and abnormal antibody function, which occur with leukemia and lymphoma. Bacterial and viral infections may lead to early platelet destruction or impaired bone marrow production of platelets and subsequent thrombocytopenia. Some medications (e.g., heparin, vancomycin) may cause bone marrow toxicity leading to decreases in circulating platelets. Less commonly, posttransfusion complications may lead to antibody destruction of platelets causing profound thrombocytopenia (Mones & Soff, 2019). The nursing care plan addresses nursing assessment parameters and interventions for patients at risk for bleeding (see Chart 12-6).

Quality and Safety Nursing Alert

Although laboratory test results confirm the diagnosis of thrombocytopenia, the patient who is developing thrombocytopenia may display early signs and symptoms. Thus, nurses need to observe keenly for petechiae and ecchymoses, which are early indicators of decreasing platelet levels. Early detection promotes early intervention.

Additional medications may be prescribed to address bleeding or thrombocytopenia based on the underlying etiology. See Chapter 29 for further discussion of assessment and treatment of thrombocytopenia and coagulopathies.

VTE, a common problem for patients with cancer, includes deep venous thrombosis (DVT), pulmonary embolism (PE), superficial venous thrombosis (SVT), and thrombosis in other abdominal or thoracic venous tributaries such as the mesenteric veins or the superior vena cava. The incidence of VTE has been linked to an increased likelihood of death in patients with cancer (NCCN, 2019k). Factors associated with risk for VTEs in cancer patients include preexisting underlying or cancer-related coagulopathies, medications including chemotherapy, hospitalizations, surgical procedures, increased age, debilitation, immobility, infection, and peripheral and central venous catheters (NCCN, 2019k). Patients with cancer are monitored for associated risk factors and are assessed on an ongoing basis for VTE. Nurses provide patient and family education regarding symptoms of VTE to report to the provider. Recommendations for prophylaxis are based on national guidelines and patient risk factors. Nursing assessment findings associated with VTE are reported promptly so that VTE evaluation and treatment can be initiated expeditiously.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

Most commonly, patients with cancer are diagnosed and treated in the outpatient setting. Nurses in outpatient settings often have the responsibility for patient education and helping coordinate care in the home (see Chart 12-10). The shift of care from acute care facilities to the home or outpatient settings as well as the increasing use of oral antineoplastic agents places significant responsibility for care on the patient and family. In order to maintain optimal patient outcomes and quality of life, patients and families require support and information that will prepare them to engage in self-care. Education initially focuses on the most immediate care needs likely to be encountered at home.

Approaches to preparing patients for self-care responsibilities are chosen with consideration of the patient's preferred learning strategies, level of education, and health literacy (Howell, Harth, Brown, et al., 2017). Nurses are in a prime role to

promote self-care by ensuring that the educational needs of patients and families are met across time points of the cancer continuum (Eller, Lev, Yuan, et al., 2018; White, Cohen, Berger, et al., 2017). Easily understood, concrete, objective information that assists patients to understand what to expect and includes sensory and temporal components is important. Symptoms, side effects of treatment, and changes in the patient's status that should be reported are discussed and reinforced with printed materials that can be referred to in the home. Nurses help to empower patients by sharing strategies to manage side effects or other symptoms. Additional learning needs are based on the priorities conveyed by the patient and family as well as on the complexity of care required (Howell et al., 2017).

Chart 12-10 **HOME CARE CHECKLIST**

The Patient Receiving Care for an Oncologic Disorder

At the completion of education, the patient or caregiver will be able to:

- State the impact of cancer treatment on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- State changes in lifestyle (e.g., diet, activity) necessary to maintain health.
- State the name, dose, side effects, frequency, and schedule for all medications.
- Demonstrate how to administer the chemotherapy agent in the home:
  - Describe safe storage and handling of oral chemotherapy/immunotherapy/targeted therapy agents in the home.
  - Demonstrate safe disposal of needles, syringes, IV supplies, or unused chemotherapy medications.
  - List possible side effects of chemotherapy/immunotherapy/targeted therapy agents and suggested management approaches.
- List possible side effects of radiation therapy and suggested management approaches.
- List complications of medications/therapeutic regimen necessitating a call to the nurse or primary provider.
- List complications of medications/therapeutic regimen necessitating a visit to the emergency department.
- Locate list of names and contact details of resource personnel involved in care (e.g., home health nurse, infusion services, IV vendor, equipment company, radiation therapy department).
- Explain treatment plan and importance of upcoming visits to the primary provider.
- State how to obtain medical supplies after discharge.
- Identify durable medical equipment needs, proper usage, and maintenance necessary for safe utilization.
- Demonstrate usage of adaptive equipment for ADLs.
- Identify community resources for peer and caregiver/family support:
  - Identify sources of support (e.g., friends, relatives, faith community)
  - Identify phone numbers of support groups for people with cancer and their caregivers/families
  - State meeting locations and times
- Identify the need for health promotion, disease prevention, and screening activities

ADL, activities of daily living; IADL, independent activities of daily living.

Technologic advances allow home administration of IV chemotherapy, blood products, and antibiotics; enteral or parenteral nutrition; and parenteral analgesics. Patients and families are taught to care for vascular access devices, infusion pumps, various types of drainage catheters, and on occasion complex wounds. The importance of patient safety and infection control is included in patient and family education. Although nurses are often available to provide some assistance with

cancer care in the home, patients and families need to acquire the requisite knowledge and skills that will enable them to develop a strong sense of self-efficacy to not only foster self-care, but also to promote a more positive health status and better quality of life (Eller et al., 2018; White et al., 2017).

Continuing and Transitional Care

Referral for home or transitional care is often indicated for patients with cancer. The responsibilities of the nurse include assessing the home environment and suggesting modifications in the home or in care to help address the patient's physical and safety needs. Home health nurses also assess the psychosocial impact of cancer on the patient and family so that appropriate interventions can be identified or referrals for support services are instituted.

Ongoing nursing visits or phone contact from the home or transitional care nurse assist in prevention, early identification, prompt reporting, and management of patient problems. Timely modifications in therapy to manage symptoms and adverse effects of treatment may decrease patient suffering and decrease emergency department visits or hospital admissions. Continued contact facilitates evaluation of the patient's progress, responses to treatment, and assessment of the ongoing needs of the patient and family. It is necessary to assess the patient's and family's understanding of the treatment plan and management strategies and to reinforce previous education. The nurse facilitates coordination of patient care by maintaining close communication with all involved health care providers. The nurse may make referrals and coordinate available community resources (e.g., local office of the ACS, home aides, church groups, faith community nurses, support groups) to assist patients and caregivers.

Gerontologic Considerations

Approximately 55% of cancer incidence and 70% of cancer deaths occur in persons aged 65 years or older (ACS, 2019a). The rising number of individuals over age 65 with cancer has led to the emergence of geriatric oncology, a multidimensional and multidisciplinary approach to treating growing numbers of older adults with cancer.

Nurses working with older adults must understand the normal physiologic changes that occur with aging and the implications for the patient with cancer (see Table 12-11). These changes that affect all body systems may ultimately influence older patients' responses to cancer treatment. In addition, many older patients have other chronic diseases requiring multiple medications. The existence of comorbidities and multiple medications may contribute to drug interactions and toxicities in older patients.

The understanding of the effects and tolerance of chemotherapy, immunotherapy, targeted therapies, and radiation in the older adult is limited, as older adults have been underrepresented in oncology clinical trials. Potential chemotherapy-related toxicities, such as renal impairment, myelosuppression, fatigue, and cardiomyopathy, may increase as a result of declining organ function and diminished physiologic reserves. The recovery of normal tissues after radiation

therapy may be delayed, and older adult patients may experience more severe adverse effects, such as mucositis, nausea and vomiting, and myelosuppression. Because of impaired healing and declining pulmonary and cardiovascular functioning, older patients are slower to recover from surgery. Older patients are also at increased risk for complications, such as atelectasis, pneumonia, and wound infections.

TABLE 12-11 Age-Related Changes and Their Effects on Patients with Cancer

Age-Related Changes	Implications
Impaired immune system	Use special precautions to avoid infection; monitor for atypical signs and symptoms of infection.
Altered drug absorption, distribution, metabolism, and elimination	Mandates careful calculation of chemotherapy and frequent assessment for drug response and side effects; dose adjustments may be necessary.
Increased prevalence of other chronic diseases	Monitor for effect of cancer or its treatment on patient's other chronic diseases; monitor patient's tolerance for cancer treatment; monitor for interactions with medications used to treat chronic diseases.
Diminished renal, respiratory, and cardiac reserve	Be proactive in prevention of decreased renal function, atelectasis, pneumonia, and cardiovascular compromise; monitor for side effects of cancer treatment.
Decreased skin and tissue integrity; reduction in body mass; delayed healing	Prevent pressure ulcers secondary to immobility; monitor skin and mucous membranes for changes related to radiation or chemotherapy; monitor nutritional status.
Decreased musculoskeletal strength	Prevent falls; assess support for performing activities of daily living in home setting; encourage safe use of assistive mobility devices.
Decreased neurosensory functioning: loss of vision, hearing, and distal extremity tactile senses	Provide instruction modified for patient's hearing and vision changes; provide instruction concerning safety and skin care for distal extremities; assess home for safety.
Altered social and economic resources	Assess for financial concerns, living conditions, and resources for support.
Potential changes in cognitive and emotional capacity	Provide education and support modified for patient's level of functioning and safety.

Adapted from Eliopoulos, C. (2018). *Gerontological nursing* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Cancer Survivorship

In the United States, there are currently an estimated 16.9 million adult cancer survivors; by 2030, that number is estimated to be 22.1 million (ACS, 2019f). Advances in cancer screening, treatment, and management of complications have contributed to a lengthened survival period for many, with long-term survival

becoming possible for many patients. *Cancer survivorship* has been defined as the period from cancer diagnosis through the remaining years of life and focuses on the health and life of a person beyond diagnostic and treatment phases. Although individuals vary and many types of cancers and treatments exist, the acute, long-term, and late effects of cancer and its treatment may have multiple long-term physical, cognitive, psychological, social, and financial consequences that can impact activities of daily living, ultimately affecting quality of life (ACS, 2019f).

Survivorship care is often based on expert opinion and experience rather than on evidence-based practices. Knowledge regarding survivorship concerns continues to evolve. The Institute of Medicine has identified four components of survivorship care, the period that follows primary treatment for cancer and lasts until end of life. In addition to a summary of prior diagnosis and treatment, survivorship care includes monitoring and treatment for late effects related to disease and prior treatments, physical and vocational rehabilitation, psychosocial support and counseling as necessary, surveillance and screening for new and recurrent cancer, and coordination between specialists and primary care providers to ensure that all of the survivor's needs are met (Hewitt, Greenfield, & Stovall, 2006) (see Table 12-12). Advocacy organizations across the country have recommended that a survivorship care plan be provided to all patients with cancer and their primary provider at the completion of treatment. The survivorship care plan includes a summary of cancer diagnosis, treatment, recommendations for follow-up care, including approaches to treat symptoms, rehabilitative needs, monitoring for late effects, and surveillance and screening for new and recurrent cancer. Referrals for specific services such as lymphedema therapy, chronic pain management, and genetic counseling are also provided. Nurses assist in the development of the survivorship care plan and provide education and care for cancer survivors. Nurses, other health care providers, public health professionals, and patient advocates design and conduct research to identify needs of cancer survivors and evidence-based approaches to care.

TABLE 12-12 Components of Survivorship Care

Component	Examples of Care
Prevention and detection of new and recurrent cancer	Mammography (per ACS guidelines) Papanicolaou (Pap) smears (per ACS guidelines) Smoking cessation programs Nutrition counseling
Surveillance for cancer spread, recurrence, or second cancers	Colonoscopy post colon cancer Mammography post breast cancer Liver function tests post colon cancer Prostate-specific antigen post prostate cancer
Intervention for consequences of cancer and its treatments	Lymphedema therapy Pain management Enterostomal therapy Fertility care Psychosocial support or counseling Reconstructive surgery
Coordination between specialists and primary providers to meet health needs	Care for comorbidities (e.g., diabetes) Influenza vaccination Bone densitometry Monitoring for chemotherapy induced cardiotoxicity

ACS, American Cancer Society.

Adapted from Hewitt, M., Greenfield, S., & Stovall, E. (Eds.). (2006). *From cancer patient to cancer survivor: Lost in translation*. Washington, DC: Institute of Medicine and National Research Council, National Academies Press. Components of survivorship care provided by the Institute of Medicine report on cancer survivorship.

Providing Care to the Patient with Advanced Cancer

The patient with advanced cancer needs to be monitored for oncologic emergencies and have appropriate treatment should emergencies occur. These patients may have end-of-life and palliative care needs that must be addressed.

Providing Care in Oncologic Emergencies

Table 12-13 discusses select nursing and medical care of oncologic emergencies.

As a result of advances in all aspects of cancer care, it is more common that individuals are living with cancer that has advanced beyond the original site of development to regional or distant sites. Patients with advanced cancer are likely to experience many of the problems described previously, although more often and to a greater degree. Symptoms of pain, anorexia, weight loss, CACS, fatigue, and impaired functional status and mobility make patients more susceptible to depressive symptoms, skin breakdown, fluid and electrolyte imbalances, and infection.

Treatment for the patient with advanced cancer is likely to be palliative rather than curative, with an emphasis on prevention and appropriate management of pain.

The use of long-acting analgesic agents at set intervals, rather than on an "as needed" basis, is recommended in addressing pain management. Working with the patient and family, as well as with other health care providers, to manage pain is essential to increase the patient's comfort and offer some sense of control. Other medications (e.g., sedatives, tranquilizers, muscle relaxants, antiemetics) are added to assist in palliating additional symptoms and promoting quality of life.

TABLE 12-13 Oncologic Emergencies: Manifestations and Management

Oncologic Emergency	Clinical Manifestations and Diagnostic Findings	Medical and Nursing Management
Superior Vena Cava Syndrome (SVCS) Compression or invasion of the superior vena cava by tumor; enlarged lymph nodes; intraluminal thrombus that obstructs venous circulation; or drainage of the head, neck, arms, and thorax. Most often associated with lung cancer, SVCS is also associated with lymphoma, thymoma, and testicular cancers and mediastinal metastases from breast cancer. If untreated, SVCS may lead to cerebral anoxia (because not enough oxygen reaches the brain), laryngeal edema, bronchial obstruction, and death.	**Clinical Manifestations:** Gradually or suddenly impaired venous drainage giving rise to: progressive dyspnea (shortness of breath), cough, hoarseness, chest pain, and facial swelling Edema of the neck, arms, hands, and thorax and reported sensation of skin tightness, difficulty swallowing, and stridor. Possibly engorged and distended jugular, temporal, and arm veins. Dilated thoracic vessels causing prominent venous patterns on the chest wall. Increased intracranial pressure, associated visual disturbances, headache, and altered mental status **Diagnostic Findings:** Diagnosis confirmed by: Clinical findings Chest x-ray Thoracic CT scan Thoracic MRI	**Medical Management:** Radiation therapy to shrink tumor or enlarged lymph nodes and relieve symptoms. Chemotherapy for sensitive cancers (e.g., lymphoma, small cell lung cancer) or when the mediastinum has been irradiated to maximum tolerance. Anticoagulant or thrombolytic therapy for central venous catheter–related intraluminal thrombosis. Percutaneously placed intravascular stents may be priority consideration rather than surgery unless symptoms are rapidly progressing. Supportive measures such as oxygen therapy, corticosteroids, and diuretics (in cases of fluid overload). **Nursing Management:** Identify patients at risk for SVCS. Provide patient and family education regarding signs and symptoms to report. Monitor and report clinical manifestations of SVCS. Monitor cardiopulmonary and neurologic status.

	Venogram if intraluminal thrombosis is suspected	Avoid upper extremity venipuncture and blood pressure measurement; instruct patient to avoid tight or restrictive clothing and jewelry on fingers, wrist, and neck. Facilitate breathing and drainage from upper portion of body by instructing patient to maintain some elevation of head and upper body with semi-Fowler position; avoid completely supine or prone position (this helps to promote comfort and reduce anxiety associated with dependent and progressive edema). Promote energy conservation to minimize dyspnea. Monitor the patient's fluid volume status; administer fluids cautiously to minimize edema. Assess for thoracic radiation-related problems such as mucositis with resultant dysphagia (difficulty swallowing) and esophagitis. Monitor for chemotherapy-related problems, such as myelosuppression. Provide postoperative care as appropriate.
Spinal Cord Compression Most commonly caused by compression of the cord and its nerve roots by a metastatic paravertebral tumor that extends into the epidural space; vertebral bone metastasis leading to bone collapse and displacement impinging on the spinal cord or nerve roots; and less commonly, primary malignancy of the cord. May potentially lead to significant and permanent neurologic impairment associated with multiple physical, psychosocial consequences. Most often associated with cancers that metastasize to the bone such as breast, lung, and prostate cancers and lymphoma. Also seen in nasopharyngeal cancer and multiple myeloma.	**Clinical Manifestations:** Local inflammation, edema, venous stasis, and impaired blood supply to nerve tissues. Local or radicular back or neck pain along the dermatomal areas innervated by the affected nerve root (e.g., thoracic radicular pain extends in a band around the chest or abdomen). Pain exacerbated by movement, supine recumbent position, coughing, sneezing, or the	**Medical Management:** Radiation therapy to reduce tumor size and halt progression; corticosteroid therapy to decrease inflammation and swelling at the compression site. Surgery to debulk tumor and stabilize the spine if symptoms progress despite radiation therapy or if vertebral fracture or bone fragments lead to additional nerve damage; surgery is also an option when the tumor is not radiosensitive or is located in an area that was previously irradiated. Minimally invasive surgical procedures, referred to as vertebral augmentation, may be used for patients with vertebral fractures to attain stability of the bone, prevent nerve compression, and decrease pain. Procedures include: Vertebroplasty: involves percutaneous injection of polymethyl methacrylate (PMMA), a bone cement filler, into the vertebral body. Kyphoplasty: a balloon is inserted into the damaged vertebral body and then inflated to create a cavity within the bone that can be filled with bone cement. The balloon

About 60% of spinal cord compressions occur at the thoracic level, 30% in the lumbosacral level, and 10% in the cervical and sacral regions. The prognosis depends on the severity and rapidity of onset.	Valsalva maneuver. Neurologic dysfunction and related motor and sensory deficits (numbness, tingling, feelings of coldness in the affected area, inability to detect vibration, loss of positional sense). Motor loss ranging from subtle weakness to flaccid paralysis. Bladder or bowel dysfunction depending on level of compression (above S2, overflow incontinence; from S3 to S5, flaccid sphincter tone and bowel incontinence).	helps to compress the fracture fragments together as the cavity is created.
	Diagnostic Findings: Percussion tenderness at the level of compression; abnormal reflexes; and sensory and motor abnormalities. MRI is a preferred diagnostic tool; may also utilize x-rays, bone scans, and CT scan.	Radiofrequency vertebral augmentation: similar to kyphoplasty; instead of the balloon, a small navigational cannula is inserted into the vertebra to create small pathways for cement. The cement is heated with radiofrequency to create an ultra-high viscosity that is thought to promote bone stability. Chemotherapy as adjuvant to other local therapies for patients with chemosensitive cancers, such as lymphoma or small cell lung cancer. *Note:* Despite treatment, patients with poor neurologic function before treatment are less likely to regain complete motor and sensory function; patients who develop complete paralysis usually do not regain all neurologic function. **Nursing Management:** Perform ongoing assessment of neurologic function to identify existing and progressing dysfunction. Control pain with pharmacologic and nonpharmacologic measures.

		Prevent complications of immobility resulting from pain and decreased function (e.g., skin breakdown, urinary stasis, thrombophlebitis, decreased clearance of pulmonary secretions). Maintain muscle tone by assisting with range-of-motion exercises in collaboration with physical and occupational therapists; patients with unstable vertebral fractures do not initiate physical therapy until spine stabilization procedures have been completed. Institute intermittent urinary catheterization and bowel training programs for patients with bladder or bowel dysfunction. Provide encouragement and support to the patient and family coping with pain and altered functioning, lifestyle, roles, and independence. Institute appropriate referrals for home care and physical and occupational therapy. Provide patient and family education about pharmacologic and nonpharmacologic interventions
Hypercalcemia Hypercalcemia is a potentially life-threatening metabolic abnormality resulting when the calcium released from the bones is more than the kidneys can excrete or the bones can reabsorb. It may result from production of cytokines, hormonal substances, and growth factors by cancer cells, or by the body in response to biochemical mediators produced by cancer cells, which lead to bone breakdown and calcium release. Occurs in about 20% of patients with cancer; most commonly seen in patients with multiple myeloma and cancers of the lung and breast.	**Clinical Manifestations:** Fatigue, weakness, confusion, decreased level of responsiveness, hyporeflexia, nausea, vomiting, constipation, ileus, polyuria (excessive urination), polydipsia (excessive thirst), dehydration, and arrhythmias. **Diagnostic Findings:** Total serum calcium level >10.4 mg/dL (2.6 mmol/L) Ionized serum calcium >1.29 mmol/L	**Medical Management:** Identify patients at risk for hypercalcemia and assess for signs and symptoms of hypercalcemia. Treatment of the underlying malignancy (e.g., chemotherapy, radiation therapy, hormone therapy, immunotherapy or targeted therapy). Reduce serum calcium levels: Oral hydration (3–4 L of fluid daily unless contraindicated by existing renal or cardiac disease) or IV hydration followed by diuretics (forced diuresis). Avoid dietary supplements and medications that can increase serum calcium levels (e.g., thiazide diuretics, nonsteroidal anti-inflammatory drugs; and vitamins A and D, and calcium supplements). Bisphosphonate therapy may be indicated for the long-term management. Maintenance of nutritional intake without restricting normal calcium intake. Dietary and pharmacologic interventions such as stool softeners and laxatives for constipation. Antiemetic therapy for nausea and vomiting. **Nursing Management:** Monitor closely for changes in mental status; fluid and electrolyte imbalances;

		and renal, gastrointestinal, cardiac dysfunction. Monitor treatment effectiveness and for the presence of side effects. Ensure proper hydration and monitor fluid and electrolyte balance closely. Educate patients who are at-risk and their families to recognize and report signs and symptoms of hypercalcemia. Encourage mobilization / weight-bearing activities, as tolerated, to limit bone resorption. Maintain patient safety and ensure comfort. Educate patient and families about prescribed management strategies.
Tumor Lysis Syndrome (TLS) Potentially fatal complication that occurs spontaneously or more commonly following radiation, immunotherapy, targeted therapy, or chemotherapy-induced cell destruction of large or rapidly growing cancers such as leukemia, lymphoma, and small cell lung cancer. The release of tumor intracellular contents (nuclei acids, electrolytes, and debris) leads to rapidly induced electrolyte imbalances—hyperkalemia, hyperphosphatemia (leading to hypocalcemia), and hyperuricemia—that can have life-threatening end-organ effects on the myocardium, kidneys, and central nervous system.	**Clinical Manifestations:** Clinical manifestations depend on the extent of metabolic abnormalities. *Neurologic:* Fatigue, weakness, memory loss, altered mental status, muscle cramps, tetany, paresthesias (numbness and tingling), and seizures. *Cardiac:* Elevated blood pressure, shortened QT complexes, widened QRS waves, altered T waves, arrhythmias, and cardiac arrest. *Gastrointestinal*: Anorexia, nausea, vomiting, abdominal cramps, diarrhea, and increased bowel sounds *Renal*: Flank pain, oliguria, anuria, kidney injury, and acidic urine pH.	**Medical Management:** To prevent kidney injury and restore electrolyte balance. Aggressive fluid hydration is initiated 24–48 h before and after the initiation of cytotoxic therapy to increase urine volume and eliminate uric acid and electrolytes. Diuresis with a loop diuretic or osmotic diuretic, if urine output is inadequate. Allopurinol therapy to inhibit the conversion of nucleic acids to uric acid (oral or IV). Rasburicase may be used to convert already formed uric acid to allantoin, which is highly water soluble and eliminated in urine. Administration of a cation-exchange resin, such as sodium polystyrene sulfonate to treat hyperkalemia by binding and eliminating potassium through the bowel. Administration of IV sodium bicarbonate, hypertonic dextrose, and regular insulin temporarily shifts potassium into cells and lowers serum potassium levels if a rapid decrease in potassium is necessary. Administration of phosphate-binding gels, such as aluminum hydroxide, to treat hyperphosphatemia by promoting phosphate excretion in the feces. Hemodialysis when patients are unresponsive to the standard approaches for managing uric acid and electrolyte abnormalities. Identify at-risk patients. Institute essential preventive measures (e.g., fluid hydration, medications) as prescribed. Assess patient for signs and symptoms of electrolyte imbalances.

	Other: Gout, malaise, and pruritis. **Diagnostic Findings:** Electrolyte imbalances identified by serum electrolyte measurement and urinalysis (see Chapter 10); electrocardiogram to detect cardiac arrhythmias. Clinical TLS is diagnosed when ≥1 of 3 conditions arise either 3 days prior to or 7 days after cytotoxic cancer therapy: acute kidney injury (defined as a rise in creatinine to ≥1.5 times the upper limit of normal that is not attributable to medications, arrhythmias, and seizures).	**Nursing Management:** Monitor for signs and symptoms of TLS in patients who are at-risk (e.g., those with hematologic malignancies). Monitor vital signs, laboratory values (i.e., electrolyte), fluid balance closely (i.e., daily weights, intakes and outputs), and cardiac status closely. Educate patients and families about risk factors for TLS; teach about current treatments (e.g., hydration, dietary restrictions [e.g., potassium and phosphorous], and pharmacologic therapy); signs and symptoms of complications; and when to report symptoms indicating electrolyte disturbances to the provider.

CT, computed tomography; IV, intravenous; MRI, magnetic resonance imaging.

Adapted from Kaplan, M. (Ed.). (2018). *Understanding and managing oncologic emergencies: A resource for nurses*. Pittsburgh, PA: Oncology Nursing Society; Rimmer, A., & Yahalom, J. (2018). Superior vena cava syndrome. In DeVita, V. T., Lawrence, T. S., Rosenberg, S. A. (Eds.). *Cancer: Principles & practice of oncology* (11th ed.). Philadelphia, PA: Lippincott Williams & Wilkins; Stein, S., & Deshpande, H. A. (2018). Metabolic emergencies. In DeVita, V. T., Lawrence, T. S., Rosenberg, S. A. (Eds.). *Cancer: Principles & practice of oncology* (11th ed.). Philadelphia, PA: Lippincott Williams & Wilkins; and Szerlip, N., Beeler, W. H., & Spratt, D. E. (2018). Spinal cord compression. In DeVita, V.T., Lawrence, T. S., Rosenberg, S. A. (Eds.). *Cancer: Principles & practice of oncology* (11th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

If the patient is a candidate for radiation therapy or surgical interventions to relieve pain or other symptoms, the potential benefits and risks of these procedures (e.g., percutaneous nerve block, cordotomy) are explained to the patient and family. Measures are taken to prevent complications that result from altered sensation, immobility, and changes in bowel and bladder function.

Weakness, altered mobility, fatigue, and inactivity typically increase with advanced cancer as a result of the disease, treatment, inadequate nutritional intake,

or dyspnea. The nurse works with the patient and family to identify realistic goals and promote comfort. Measures include use of energy conservation methods to accomplish tasks and activities that the patient values most.

Efforts are made to provide the patient with as much control and independence as desired but with assurance that support and assistance are available when needed. In addition, health care teams work with the patient and family to ascertain and comply with the patient's wishes about treatment methods and care as the terminal phase of illness and death approach.

Hospice

The needs of patients with end-stage illness are best met by a comprehensive interdisciplinary specialty program that focuses on quality of life; palliation of symptoms; and provision of physical, psychosocial, and spiritual support for patients and families when cure and control of the disease are no longer possible. The concept of hospice best addresses these needs.

Hospice care is often delivered through coordination of specialty services provided by hospitals, home care programs, and the community. Patients need to be referred to hospice services in a timely fashion so that complex patient and family needs can be addressed. See Chapter 13 for detailed discussion of end-of-life care.

CRITICAL THINKING EXERCISES

1 ebp A 38-year-old man with early-onset colorectal cancer completed his first cycle of chemotherapy 2 days ago. He is now being admitted to the inpatient oncology unit with febrile neutropenia. What interventions and education should be considered for febrile neutropenia? What is the evidence for these interventions and education that you identified for febrile neutropenia? How strong is that evidence, and what criteria will you use to assess the strength of that evidence?

2 pq A 76-year-old woman, with a past medical history that is significant for cataracts, arthritis, and hypertension, was recently diagnosed with stage II breast cancer. She is being discharged today from the hospital following a bilateral mastectomy with several surgical drains in place. What are the priorities for the assessment of this patient to ensure her readiness for discharge to home? What will be your priorities when educating this patient for self-care?

3 ipc You are caring for a 53-year-old man with diffuse large B-cell lymphoma who received CAR T–cell therapy 2 days ago. How does CAR T–cell therapy differ from conventional chemotherapy? What type of referrals might be appropriate for this patient? What members of the interprofessional health care team do you anticipate as being integral to the care of this patient?

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

American Association of Cancer Research (AACR), www.aacr.org
American Cancer Society (ACS), www.cancer.org
American College of Surgeons Commission on Cancer (CoC), www.facs.org/quality-programs/cancer/coc
American Pain Society (APS), www.ampainsoc.org
American Society of Clinical Oncology (ASCO), www.asco.org
American Society for Radiation Oncology (ASTRO), www.astro.org
Association of Oncology Social Work (AOSW), www.aosw.org
Cancer Care, www.cancercare.org/
Centers for Disease Control and Prevention (CDC): Cancer Control and Prevention, www.cdc.gov/cancer/
Hospice and Palliative Nurses Association (HPNA), www.hpna.org
LIVESTRONG Survivorship Centers of Excellence, www.livestrong.org
National Cancer Institute (NCI), www.cancer.gov
National Coalition for Cancer Survivorship, www.canceradvocacy.org
National Comprehensive Cancer Network (NCCN), www.nccn.org
National Hospice and Palliative Care Organization, www.nhpco.org
National Institutes of Health, National Center for Complementary and Integrative Health (NCCIH), nccih.nih.gov
OncoLink (cancer resources), www.oncolink.org
Oncology Nursing Society (ONS), www.ons.org
Quackwatch, www.quackwatch.org

The Bone Marrow Foundation, bonemarrow.org/
The Cancer Support Community, www.cancersupportcommunity.org
The COVID-19 and Cancer Consortium, ccc19.org
The Leukemia and Lymphoma Society, www.lls.org

13 Palliative and End-of-Life Care

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Compare and contrast the settings where palliative care and end-of-life care are provided.
2. Describe the principles and components of hospice care in the United States, including the Medicare hospice benefit.
3. Apply skills for communicating with patients who are seriously ill and their families in order to provide culturally and spiritually sensitive care.
4. Identify components of uncomplicated grief and mourning and implement nursing measures to support patients and families.

NURSING CONCEPTS

Assessment
Comfort
End-of-Life
Ethics
Grief and Loss
Palliative Care

GLOSSARY

autonomy: self-determination; in the health care context, the right of the person to make choices about the use and discontinuation of medical interventions

bereavement: period during which mourning for a loss takes place

grief: personal feelings that accompany an anticipated or actual loss

hospice: a coordinated program of interdisciplinary care and services for terminally ill patients and their families

interdisciplinary collaboration: communication and cooperation among members of diverse health care disciplines jointly to plan, implement, and evaluate care

Medicare Hospice Benefit: a Medicare Part A entitlement that provides for comprehensive, interdisciplinary palliative care and services for eligible beneficiaries who have a terminal illness and a life expectancy of less than 6 months

mourning: individual, family, group, and cultural expressions of grief and associated behaviors

palliative care: a patient/person and family-centered approach to care that attends to the physical, functional, psychological, spiritual, and existential aspects of a serious illness

palliative sedation: controlled and monitored use of certain sedatives and nonopioid medications with the intention of reducing the patient's level of consciousness for the relief of refractory pain and symptoms that have not responded to other management measures; the purpose is not to hasten the patient's death but to relieve intractable symptoms

prognosis: the expected course of an illness and the chance for recovery

spirituality: personal belief systems that focus on a search for meaning and purpose in life, intangible elements that impart meaning and vitality to life, and a connectedness to a higher or transcendent dimension

terminal illness: progressive, irreversible illness that despite cure-focused medical treatment will result in the patient's death

Nurses have a significant and lasting effect on the way patients live until they die, the manner in which death occurs, and the enduring memories of that death for patients' families. The contemporary definition of nursing includes "…the diagnosis and treatment of human responses, and advocacy in the care of individuals, families, groups, communities, and populations" (American Nurses Association [ANA], 2015, p. 1). There may be no group more important than seriously ill and dying patients.

Knowledge about palliative and end-of-life principles of care and the ability to recognize the unique response of each patient and family to a given illness

are essential components required to support the unique values, preferences, and goals of a person's care. Nurses have an opportunity to bring research, education, and practice together to impact the culture of dying, allowing for much-needed improvement to care that is relevant across practice settings, age groups, cultural backgrounds, and illnesses. Nurses in all settings are likely to encounter patients who are seriously ill and families who can benefit from palliative care during advanced illness and at end-of-life. This chapter presents concepts about death and dying in the United States, settings for end-of-life care of the dying, and ways that nurses can address the health issues of patients who are terminally ill.

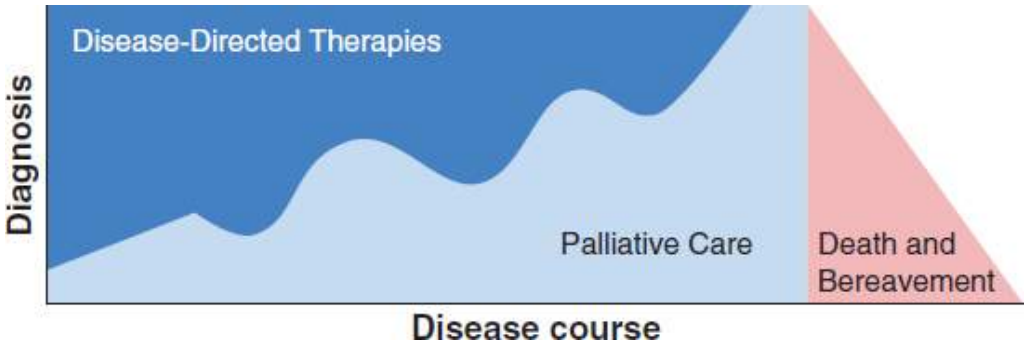

Figure 13-1 • This model shows the intersection of disease-directed therapies and palliative care beginning at diagnosis and continuing to death and bereavement. Adapted from Ferrell, B. R., Twaddle, M. L., Melnick., A., et al. (2018). National consensus project clinical practice guidelines for quality palliative care guidelines, 4th edition. *Journal of Palliative Medicine*, *21*(12), 1684–1689.

Palliative Care and End-of-Life Care

Palliative care uses an interdisciplinary model of care, focusing on symptom management and psychosocial/spiritual support for those with serious, life-limiting illnesses. Palliative care aims to improve quality of life for people and families through early integration into the plan of care strategies for managing pain and symptoms and for reducing burdensome care transitions through interdisciplinary teamwork, care coordination, clinician–patient communication, and decisional support. It is appropriate for patients at any age and at any stage in a serious illness, even while pursuing disease-directed or curative therapies, and extending into bereavement for families (Fig. 13-1). Palliative care can be viewed as both an approach to care and as a structured system for care delivery that aims to optimize quality of life by anticipating, preventing, and treating suffering (National Consensus Project for Quality Palliative Care [NCP], 2018). **Interdisciplinary collaboration** is an essential

component which is rooted in communication and cooperation among the various disciplines, with each member of the team contributing to a single integrated care plan that addresses the needs of the patient and the family. In contrast, multidisciplinary care refers to participation of clinicians with varied backgrounds and skill sets but without coordination and integration of care into a unified plan.

Hospice is a type of palliative care, focusing on comfort at the end-of-life. When patients enroll in hospice, they have made the decision to forego disease-directed therapies and focus solely on the relief of symptoms associated with their illness and the dying process. Both palliative care and hospice clinicians are skilled in the delivery of end-of-life care (which may include the months or weeks prior to death), expert pain and symptom management, life review and bereavement support. Focus on care of the dying is motivated by the aging of the population, the prevalence of and publicity surrounding life-threatening illnesses, and the increasing likelihood of a prolonged period of chronic illness prior to death. Figure 13-2 depicts four illness trajectories: sudden death, terminal illness, organ failure, and frailty. Sudden death is unexpected and accounts for the minority of deaths in this day and age. The other trajectories depict a common course in three types of chronic life-limiting illness: (1) terminal illness (e.g., cancer) is generally diagnosed when one is highly functioning, with a short steady decline before death; (2) organ failure (e.g., heart failure, end-stage kidney disease, or chronic lung disease) usually follows a slow decline after diagnosis, with episodic illnesses, perhaps exacerbation or hospitalization, where one has difficulty returning back to functional baseline; and (3) frailty (e.g., dementia) is typically diagnosed when one is already frail, with a slow decline over years. With the exception of sudden death, functional status can be a good prognostic indication; one such scale, the Palliative Performance Scale, is based on ambulation, activity, outward evidence of disease, self-care, intake, and level of consciousness (10-point increments, with 100% being fully functional and independent) (Hui, Park, Liu, et al., 2016).

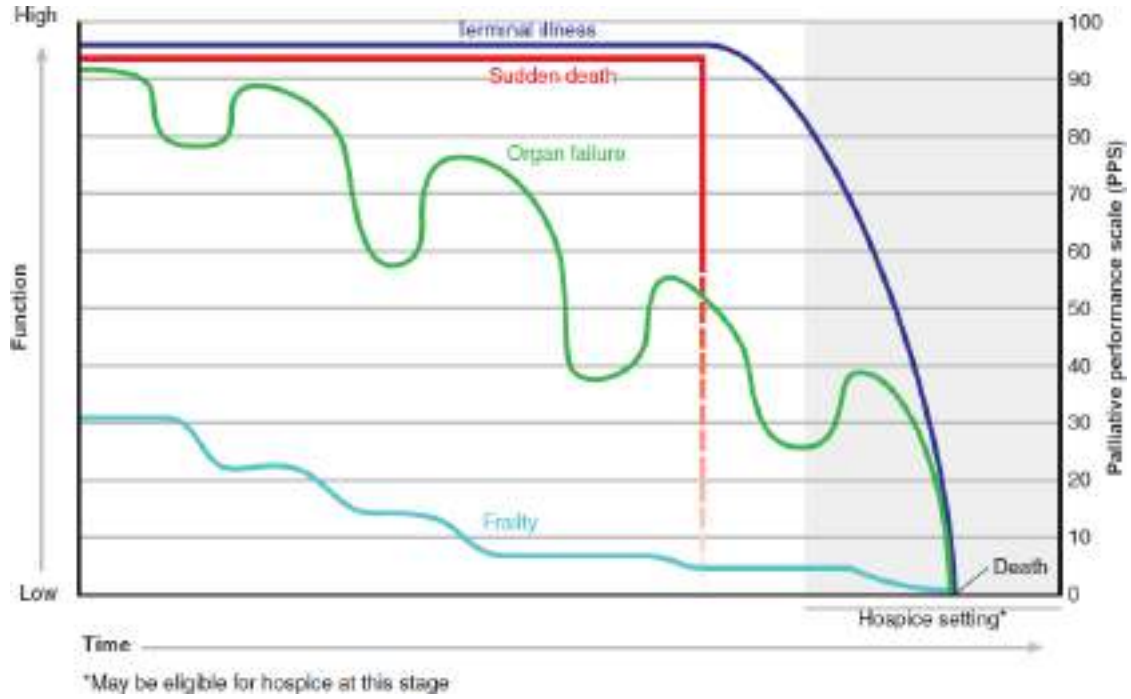

Figure 13-2 • The four trajectories of illness.

The Evolution of End-of-Life Care

In the 20th century, chronic, degenerative diseases replaced communicable diseases as the major causes of death. In the earlier part of the 20th century, most deaths occurred at home and most families had direct experience with death, through providing care to family members at the end-of-life and then mourning their losses together as a family unit. As the place of death shifted from home to hospitals, families became increasingly distanced from the death experience, placing the care of the patient into the health care provider's hands.

In the latter half of the 20th century, a technologic imperative practice pattern among health care professionals emerged, along with an expectation among patients and families that every available means to extend life must be tried. In the 21st century, technologic intervention at the end-of-life continues to have profound implications, affecting how clinicians care for the dying, how family and friends participate in care, how patients and families understand and choose among end-of-life care options, how families prepare for **terminal illness** (a progressive, irreversible illness that despite medical treatment will result in the patient's death) and death, and how they heal after the death of a loved one. Palliative and end-of-life care continues to evolve with the technology and medical interventions that are used to care for the seriously ill.

Between 2000 and 2050, the number of people older than 85 years is expected to quadruple (West, Cole, Goodkind, et al., 2014). More than half of the aged population has one or more chronic, serious illness (West et al.,

2014). The incidence of life-limiting illness is expected to continue to rise. Numerous initiatives aimed at improving end-of-life care have been launched in recent years, spurred by a widespread call for substantive change in the way Americans deal with death. In 2014, the Institute of Medicine (IOM) released a consensus report titled *Dying in America: Improving Quality and Honoring Individual Preferences Near the End of Life.* The report presented a summary of findings from a review of the evidence and provided recommendations for improving palliative and end-of-life care. The authors noted that patients experienced many transitions in settings, frequent and potentially avoidable hospital readmission, and inconsistent referral to palliative care. Recommendations include widespread and timely access to, and comprehensive coverage for palliative care services, improved clinician–patient communication, greater emphasis on advance care planning, professional education and development, and stronger public education and engagement (IOM, 2014).

The NCP identified eight key domains that underline a more comprehensive and humane approach to the care of the seriously ill patient at any stage, age, setting or prognosis, with the most recent update released in 2018 and outlined in Chart 13-1 (NCP, 2018). These practice guidelines have been endorsed by more than 80 national organizations, such as the Institute for Healthcare Improvement (IHI), American Cancer Society (ACS), Hospice and Palliative Nurses Association (HPNA), and the National Hospice and Palliative Care Organization (NHPCO), to structure and evaluate quality palliative and end-of-life programs for all those with serious illness at any stage, age, setting or prognosis.

In 2017, the ANA in collaboration with HPNA developed a *Call for Action —Nurses Lead and Transform Palliative Care,* which outlined the five areas of palliative nursing care: clinical practice, education, policy, research, and administration. In the document, the ANA and HPNA outline ways that nurses can transform palliative care, both as primary and specialty palliative care clinicians (ANA, 2017a). Primary palliative care is defined as the fundamental palliative care skills that all health care providers should have, including basic symptom assessment and management and the ability to explore goals of care through therapeutic communication. In contrast, the palliative care specialist addresses complex symptoms and navigates difficult goals of care conversations and family conflict. As a measure to better incorporate primary palliative care into nursing education, the American Association of Colleges of Nursing (AACN) recommended a new curriculum for palliative education for undergraduate nurses, including developing an online version of the End-of-Life Nursing Education Consortium (ELNEC) (Ferrell, Malloy, Mazanec, et al., 2016). See Resources section at end of chapter.

Settings for Palliative Care and End-of-Life Care

As the landscape of care at the end-of-life moved from the home to a more institutionalized death, the models of palliative care delivery changed as well. At hospice's inception, end-of-life care was home based or at a free-standing hospice. Palliative care was largely hospital based; it was born out of academic medical centers, where some health care providers felt that everyone deserves to receive treatment based on the tenets of hospice care throughout the progression of serious illness (Morrison, 2013). Current models for palliative and end-of-life care delivery will be described in greater detail in the following sections and include (NCP, 2018):

- Institution-based palliative care programs (e.g., programs within hospitals or long-term care facilities)
- Outpatient-based palliative care programs (e.g., outpatient clinics, ambulatory settings)
- Community-based palliative care program (consultative teams collaborate with hospice or home health agencies, to support patients not yet receiving hospice care in their place of residence)
- Hospice care (under Medicare Part A)

As our population ages and is expected to develop multiple comorbidities, the need for a palliative care workforce also grows. Yet, experts project a workforce shortage of all palliative clinicians that may not recover for nearly three decades. Proposed policy changes include (Kamal, Wolf, Troy, et al., 2019):

Chart 13-1

Overview of National Consensus Project Guidelines, Fourth Edition

Domain 1: Structure and Processes of Care

- *Overview:* Palliative care is based on a comprehensive interdisciplinary assessment of the patient and the family, by all clinicians with assistance from palliative care specialists as needed.
- *Clinical Implications:* Palliative care may improve quality of life for patients and families when well-trained interdisciplinary clinicians create care plans based on patient-stated values and preferences.

Domain 2: Physical Aspects of Care

- *Overview:* Pain, other symptoms, and side effects are managed based on the best available evidence, with attention to disease-specific pain and symptoms, which is skillfully and systematically applied.
- *Clinical Implications:* Interdisciplinary teams treat physical symptoms through recognition that physical symptoms impact a patient's emotional and spiritual well-being. Clinicians also consider goals, cultural, and developmental needs when choosing pharmacologic and nonpharmacologic treatments.

Domain 3: Psychological and Psychiatric Aspects of Care

- *Overview:* Psychological status, including need for assistance with distress, coping, family conflict, grief support and resources is assessed and managed based on the best available evidence, which is skillfully and systematically applied. When necessary, psychiatric issues are addressed and treated.
- *Clinical Implications:* Initial assessment is usually performed by social workers with assistance from psychologists and psychiatrists as needed.

Domain 4: Social Aspects of Care

- *Overview:* Comprehensive interdisciplinary assessment identifies the environmental and social factors that may impact the patient's and family members' quality of life, and a plan of care is developed to respond to these needs as effectively as possible.
- *Clinical Implications:* Coordination of care to address social and environmental vulnerabilities.

Domain 5: Spiritual, Religious, and Existential Aspects of Care

- *Overview:* Spiritual and existential dimensions are assessed and responded to based on the best available evidence, which is skillfully and systematically applied.
- *Clinical Implications:* The interdisciplinary team assesses each patient's sources of meaning and purpose, while respecting patient-specific beliefs, values, and traditions.

Domain 6: Cultural Aspects of Care

- *Overview:* Palliative care team members assess and attempt to meet the needs of the patient, family, and community in a culturally sensitive manner.
- *Clinical Implications:* Health care providers must examine their own biases to work to avoid judgment and provide culturally sensitive care.

Domain 7: Care of the Patient Nearing the End-of-Life

- *Overview:* Care is provided by interdisciplinary team members skilled in end-of-life care domains including expert symptom management, skilled communication, and grief/bereavement support.
- *Clinical Implications:* Signs and symptoms of impending death are recognized and communicated in developmentally appropriate language for the patient, family, and children, if applicable, with respect to information preferences.

Domain 8: Ethical and Legal Aspects of Care

- *Overview:* The patient's goals, preferences, and choices are respected within the limits of applicable state and federal law, within current accepted standards of medical care, and form the basis for the plan of care.
- *Clinical Implications:* Knowledge of ethical principles (beneficence, nonmaleficence, justice, self-determination) as well as pertinent health care laws is required. Clinicians must determine moral agency and understand when to engage surrogate decision makers to employ substituted judgment.

Adapted from Ferrell, B. R., Twaddle, M. L., Melnick., A., et al. (2018). National consensus project clinical practice guidelines for quality palliative care guidelines, 4th edition. *Journal of Palliative Medicine*, *21*(12), 1684–1689.

- The adoption of the Palliative Care and Hospice Education and Training Act (PCHETA), which if passed would increase the field by over 9000 practitioners.
- Policy to financially support palliative fellowship training across disciplines.
- Further research defining nonphysician palliative care specialist clinicians (nurses, social workers, chaplaincy).
- Creative reimbursement models that support the full interdisciplinary team.
- Policy to promote resiliency and, in turn, prevent burnout. (For more on burnout see later section entitled "Professional Caregiver Issues.")

Institution-Based Palliative Care

The landmark Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatments (SUPPORT) documented troubling deficiencies in the care of the dying in hospital settings (SUPPORT Principal Investigators, 1995). Subsequently, the IOM's *Dying in America* (2014), the NCP *Clinical Practice Guidelines* (2018), and the ANA-HPNA *Call for Action* (2017a) have been shaping palliative and end-of-life care through developing and encouraging adherence to standards of care for patients with advanced illness and at end-of-life that will apply regardless of where the patients are receiving care (ANA, 2017a; IOM, 2014; NCP, 2018). There has been a steady increase in American hospital-based palliative care, with reportedly 90% of hospitals with 300 beds or more offering palliative care, compared to 56% of hospitals with fewer than 300 beds (Dumanovsky, Augustin, Rogers, et al., 2016).

In the hospital, the delivery of palliative care is typically through an interdisciplinary consultation service where primary teams consult specialists for one or more of the following reasons:

- Pain management
- Symptom management
- Goals of care discussions
- End-of-life issues
- Psychosocial distress
- Spiritual or existential distress

The core interdisciplinary team usually consists of physicians, nurses, advanced practice nurses, social workers, and chaplains (National Palliative Care Registry, 2017). Additional team members may include pharmacists, nutritionists, music or art therapists, ethicists, and psychologists. Occasionally, institutions have palliative care units where palliative care clinicians oversee a patient's care when palliative care needs supersede other hospital conditions. The most common reason for palliative care consultation in the hospital setting is goals of care discussion; those referred for care planning are most often older with a serious illness other than cancer and typically have a full code status (Bischoff, O'Riordan, Marks, et al., 2017).

In 2011, The Joint Commission launched an advanced certification program for palliative care to recognize hospitals that provide exceptional patient and family-centered care (The Joint Commission, 2018). The Center to Advance Palliative Care (CAPC) has a plethora of institutional resources for developing hospital–hospice partnerships to provide high-quality palliative care for hospitalized patients and for addressing the palliative care needs of other specialized populations. See Resources section at the end of the chapter.

According to the National Palliative Care Registry in 2017, the most common primary diagnoses seen by palliative care specialists included cancer (26%), cardiac diseases (15%), pulmonary conditions (9%), neurologic diagnoses (9%), and infectious causes (7%). For patients with diagnoses for

which palliative care specialists have rarely been consulted, the efficacy of palliative care has been demonstrated. In one study, for example, patients undergoing stem cell transplant at an academic medical center reported better quality of life during transplant hospitalization after palliative care intervention (El-Jawahri, LeBlanc, VanDusen, et al., 2016).

Researchers have reported that seriously ill hospitalized patients who receive palliative care consultations for goals of care have lower future health care utilization and cost (O'Connor, Junker, Appel, et al., 2018). Despite the growth of palliative care, many believe that palliative care resources are still lacking; in a survey of administrators and clinicians, respondents felt that 60% of patients who may benefit from palliative or end-of-life care do not receive this type of support (Compton-Phillips & Mohta, 2019). Additionally, there is ample room for improvement in end-of-life care delivery. Hospital end-of-life care has been found to be of higher quality in hospitals with better rated nurse practice environments (as measured by the Practice Environment Scale of the Nursing Work Index survey, where nurse workload, autonomy, and interdisciplinary collaboration are favored); however, the majority of nurses rated overall end-of-life care in hospitals unfavorably (Lasater, Sloane, McHugh, et al., 2019).

Experts estimate that the number of people who will need some form of short- or long-term skilled nursing care in their lifetimes, whether in the community or in a residential care facility, is likely to increase exponentially (West et al., 2014). As a result, the likely place of death for a growing number of Americans after the age of 65 years will be a skilled nursing facility. A 2018 study by Teno and colleagues found that, among Medicare fee-for-service beneficiaries, the proportion of death in acute care hospitals has decreased, yet one in five beneficiaries continues to die in acute care settings. More than one in four (29%) fee-for-service beneficiaries are admitted to intensive care units in the last 30 days of their life. Based on recent trends, about two in five (40%) of fee-for-service beneficiaries die at home and community settings, including assisted living facilities. Nursing homes remain the site of death for 25% of Medicare beneficiaries. Thus, while dying at home has increased for those older than age 65 in recent years, deaths in other locations still exceed the number of deaths occurring at home (Teno, Gozalo, Trivedi, et al., 2018).

Residents of skilled nursing facilities typically have poor access to palliative care. Regulations that govern how care in these facilities is organized and reimbursed tend to emphasize restorative measures and serve as a disincentive to palliative care. Since 1989, home hospice programs have been permitted to enroll long-term care facility residents in hospice programs and to provide interdisciplinary services to residents who qualify for hospice care. Of over one million Medicare beneficiaries who received hospice services in 2016, close to a third resided in long-term care facilities, an increase from 14.5% in 2013 to 32.8% (NHPCO, 2018). Because hospices provide some

services that may overlap with services provided by the skilled nursing provider, payment models have been developed to define and reconcile duplication of services. In 1997, the Office of Inspector General (OIG), an oversight arm of the federal government, questioned whether hospice services in nursing homes were an unnecessary duplication of services already provided by long-term care facility staff. Hospice/skilled nursing facility contracts continue to be scrutinized by federal regulators. More recently, facilities are under increasing public pressure to improve care of the dying and are beginning to develop palliative care units or services; continuing to contract with home hospice programs to provide palliative care consultations and hospice care in the facilities; and to educate staff, residents, and their families about pain and symptom management and end-of-life care. Many skilled nursing providers have implemented culture change innovations such as resident-centered care plans and consistent staff assignments to change the experience of long-term skilled nursing care. In nursing homes, "comfort measures" are used to identify residents who do not wish to receive life-sustaining interventions. Nevertheless, hospitalizations continue to occur and research reports that 77% of events (i.e., fall, change in mental status, or development of a new symptom) are unavoidable, yet opportunities exist for improvement in communication and monitoring (Unroe, O'Kelly Phillips, Effler, et al., 2019). Palliative care education and training for nursing home staff may improve the quality of care residents receive at the end-of-life.

Outpatient-Based Palliative Care

As palliative care has become more prevalent in hospitals, skilled nursing settings, and in home hospice programs, outpatient palliative care has emerged as an approach to providing services and support to patients and families who opt not to, or are not eligible for, home hospice but could benefit from comprehensive palliative care in the community. Outpatient palliative care benefits both patients and their families and other providers by providing expert consultation and management of symptoms and other needs. A growing body of evidence supports the role of palliative care that is delivered *concurrently* with standard medical treatment. For example, in a landmark study of outpatient referral to palliative care for patients newly diagnosed with metastatic non–small cell lung carcinoma (a disease with very poor prognosis), researchers found that those patients randomized to the palliative care plus standard oncology care arm of the trial not only showed improved quality of life and mood, but also had longer median survival than those who received standard oncology care alone (Temel, Greer, Muzikansky, et al., 2010). Such studies underscore the value of palliative care.

Models for palliative care in ambulatory clinics vary and include independent clinics, colocated clinics and embedded practices (Finlay,

Newport, Sivendran, et al., 2019). Each model differs in the referral process, financial makeup, staffing and population served (Finlay et al., 2019). In addition, clinics may follow a consultative only, comanagement with one or shared opioid prescribing (Finlay et al., 2019). Although many outpatient palliative care clinics start with oncology patients, as palliative care has gained traction in many disease states in the hospital, other medical specialties (cardiologists, pulmonologist, nephrologists, etc.) are lacking proper palliative care follow-up and requesting nononcology palliative care clinics.

Community-Based Palliative Care

Home-based primary care has become more common due to the aging of society and a desire for people to remain at home rather than live in an institution (Schuchman, Fain, & Cornwell, 2018). Home-based primary care incorporates palliative care skills, and specialty palliative care home programs have developed with the goal of managing symptoms and providing support in the home. The Affordable Care Act, passed in 2010, also included new payment models for home-based palliative care in an effort to reduce hospital readmissions and mortality (Morrison, 2013).

Hospice Care

The broadening of the application of palliative care in the United States actually *followed* the development of hospice programs. All hospice care is palliative care; however, not all palliative care is hospice care. The difference is that hospice care is an application of palliative care delivered at the end-of-life. Hospice care focuses on quality of life, and by necessity, it usually includes realistic emotional, social, spiritual, and financial preparation for death. Hospice in the United States is not a *place* but a philosophy of care in which the end-of-life is viewed as a developmental stage.

Originally, the concept of hospice care as an alternative to depersonalized death in institutions began in the early 1970s as a volunteer-based, grassroots, and spiritually centered movement (Meghani, 2004). In 2016, there were 4382 hospice programs in operation across all 50 states (as well as Washington, DC and Puerto Rico), serving an estimated 1.43 million patients (NHPCO, 2018). Currently the most common diagnosis for hospice patients in the United States is cancer (Table 13-1). While median length of hospice stay in 2016 was approximately 24 days across diagnoses, for patients with dementia, the average length of stay was 104 days (NHPCO, 2018).

TABLE 13-1 Hospice Admission Diagnosis Prevalence

Diagnosis	Percent of Hospice Patients (%)
Cancer	27.2
Cardiac/circulatory	18.7
Dementia	18.0
Respiratory	11.0
Stroke	9.5
Other	15.6

Adapted from National Hospice and Palliative Care Organization (NHPCO). (2018). *NHPCO facts and figures: Hospice care in America*. Alexandria, VA: Author.

After hospice care was recognized as a distinct program of services under Medicare in early 1983, organizations providing hospice care were able to receive Medicare reimbursement if they could demonstrate that the hospice program met the Medicare conditions of participation, or regulations for hospice providers as enforced by the Centers for Medicare & Medicaid Services (CMS, 2019). In many aspects, Medicare standards have come to largely define hospice philosophy and services. State Medical Assistance (Medicaid) also provides coverage for hospice care, as do most commercial insurers.

Hospice is a coordinated program of interdisciplinary services provided by professional caregivers and trained volunteers to patients with serious, progressive illnesses that are not responsive to cure. The root of the word *hospice* is *hospes,* meaning "host." According to Cicely Saunders, who founded the world-renowned St. Christopher's Hospice in London, the principles underlying hospice are as follows:

- Death must be accepted.
- The patient's total care is best managed by an interdisciplinary team whose members communicate regularly with one another.
- Pain and other symptoms of terminal illness must be managed.
- The patient and the family should be viewed as a single unit of care.
- Home care of the dying is necessary.
- Bereavement care must be provided to family members.
- Research and education should be ongoing.

The goal of hospice is to enable the patient to remain at home, surrounded by the people and objects that have been important to them throughout life. The patient and the family comprise the unit of care. Hospice care does not seek to hasten death or encourage the prolongation of life through artificial means.

Despite more than 45 years of existence in the United States and the early calls for its concurrent integration with disease-modifying treatments

(Meghani, 2004), hospice remains an option for end-of-life care that has not been fully integrated into mainstream health care. Reasons include the difficulties in making a terminal prognosis (especially for those patients with noncancer diagnoses), the strong association of hospice with death, advances in "curative" treatment options in late-stage illness, and financial pressures on health care providers that may cause them to retain rather than refer patients who are eligible for hospice. Moreover, there are significant racial differences in the utilization of hospice care; for example, Asian Americans tend to have shorter lengths of hospice stay, and non-White patients have a higher incidence of revoking hospice when compared to White patients (Wang, Hsu, Aldridge, et al., 2019).

The Medicare-certified hospice is paid a predetermined dollar amount for each day of hospice care that each patient receives. Four levels of hospice care are covered under Medicare and Medicaid hospice benefits: (1) routine care, (2) continuous care, (3) respite care, and (4) general inpatient hospice care. Most hospice care is provided at the "routine home care" level; routine and continuous care are outlined in greater detail in Chart 13-2. According to federal guidelines, hospices may provide no more than 20% of the aggregate annual patient-days at the inpatient level. Respite care allows primary caregivers a break through admission of the patient to an inpatient unit or nursing facility.

Federal rules for hospices require that eligibility be reviewed periodically. Patients who live longer than 6 months under hospice care are *not* discharged, provided that their primary provider and the hospice medical director continue to certify that they are terminally ill with a life expectancy of 6 months or less (assuming that the disease continues its expected course). Thus, the patient is re-certified and continues to receive hospice benefits. Once a patient meets eligibility criteria and elects to use the benefit, the Medicare-certified hospice program assumes responsibility for providing and paying for the care and treatment to palliate the terminal illness for which hospice care was elected. Patients may revoke their hospice benefits at any time, resuming traditional coverage under Medicare or Medicaid for the terminal illness. Those who revoke their benefits may also reelect to use them at a later time.

The **Medicare Hospice Benefit** requirement that beneficiaries make a choice between palliative care (to enroll in hospice) and cure-focused treatment has long been a barrier to earlier hospice enrollment. A Medicare beneficiary could not receive BOTH palliative care and cure-focused care under their hospice benefit. The Affordable Care Act authorized a study of concurrent palliative and curative care services. Under this federally funded study, titled Medicare Care Choices, CMS is evaluating whether beneficiaries would choose palliative care under hospice guidelines while they *continue to receive* cure-focused care (CMS, 2018). The model is being tested with 104 hospices currently participating and 1092 Medicare patients receiving this

concurrent care, with a hope to reach 150,000 in the coming years (CMS, 2018).

Veterans Considerations

The Veterans Administration (VA) offers concurrent care, whereby a veteran has the option to receive disease-directed therapy, such as radiation or chemotherapy, while receiving hospice care. The VA reported that veterans with cancer at the end-of-life received radiation and chemotherapy at the same rate as before concurrent care was offered, but the utilization of hospice increased, thus allowing patients to receive significant support in the last weeks of life (Mor, Joyce, Cote, et al., 2016).

Chart 13-2

Eligibility Criteria for Hospice Care

Who? A Patient with a Serious, Progressive Life-Limiting Illness Must Meet Two Criteria:

- Two primary providers certify that prognosis is less than 6 mo if the disease runs usual course
- Patient and family agree with comfort as the goal of care

When? The patient wishes to pursue comfort-focused care and prognosis is believed to be months. If a patient survives >6 mo they may be re-enrolled in hospice care.

What? Medicare and Medicaid Hospice Benefits

- Medicare Part A; Medical Assistance eligibility
- Waiver of traditional Medicare/Medicaid benefits for the terminal illness (e.g., surgery, skilled nursing care, hospital stay)
- Care must be provided by a Medicare-certified hospice program

Where? Hospice settings vary depending on a person's care needs and may include:

- Home (*Routine Hospice Care,* delivered in a private residence, nursing home)
  - The majority of patients receive hospice at home
  - Care is primarily delivered by family and friends
  - Hospice staff (nurses, aides, social workers and chaplains) provide additional support as needed
  - All services (staff visits, medications, durable medical equipment) provided are included in the daily rate to the hospice
  - Phone hotline available for caregivers to reach a hospice nurse 24 hours a day
  - *Continuous care:* This is a temporary level of care provided in the patient's home where continuous nursing care is provided in the home for the management of a medical crisis (e.g., the hospice patient seizes and a hospice nurse comes to the home to monitor the patient and administer medications; nursing need is reevaluated every shift). Care reverts to the routine home care level after the crisis is resolved
- Long-term care facility
  - Hospice staff is added as additional layer of support for established residents
  - Facility staff continue to provide 24-h care
  - Facility room and board paid separately from hospice care
- Residential hospice
  - Residences for long-term stay

- Payment is typically prorated based on income
- Not many exist and travel may be prohibitive for family or friends

- General inpatient hospice
  - Indicated for acute pain or symptom management requiring 24-h care
  - Usually in a free-standing inpatient hospice unit or in a Medicare certified hospital

Communication in Palliative Care

Expert communication is a tenet of palliative and end-of-life care. Historically, communication was thought of as an innate art. Experts now view communication as a set of skills that can be taught, practiced, and built upon. Nurses need to develop skill and comfort in assessing patients' and families' responses to serious illness and planning interventions that support their values and choices throughout the continuum of care (Wittenberg-Lyles, Goldsmith, Ferrell, et al., 2013). To develop a level of comfort and expertise in communicating with seriously and terminally ill patients and their families, nurses must first consider their own experiences with and values concerning illness and death through reflection, discussion with colleagues, reading, and self-discovery.

Skills for Communicating with the Seriously Ill

Throughout the course of a serious illness, patients and their families encounter complicated treatment options and bad news about disease progression. They may have to make difficult decisions at the time of diagnosis, when disease-focused treatment fails, when the effectiveness of a particular intervention is being discussed, and when decisions about hospice care are presented. These critical points on the treatment continuum demand patience, empathy, and honesty from nurses. Over the years, many communication training models have been developed to improve goals of care and end-of-life conversations (Table 13-2). One such program, the Serious Illness Conversation Project (SICP) communication guide, has helped clinicians have earlier, more thorough, and more accessible conversations around patients' values, worries, and preferences (Paladino, Bernacki, Neville, et al., 2019).

Therapeutic communication can be learned and, like other skills, must be practiced to gain expertise. Like other skills, communication should be practiced in a safe setting, such as a classroom or clinical skills laboratory with other students and clinicians. One skill that nurses have the opportunity to master is responding to emotion. Nurses often meet patients in vulnerable states experiencing strong emotions such as anxiety, anger, fear, and sadness. The NURSE framework (Table 13-3) should be considered when a patient

expresses an emotion. Typically, the nurse would choose one response listed at a time.

Patients often direct questions or concerns to nurses before they have been able to fully discuss the details of their diagnosis and prognosis with their primary providers or the entire health care team. Using open-ended questions allows the nurse to elicit the patient's and family's concerns, explore misconceptions and needs for information, and form the basis for collaboration with primary providers and other team members. Chart 13-3 provides sample language for exploring a patient's values and preferences. In practice, communication with each patient and family should be tailored to their particular level of understanding and values concerning disclosure.

TABLE 13-2 Interdisciplinary Communication Training Models

Model Name	Target Clinicians	Format	Curriculum	Considerations
Center to Advance Palliative Care Continuing Medical Education modules[a]	All disciplines	Online, case-based, open-ended answers	Five modules on foundational communication skills. Additional PC modules available	Included in institutional CAPC membership
Education on Palliative and End-of-Life Care[b]	All disciplines	Classroom didactic	Overview of communication skills embedded in PC curriculum	A separate 2-d facilitator training is available
End-of-Life Nursing Education Consortium (ELNEC)[c]	RN, NP	Classroom didactic	Communication is focus during 1 h of a 2-d course. Various tracks including: ELNEC-Core, ELNEC-APRN, ELNEC Critical Care, ELNEC-Geriatrics	"Train-the-trainer" model. ELNEC added a communication-only course called COMFORT
Respecting Choices	RN, SW, APP, MD	Classroom didactic	First steps (RN/SW focused), next steps (RN/SW focused), last steps (MD focused). From advanced care planning to decision making	Usually paired with system implementation
Serious Illness Care Program at Ariadne Labs[d]	All disciplines	3-h workshop with didactic and roleplay	Training on the Serious Illness Conversation Guide (see Chart 13-3) with scripted exploratory questions	Usually paired with system implementation. Faculty members have 2+ d training
ViralTalk[e]	MD, APP, and ICU RN	Online video, Smartphone application, small-group workshop (0.5–2 d) with simulated patient actors	Content across disease continuum customized to learner needs organized by clinical task. Includes five-step talking map	Core workshop with actors, constructive feedback, and opportunity to replay

[a]Available at: www.capc.org/providers/courses/communication-skills-34
[b]Available at: www.bioethics.northwestern.edu/programs/epec/index.html
[c]Available at: www.aacnnursing.org/ELNEC
[d]Available at: www.ariadnelabs.org/areas-of-work/serious-illness-care
[e]Available at: www.viraltalk.org
APP, advanced practice provider; ICU, intensive care unit; MD, medical doctor; NP, nurse practitioner; RN, registered nurse; SW, social worker.
Adapted from Back, A. L., Fromme, E. K., & Meier, D. E. (2019). Training clinicians with communication skills needed to match medical treatments to patient values. *Journal of American Geriatric Society, 67*(S2), S485–S491.

Chart 13-3 **ASSESSMENT**

Preferred Language for Assessing Goals of Care

Assess understanding of diagnosis and prognosis: Seek patient's knowledge of illness.

- What is your understanding of your condition?
- What did your provider say about your illness?
- How have things been going with your treatment?
- What is the plan moving forward?

Exploratory questions: Ask for clarifications and allow patient the space to tell narrative.

- Tell me more.
- Can you say more about that?
- I heard you say [x], can we go back to that?
- Will you tell me more about how you are feeling about [x]?

Ask about patient's values, preferences, and concerns: These questions allow health care providers to match patient values to treatment options, often called goals of care.

- What is most important to you?
- What are you hoping for, in terms of your illness?
- What you hoping from this treatment?
- What concerns you when you think about the future?
- What is most important to you?

Assess coping and support system: In learning more about how a person has coped in the past, you can incorporate appropriate supports (e.g., social work, chaplain)

- How have you coped with challenges in the past?
- What gives you strength?
- What gives you meaning and purpose?
- Is there anything we should consider or anyone we should include when making decisions about your care?
- If you cannot participate in health care decisions, with whom should we speak?

Important questions for family members when patient is unable to participate in conversation.

- Tell me about your loved one.
- What did they value?
- Did they ever talk about what they would or would not want if they were in a situation like this?

- Did they ever discuss states of living that would not be acceptable (e.g., being bedbound, unable to toilet, inability to speak)?

Adapted from Peereboom, K., & Coyle, N. (2012). Facilitating goals-of-care discussions for patients with life-limiting disease—Communication strategies for nurses. *Journal of Hospice and Palliative Nursing, 14*(4), 251–258.

The Role of the Nurse in Family Meetings

Family meetings, prompted by either the patient and family or the care team, are often held to clarify goals, address concerns, and formulate a plan. The objectives of a family meeting are to both gather information and share information. Family meetings may be held at any time during a serious illness and should especially be arranged when new diagnostic information is available. More often than not, difficult news is shared at a family meeting. As such, patient and family members may become emotional and the nurse has the unique opportunity to offer support (see Table 13-3).

TABLE 13-3 Responding to Emotions

Patient Statement: "I just can't handle any more setbacks."		
	Empathic Response	Sample Language
N	NAME the emotion	It sounds like you are worried about the future.
U	UNDERSTAND the emotion	You have been through so much already.
R	RESPECT (or praise) the patient	I am so impressed with how you have dealt with so many ups and downs.
S	SUPPORT the patient	I hope you don't have any more setbacks and I'm here for you no matter what the future holds.
E	EXPLORE the emotion	You seem more worried than usual; can you tell me more about what's different about today than yesterday?

Adapted from Back, A., Arnold, R., Tulsky, J. (2009). *Mastering communication with seriously ill patients: Balancing empathy and hope*. New York: Cambridge University Press.

Before a family meeting, the nurse in collaboration with the primary team can perform a stakeholder analysis to ensure that important people are present. The nurse can ask the patient who helps them make decisions and help arrange for their presence. Engaging integral medical team members and consults is important to ensure that experts can answer all patient and family questions.

The nurse can assure the patient that they will be present at the meeting to support the patient. The nurse can also ensure the setting is right—free from disturbances, private, ample seating. Additional roles for the nurse in a family meeting are listed in Chart 13-4.

Advanced Care Planning

The process of thinking through, and possibly documenting, the medical interventions that one would or would not want in the case one is no longer able to voice one's own decisions is called advanced care planning (ACP). Nurses play an integral role in ACP. With the proper training and understanding of ACP, nurses should feel empowered to engage with patients about their goals of care and, when applicable, assist patients with completion of ACP documentation (Izumi, 2017). Two components of ACP are designating a health care surrogate and documenting end-of-life preferences (Chart 13-5).

Chart 13-4

The Role of the Nurse in a Family Meeting

- Advocate for patient based on values shared by patient and family.
- Act as interpreter when medical jargon is not clearly understood by patient and family.
- Respond to emotion expressed in meeting.
- Prior to meeting, encourage and assist patient and family with developing questions to ask of interdisciplinary teams during meeting.
- Express concerns.
- Share clinical nursing updates.

Adapted from Nelson, J. E., Cortez, T. B., Curtis, J. R., et al. (2011). Integrating palliative nursing in the ICU: The nurse in a leading role. *Journal of Hospice and Palliative Nursing, 13*(2), 89–94; Wittenberg-Lyles, E., Goldsmith, J., Ferrell, B. R., et al. (2013). *Communication in palliative nursing*. New York: Oxford.

Chart 13-5

Methods of Stating End-of-Life Preferences

Advance directives: written documents that allow the person of sound mind to document preferences regarding end-of-life care that should be followed when the signer is terminally ill and unable to verbally communicate their wishes. The documents are generally completed in advance of serious illness but may be completed after a diagnosis of serious illness if the signer is still of sound mind. The most common types are the durable power of attorney for health care and the living will.

Do not resuscitate: a medical order to withhold cardiopulmonary resuscitation (CPR) in the event of cardiac arrest. In some settings, the term "allow natural death" (AND) is used in place of "do not resuscitate" (DNR).

Durable power of attorney for health care: a legal document through which the signer appoints and authorizes another person to make medical decisions on their behalf when they are no longer able to speak for themselves. This is also known as a health care power of attorney, medical power of attorney, or a proxy directive.

Living will: a type of advance directive in which the individual documents treatment preferences. It provides instructions for care in the event that the signer is terminally ill and not able to communicate their wishes directly and often is accompanied by a durable power of attorney for health care. This is also known as a medical directive or treatment directive.

Physician orders for life-sustaining treatment (POLST): a form that translates patient preferences expressed in advance directives to medical "orders" that are transferable across settings and readily available to all health care providers, including emergency medical personnel. The POLST form is a brightly colored form that specifies preferences related to CPR, intubation, artificial nutrition and hydration, antibiotics, and other medical interventions. The form is signed by the patient or surrogate and the primary provider, advanced practice nurse, or physician assistant. The use of the POLST is subject to state laws and regulations. Numerous states have endorsed the POLST or a similar form and some states have implemented electronic registries and electronic versions of POLST forms (e.g., New York's e-MOLST program).

Information about the advance care planning and state-specific advance directive documents and instructions is available at www.caringinfo.org. Information about the POLST is available at www.polst.org

Now legally sanctioned in every state and federally sanctioned through the Patient Self-Determination Act of 1991, advance directives are written documents that allow competent people to document their preferences regarding the use or abatement of medical treatment at the end-of-life, specify their preferred setting for care, and communicate other valuable insights into their values and beliefs. These documents are widely available from health care providers, community organizations, bookstores, and from trusted Web sites. Unfortunately, ACP documents remain underutilized, as a systematic review found that only one in three Americans have completed any advanced

directive (Yadav, Gabler, Cooney, et al., 2017). Data was similar for those with chronic illnesses and healthy adults in this study. The underuse of advanced directives may reflect society's continued discomfort with openly confronting the subject of death. Furthermore, the existence of a properly executed advance directive does not reduce the complexity of end-of-life decisions.

The Patient Self-Determination Act requires that health care entities receiving Medicare or Medicaid reimbursement must ask whether patients have advance directives, provide information about advance directives, and incorporate advance directives into the medical record. However, advance directives should not be considered a substitute for ongoing communication among the health care provider, patient, and family as the end-of-life approaches.

Concept Mastery Alert

An advance directive states a patient's wishes for treatment. A proxy directive appoints another person to make medical decisions on behalf of the patient and is added to the advance directive.

Symptom Assessment and Management

Expected Physiologic Changes

Patients approaching the end-of-life experience many of the same symptoms, regardless of their underlying disease processes. Symptoms in terminal illness may be caused by the disease, either directly (e.g., dyspnea owing to chronic obstructive lung disease) or indirectly (e.g., nausea and vomiting related to pressure in the gastric area), by the treatment for the disease, or by a coexisting disorder that is unrelated to the disease. Symptoms should be carefully and systematically assessed and managed. Pharmacologic and nonpharmacologic methods of symptom management may be used in combination with medical interventions to modify the physiologic causes of symptoms. The principles of pharmacologic symptom management are the use of the smallest dose of the medication to achieve the desired effect, avoidance of polypharmacy, anticipation and management of adverse effects, and creation of a therapeutic regimen that is acceptable to the patient based on the patient's goals for maximizing quality of life.

The patient's goals should guide symptom management. The clinician should help the patient and the family weigh the benefits and risks of continued diagnostic testing and disease-focused medical treatment in the context of their goals for care. The patient and the family may be extremely

reluctant to forego monitoring that has become routine throughout the illness (e.g., blood testing, x-rays) but that may contribute little to a primary focus on comfort. Medical interventions may be aimed at treating the underlying causes of the symptoms or reducing the impact of symptoms. For example, a medical intervention such as thoracentesis (an invasive procedure in which fluid is drained from the pleural space) may be performed to temporarily relieve dyspnea in a patient with pleural effusion secondary to lung cancer.

For the procedural guidelines for assisting the patient undergoing thoracentesis, go to **thepoint.lww.com/Brunner15e**.

Anticipating and planning interventions for symptoms is a cornerstone of both palliative and end-of-life care. Patients and family members cope more effectively with new symptoms and exacerbations of existing symptoms when they know what to expect and how to manage them. At the end-of-life, hospice programs typically provide a *comfort kit* which contains ready-to-administer doses of various medications that are useful to treat symptoms in advanced illness. For example, a kit might contain small doses of oral morphine liquid for pain or shortness of breath, a benzodiazepine for anxiety, and an acetaminophen suppository for fever. Family members can be instructed to administer a prescribed dose from the emergency kit, often avoiding prolonged suffering for the patient.

Although clinicians may believe that symptoms must be completely relieved whenever possible, the patient might choose instead to decrease symptoms to a tolerable level rather than to relieve them completely if the side effects of medications are unacceptable to them. This often allows the patient to have greater independence, mobility, and alertness and to devote attention to issues that they consider of higher priority and greater importance. For instance, a mother may choose to wait to take pain medication until bedtime so that she can be awake and engaged when her children return home from school.

TABLE 13-4 Stages of the Dying Process

Time Frame	Symptoms: *How the patient is feeling*	Nursing Interventions: *What you can do*
Months before death	• Gradual generalized weakness • Fatigue • Social isolation • Decreased appetite	• Provide education to patient and family that symptoms are expected. • Allow patient choice in activity level and sleep schedule. • Assist with life review. Provide support to family who are distressed by patient's withdrawal. • Educate patient/family on eating for comfort.
Weeks before death	• Neurologic: ↑ sleepiness, possible delirium, dulled senses (except hearing) • Cardiopulmonary: ↑ pulse and ↑ RR, ↓ BP, Periodic apnea or agonal breathing, inability to clear secretions • Renal: ↓ urinary output + incontinence or retention • Skin: feverish or cold, possible perspiration, pallor	• Provide education on terminal delirium. Engage family in periods of lucidity. Talk to patient even when appears to be sleepy (to avoid leaving anything unsaid). • Assess and treat dyspnea as appropriate. Cluster care. Assess if ANH is contributing to pulmonary congestion. Position patient in side-lying position with HOB elevated. • Insert urinary catheter for comfort if indicated. Use absorbent pads and change as needed. Consider retention if patient is restless. • Bath and change linens as needed. Engage family in scheduling.
Days before death	• Neurologic: somnolence, restlessness, further dulled senses (except hearing), possible "rally" in energy • Cardiopulmonary: ↑ pulse and ↑ or ↓ RR, ↓ BP, more frequent periods of apnea or agonal breathing, inability to clear secretions • Renal: ↓ urinary output +	• Normalize the dying process for family. If patient has a "rally" in energy, guide family to take patient's lead in preference for this time (e.g., a favorite meal). • Assess and treat dyspnea as appropriate. Cluster care. Position patient in side-lying position with HOB elevated. Avoid suctioning; administer anticholinergics for impaired secretions as prescribed. • Provide education to family. Use absorbent pads and change as needed. Consider retention if patient is restless. • Change linens as needed. Bed bath for comfort.

	incontinence or retention • Skin: feverish or cold, mottling of extremities, pallor	
Hours before death (or *actively dying* phase)	• Neurologic: obtunded, nonresponsive, hearing may remain • Cardiopulmonary: ↑ pulse (may be irregular or difficult to palpate) and ↑or ↓ RR, ↓ BP, periods of apnea (>40 s) or agonal breathing • Renal: oliguria/anuria • Skin: worsening mottling of extremities	Interventions as above. Continue to provide education that these signs and symptoms are a normal part of the dying process. If certain family wishes to be present at the time of death, alert them of prognosis. Encourage family self-care during vigil. Additionally, the nurse may engage in conversation with family around funeral/burial preferences and cultural rituals at the end-of-life. Offer chaplaincy support if helpful to family.

ANH, artificial nutrition and hydration; BP, blood pressure; ↓, decreased; HOB, head of bed; ↑, increased; +, plus; RR, respiratory rate.

Adapted from Berry, P., & Griffie, J. (2019). Planning for the actual death. In B. R. Ferrell, N. Coyle, & J. Paice (Eds.). *Oxford textbook of palliative nursing* (5th ed.). New York: Oxford.

As death approaches and organ systems begin to fail, observable, expected changes in the body take place (Table 13-4). The nurse should prepare the family for the normal, expected changes that accompany the period immediately preceding death. Although the exact time of death cannot be predicted, it is often possible to identify when the patient is very close to death. When death is imminent, patients may become increasingly somnolent and unable to clear sputum or oral secretions, which may lead to further impairment of breathing from pooled secretions. The sound and appearance of the secretions are often more distressing to family members than is the presence of the secretions to the patient. Family distress over the changes in the patient's condition may be eased by supportive nursing care. Continuation of comfort-focused interventions and reassurance that the patient is not in any distress can do much to ease family concerns. Hospice programs frequently provide written information for families so that they know what to expect and what to do as death nears.

Pain

In the final stages of illnesses such as cancer, heart disease, chronic obstructive pulmonary disease (COPD), and renal disease, pain is a common symptom. Pain results from the disease state as well as the modalities used to treat them. The Worldwide Palliative Care Alliance, World Health Organization (2014) called attention to the continuing, worldwide high prevalence of pain at the end-of-life and the inadequate supply of opioids, particularly in developing nations. A primary role for nurses in end-of-life care is to ensure that pain is assessed, prevented where possible, and managed. Chapter 9 presents the importance of pain assessment, assessment principles for pain that include identifying the effect of the pain on the patient's life, and the importance of believing the patient's report of the pain and its effect. Poorly managed pain affects the psychological, emotional, social, and financial well-being of patients. Every clinician should be able to assess and oversee the basic management of pain (IOM, 2014).

Management of moderate to severe pain in the United States is complicated by public policy and legal challenges due to an opioid crisis (Foxwell, Uritsky, & Meghani, 2019) and federal prescribing guidelines aimed at reducing opioid use (Centers for Disease Control and Prevention [CDC], 2016). While patients receiving palliative care are exempt from the opioid guidelines, there are reports of the misapplication of the guidelines for patients with serious illnesses (Dowell, Haegerich, & Chou, 2019). The current context of pain management is also feared to worsen the widely documented disparities in pain treatment in the United States (Meghani & Vapiwala, 2018). Simultaneously, there are concerns about opioid misuse in the palliative care setting (Hui, Arthur, & Bruera, 2019). Thus, palliative care clinicians are also challenged with the imperative to provide effective pain relief while balancing societal risks.

All patients on opioid therapy and their family caregivers should receive comprehensive education and support to ensure safe use of opioids while addressing fears and concerns about opioid use. Personalized treatment plans should include longitudinal assessment and documentation of pain management goals and needs, management of treatment side effects, use of integrative therapies and interventional techniques when appropriate, monitoring risk of opioid misuse, and longitudinal counseling.

In their recent position statement, the American Society for Pain Management Nursing (ASPMN) and HPNA maintain that nurses and other health care professionals "must advocate for effective, efficient, and safe pain and symptom management to alleviate suffering for every patient receiving end-of-life care regardless of their age, diseases, history of substance misuse, or site of care" (Coyne, Mulvenon, & Paice, 2018). The statement underscores the indispensable role of comprehensive and continuous pain and symptom management in all patients and, specifically, in the patient who is nonverbal during the dying phase (Coyne et al., 2018).

The nurse educates the family caregivers about continuation of comfort measures as the patient approaches the end-of-life, how to administer antispasmodic agents via alternative routes, and how to assess for pain when the patient cannot verbally report pain intensity. Short-acting antispasmodic agents are most effective for uncontrolled pain. At the end-of-life, patients may receive frequent dosing. There is always a strong possibility that a patient approaching the end-of-life will die in close proximity to the time of analgesic administration. If the patient is at home, family members administering antispasmodic agents should be prepared for this possibility. They need reassurance that they did not cause the death of the patient by administering a dose of analgesic medication. In the hospital, nurses need to understand that there is always a last dose of medication in a patient who is dying, but the last dose does not cause death.

Dyspnea

Dyspnea, an uncomfortable awareness of breathing, is one of the most prevalent symptoms at the end-of-life and can be challenging to manage. A highly subjective symptom, dyspnea often is not associated with visible signs of distress, such as tachypnea, diaphoresis, or cyanosis. Although the underlying cause of the dyspnea can be identified and treated in some cases, the burdens of additional diagnostic evaluation and treatment aimed at the physiologic problem may outweigh the benefits. The treatment of dyspnea varies depending on the underlying cause, the patient's general physical condition, and imminence of death. For example, a blood transfusion may provide temporary symptom relief for a patient with anemia earlier in the disease process; however, as the patient approaches the end-of-life, the benefits are typically short-lived or absent.

Similar to the assessment of pain, reports of dyspnea are typically a subjective report. Also, as is true for physical pain, the meaning of dyspnea to an individual patient may increase their suffering. For example, the patient may interpret increasing dyspnea as a sign that death is approaching. For some patients, sensations of breathlessness may invoke frightening images of drowning or suffocation, and the resulting cycle of fear and anxiety may increase the sensation of breathlessness. Therefore, the nurse should conduct a careful assessment of the psychosocial and spiritual components of the dyspnea. Physical assessment parameters include symptom intensity, distress, and interference with activities; auscultation of lung sounds; assessment of fluid balance, including measurement of dependent edema (circumference of lower extremities) and abdominal girth; temperature; skin color; sputum quantity and character; and cough.

To determine the intensity of dyspnea and its interference with daily activities, the patient can be asked to report the severity of the dyspnea using a scale of 0 to 10 (similar to the pain scale), where 0 is no dyspnea and 10 is the

worst imaginable dyspnea. There is new evidence that the use of the Respiratory Distress Observation Scale may be effective as well (Birkholz & Haney, 2018) (see the Nursing Research Profile in Chart 13-6). The nurse should assess the patient's baseline rating before treatment and should elicit subsequent measurements taken during exacerbation of the symptom, periodically during treatment, and whenever the treatment plan changes; these parameters provide ongoing objective evidence for the efficacy of the treatment plan. In addition, physical assessment findings may assist in locating the source of the dyspnea and selecting nursing interventions to relieve the symptom. The components of the assessment change as the patient's condition changes. Like other symptoms at the end-of-life, dyspnea can be managed effectively in the absence of assessment and diagnostic data (e.g., arterial blood gases) that are standard when a patient's illness or symptom is acute and considered reversible.

Nursing management of dyspnea at the end-of-life is directed toward administering medical treatment for the underlying pathology, monitoring the patient's response to treatment, helping the patient and the family manage anxiety (which exacerbates dyspnea), altering the perception of the symptom, and conserving energy (Chart 13-7). Pharmacologic intervention is aimed at modifying lung physiology and improving performance as well as altering the perception of the symptom. Bronchodilators and corticosteroids are used to treat underlying obstructive pathology, thereby improving overall lung function. Low doses of opioids effectively relieve dyspnea, although the mechanism of relief is not entirely clear. Although dyspnea in terminal illness is typically not associated with diminished blood oxygen saturation, low-flow oxygen often provides psychological comfort to both patients and families, particularly in the home setting.

Chart 13-6 **NURSING RESEARCH PROFILE**

Comparison of Dyspnea Assessment Tools

Birkholz, L., & Haney, T. (2018). Using a dyspnea assessment tool to improve care at the end of life. *Journal of Hospice and Palliative Nursing, 20*(3), 219–227.

Purpose

There is no standard for the assessment of dyspnea, the subjective sensation of breathlessness. Generally, patients experiencing shortness of breath tell providers. However, when a person is no longer able to report symptoms at the end-of-life, nurses rely on experiential practice to guide dyspnea management. The purpose of this study was to compare end-of-life dyspnea assessment and management before and after educational implementation of Respiratory Distress Observation Scale (RDOS).

Design

This was a pre-experimental study which used a pretest/posttest format to examine the use of the RDOS. Nurses (n = 39) who provide end-of-life care where there is no standardized dyspnea assessment tool were recruited from centers: (1) a hospice agency in the Northeastern region of United States with both home hospice and an inpatient hospice unit, and (2) a medical-surgical unit in a community hospital in the Rural Western United States. RDOS was taught by video where standardized patients simulated mild, moderate, and severe levels of dyspnea in six scenarios. Nurses watched the simulated scenarios and recorded a dyspnea assessment based on experiential knowledge, in a pretest. Then, RDOS education was provided by a palliative nurse educator. Finally, the nurses rewatched the video of simulated scenarios and documented a dyspnea assessment using the RDOS in a posttest.

Findings

Researchers found a statistically significant difference in both the nurse's ability to accurately assess level of dyspnea ($p < 0.001$) and the nurse's ability to choose the most appropriate treatment ($p = 0.021$), after RDOS education. There was no statistically significant difference after education in the nurses' determination of overall comfort. The final research question addressed the nurse's evaluation of the RDOS education, where almost all agreed that the RDOS was easy to use with strong recommendation to use in end-of-life dyspnea assessment.

Nursing Implications

Nurses working in end-of-life care treat dyspnea frequently and tend to rely on previous experiences for assessment and management of dyspnea. The RDOS is a validated dyspnea assessment tool which helps nurses to systematically assess dyspnea. When nurses used the RDOS, there was a significant improvement in both the ability to assess degree of dyspnea and select the appropriate treatment.

Chart 13-7

Palliative Nursing Interventions for Dyspnea

Treat Underlying Cause

- Administer prescribed bronchodilators and corticosteroids (obstructive pathology).
- Administer blood products as prescribed for anemia.
- Administer prescribed diuretics and monitor fluid balance.

Interdisciplinary Resources

- Respiratory Therapists: pulmonary rehabilitation, noninvasive ventilation, chest wall vibration
- Physical and Occupational Therapists: energy conservation techniques, walking aids (rolling walker, cane), exercise
- Social Work or Psychologists: cognitive-behavioral therapy, meditation/mindfulness training
- Integrative Medicine Treatments: Biofeedback, Reiki, Chiropractic, Acupuncture, Yoga, T'ai Chi, and Qi gong

Self-Management (Nursing Role: Provide Education and Foster Practices)

- Forward-leaning posture
- Pursed lips or abdominal accessory muscle breathing
- Cool air movement: portable fan, air-conditioning unit, opening window in fall/winter
- Lifestyle changes: adapting socialization practices and/or accepting limitations

As mentioned previously, dyspnea may be exacerbated by anxiety, and anxiety may trigger episodes of dyspnea, setting off a respiratory crisis in which the patient and the family may panic. For patients receiving care at home, patient and family education should include anticipation and management of crisis situations and a clearly communicated emergency plan. The patient and the family should be educated about medication administration, condition changes that should be reported to the primary provider and the nurse, and strategies for coping with diminished reserves and increasing symptomatology as the disease progresses. The patient on hospice and their family require reassurance that the symptom can be effectively managed at home without the need for activation of the emergency medical services or hospitalization and that a nurse will be available at all times via telephone and to make a visit.

Impaired Secretions at the End-of-Life

In the last stage of dying, patients typically experience impaired secretions. This may be manifested by noisy, gurgling breathing or moaning. In most cases, the sounds of breathing at the end-of-life are related to oropharyngeal relaxation with inability to clear secretions through cough or swallowing due to somnolence. Treatment of impaired secretions in the actively dying is usually achieved with the use of anticholinergic medications to dry secretions (Table 13-5). Sounds caused by impaired secretions are generally most distressing to family members. Nurses need to educate family members about impaired secretions, provide assurance on the normalcy of the symptom, and distinguish it from dyspnea.

TABLE 13-5 Medications to Control Secretions and Terminal Respiratory Congestion

Medication	Suggested Initial Dosing
Atropine 1% ophthalmic	1–2 drops PO/SL every 4 h, scheduled or PRN
Atropine injection	0.4 mg IV/SC/IM every 4 h, scheduled or PRN
Glycopyrrolate	1 mg PO TID, scheduled or PRN, up to 6 mg/day or 0.1 mg SC/IM/IV TID or PRN
Hyoscyamine	0.125 mg PO/SL every 4 h PRN, up to 1.5 mg/day
Hyoscyamine extended-release	0.375 mg PO every 12 h, up to 1.5 mg/day
Scopolamine transdermal	Apply 1 patch topically behind the ear every 72 h, up to 3 patches/72 h

IM, intramuscularly; IV, intravenously; PO, by mouth; PRN, as needed; SC, subcutaneously; SL, sublingually; TID, twice a day.

Reprinted with permission from Enclara Pharmacia, Inc. (2015). *Enclara Pharmacia medication use guidelines* (1st ed.). Philadelphia, PA: Author.

Anorexia and Cachexia at the End-of-Life

Anorexia and cachexia are common in the seriously ill. The profound changes in the patient's appearance and a lack of interest in the socially important rituals of mealtime are particularly disturbing to families. The approach to the problem varies depending on the patient's stage of illness, level of disability associated with the illness, and desires. The anorexia–cachexia syndrome (Table 13-6) is characterized by disturbances in carbohydrate, protein, and fat metabolism; endocrine dysfunction; and anemia. The syndrome results in severe asthenia (loss of energy).

Anorexia and cachexia differ from starvation (simple food deprivation) in several important ways. Anorexia is defined as inadequate nutritional intake,

while cachexia refers to severe lean muscle loss. In chronic illness, appetite is lost early in the process, the body becomes catabolic in a dysfunctional way, and supplementation by enteral feeding or parenteral nutrition in advanced disease does not replenish lean body mass that has been lost. Similarly, appetite stimulants are ineffective at this stage. Cachexia is associated with anabolic and catabolic changes in metabolism that relate to activity of neurohormones and proinflammatory cytokines, resulting in profound protein loss.

Near the end-of-life, the body's nutritional needs change, and the desire for food and fluid may diminish. People may no longer be able to use, eliminate, or store nutrients and fluids adequately. Eating and sharing meals are important social activities in families and communities, and food preparation and enjoyment are linked to happy memories, strong emotions, and hope for survival. For patients with serious illness, food preparation and mealtimes often become a constant struggle in which well-meaning family members argue, plead, and cajole to encourage ill people to eat. Patients who are seriously ill often lose their appetites entirely, develop strong aversions to foods that they have enjoyed in the past, or crave a particular food to the exclusion of all other foods.

TABLE 13-6 Anorexia/Cachexia Syndrome

Mechanism	Effect
Loss of appetite	• Generalized tissue wasting • Queasiness • Decreased pleasure at meals yielding decreased socialization
Reduced voluntary motor activity	• Sarcopenia (muscle wasting) • Skeletal muscle fatigue
Reduced rate of muscle protein synthesis	• Sarcopenia • Skeletal muscle weakness
Decreased immune response	• Increased risk of infection
Decreased response or intolerability to treatments	• Increased morbidity • Increased mortality

Nursing Interventions for Anorexia/Cachexia Syndrome:
Assess the impact of current medications (e.g., chemotherapy, antiretroviral).
Consider impact of additional therapies on appetite (e.g., radiation, dialysis).
Assess for concomitant symptoms including nausea, anxiety, depression, constipation, and diarrhea.
Perform oral assessment (e.g., presence of ulcers or thrush); administer and monitor effects of topical and systemic treatment for oropharyngeal pain.
Ensure that dentures fit properly, if applicable.
Administer antiemetics or laxatives when appropriate.
Explore barriers to eating with patient and develop plan.
Remove unpleasant odors including soiled tissues, bedpans, and emesis basin.
Position to enhance gastric emptying.
Provide frequent mouth care, especially after eating.

Adapted from Schack, E. E., & Wholihan, D. (2019). Anorexia and cachexia. In B. R. Ferrell, N. Coyle, & J. Paice (Eds.). *Oxford textbook of palliative nursing* (5th ed.). New York: Oxford.

As the patient approaches the end-of-life, the family and the health care providers should offer the patient what they prefer and can most easily tolerate. The nurse should educate the family about ways to separate feeding from caring and how to demonstrate love, sharing, and caring by being with the loved one in other ways. Preoccupation with appetite, feeding, and weight loss diverts energy and time that the patient and the family could use in other meaningful activities. Encourage patients to eat what brings them joy. For family members who are struggling with seeing their loved one eat less, the nurse ensures they understand that patients are allowed to refuse foods and

fluids. The nurse may also instruct family members how to make ice cubes from frozen fruit juices or smoothies and to offer these to the patient.

Anxiety and Depression

Almost half of patients in hospice experience significant anxiety and/or depression at the end-of-life as reported by proxy (Kozlov, Phongtankuel, Prigerson, et al., 2019). Anxiety may be exacerbated by other symptoms such as pain or dyspnea, as well as anticipating symptoms at the end-of-life. A systematic approach to anxiety involves treating the underlying cause, providing psychosocial support, referral to counseling as needed, and administering medications as prescribed.

Clinical depression should neither be accepted as an inevitable consequence of dying nor confused with sadness and anticipatory grieving, which are normal reactions to the losses associated with impending death. Emotional and spiritual support and control of disturbing physical symptoms are appropriate interventions for situational depression associated with terminal illness. Patients and their families must be given space and time to experience sadness and to grieve; however, patients should not have to endure untreated depression at the end of their lives. An effective approach to clinical depression includes relief of physical symptoms, attention to emotional and spiritual distress, psychotherapy, and pharmacologic intervention with antidepressants.

Delirium

Many patients remain alert, arousable, and able to communicate until very close to death. Others sleep for long intervals and awaken only intermittently, with eventual somnolence until death. Delirium refers to concurrent disturbances in the level of consciousness, attention, awareness, and cognitive capability that develop over a relatively short period of time (Bush, Tierney, & Lawlor, 2017). Confusion may be related to underlying, treatable conditions such as medication side effects or interactions, pain or discomfort, hypoxia or dyspnea, or a full bladder or impacted stool. In patients with cancer, confusion may be secondary to brain metastases. Delirium may also be related to metabolic changes, infection, and organ failure. In some patients, a period of agitated delirium precedes death, sometimes causing families to be hopeful that suddenly active patients may be getting better.

Nursing interventions are aimed at identifying the underlying causes of delirium; acknowledging the family's distress over its occurrence; reassuring family members about what is normal; educating family members how to interact with and ensure safety for the patient with delirium; and monitoring the effects of medications used to treat severe agitation, paranoia, and fear. Confusion may mask the patient's unmet spiritual needs and fears about dying.

Spiritual intervention, music therapy, gentle massage, and therapeutic touch may provide some relief. Reduction of environmental stimuli, avoidance of harsh lighting or very dim lighting (which may produce disturbing shadows), presence of familiar faces, and gentle reorientation and reassurance are also helpful.

Patients with delirium may become hypoactive and/or hyperactive, restless, irritable, and fearful. Sleep deprivation and hallucinations may occur. When treating delirium, it is important to attempt to treat underlying factors contributing to symptoms first. Much controversy remains on the pharmacologic treatment of delirium at the end-of-life. One study compared the use of haloperidol plus lorazepam to haloperidol alone and found improved relief of symptoms with the medication combination (Hui, Frisbee-Hume, Wilson, et al., 2017). Unfortunately, delirium is a common symptom at the end-of-life; providing education on this may be the most reassuring intervention for family members.

Additional Common Symptoms

Patients may experience other common symptoms. Progressive fatigue occurs in most chronic, progressive illnesses, worsening in the last weeks and months of life. At the end-of-life, many patients suffer from constipation as a side effect of medications, such as opioids, as well as the sedentary nature of advanced chronic illness. Nurses should be performing a physical assessment including abdominal examination and last bowel movement. The nurse can administer laxatives (either by mouth or per rectum) as prescribed if patients show signs of constipation.

Nausea and vomiting may be common at the end-of-life, especially in patients who experienced nausea during disease progression. Patients with malignant bowel obstructions may experience refractory nausea at the end-of-life requiring antiemetics to target multiple hormone receptors or decompression via a gastric tube. Further, skin breakdown occurs as the organs, including skin begin to fail. Diligent nursing care of wounds includes assessment, treatment of pain, dressing changes for comfort, and consultation with wound care specialists.

Time of Death

For patients who have received adequate management of symptoms and for families who have received adequate preparation and support, the actual time of death is commonly peaceful and occurs without struggle. Nurses may or may not be present at the time of a patient's death. In many states, nurses are authorized to make the pronouncement of death and sign the death certificate when death is expected. The determination of death is made through a physical examination that includes auscultation for the absence of breathing and heart

sounds. Home care or hospice programs in which nurses make the time-of-death visit and pronounce death have policies and procedures to guide the nurse's actions during this visit. Immediately on cessation of vital functions, the body begins to change. It becomes dusky or bluish, waxen appearing, and cool; blood darkens and pools in dependent areas of the body (e.g., the back and the sacrum if the body is in a supine position); and urine and stool may be evacuated.

Immediately after death, family members should be allowed and encouraged to spend time with the deceased. Normal responses of family members at the time of death vary widely and range from quiet expressions of grief to overt expressions that include wailing and prostration. The family members' desire for privacy during their time with the deceased should be honored. Family members may wish to independently manage or assist with care of the body after death. In the home, after-death care of the body frequently includes culturally specific rituals such as bathing the body. Home care agencies and hospices vary in the policies surrounding removal of tubes. In the absence of specific guidance from the organization, the nurse should shut off infusions of any kind (intravenous or tube feeding) and leave intravenous access devices, feeding tubes, catheters, and wound dressings in place. When an expected death occurs in the home setting, the family generally will have received assistance with funeral arrangements in advance of the death. The funeral home should be called and the funeral director will transport the body directly to the funeral home. In the hospital or long-term care facility, nurses follow the respective facility's procedure for preparation of the body and transportation to the facility's morgue. However, the needs of families to remain with the deceased, to wait until other family members arrive before the body is moved, and to perform after-death rituals should be honored.

Some patients may have elected to donate tissue such as corneas, bone, veins, or heart valves for transplant. Typically, this information would be known to the care team before the patient dies. In some cases, such as late referral or an unexpectedly rapid progression, the patient's wishes with respect to donation might be unknown. If the patient died at home or in a nursing home and the deceased's wishes are known, a team member should contact the organ procurement organization through which the deceased had arranged to donate tissue. That organization will ordinarily transport the body for tissue procurement and to the funeral home.

Providing Psychosocial and Spiritual Support

Many patients suffer unnecessarily when they do not receive adequate attention for the symptoms accompanying serious illness. Careful evaluation of

the patient should include not only the physical problems but also the psychosocial and spiritual dimensions of the patient's and family's experience of serious illness. This approach contributes to a more comprehensive understanding of how the patient's and family's life has been affected by illness and leads to nursing care that addresses their needs in every dimension.

Hope and Meaning in Illness

Clinicians and researchers have observed that although specific hopes may change over time, hope generally persists in some form across every stage of illness. In terminal illness, hope represents the patient's imagined future, forming the basis of a positive, accepting attitude and providing the patient's life with meaning, direction, and optimism. When hope is viewed in this way, it is not limited to cure of the disease; instead, it focuses on what is achievable in the time remaining. Many patients find hope in working on important relationships and creating legacies. Patients who are terminally ill can be extremely resilient, reconceptualizing hope repeatedly as they approach the end-of-life.

Numerous nurse researchers have studied the concept of hope, and they have related its presence to spirituality, quality of life, and transcendence (Tarbi & Meghani, 2019). Hope is a multidimensional construct that provides comfort as a person endures life threats and personal challenges. The following are hope-fostering and hope-hindering activities among patients who are terminally ill and in hospice with various diagnoses:

- *Hope-fostering categories:* Love of family and friends, spirituality/faith, setting goals and maintaining independence, positive relationships with clinicians, humor, personal characteristics, and uplifting memories
- *Hope-hindering categories:* Abandonment and isolation, uncontrollable pain/discomfort, and devaluation of personhood

Nurses can support hope for the patient and the family by using effective listening and communication skills, thus encouraging realistic hope that is specific to their needs for information, expectations for the future, and values and preferences concerning the end-of-life. Nurses must engage in self-reflection and identify their own biases and fears concerning illness, life, and death. As nurses become more skilled in working with patients who are seriously ill, they can become less determined to *fix* and more willing to listen; more comfortable with silence, grief, anger, and sadness; and more fully present with patients and their families.

Nursing interventions for enabling and supporting hope include the following:

- Answering questions about illness in terms the patient understands

- Listening attentively
- Encouraging sharing of feelings
- Providing accurate information
- Encouraging and supporting patients' control over their circumstances, choices, and environment whenever possible
- Assisting patients to explore ways for finding meaning in their lives
- Facilitating effective communication within families
- Making referrals for psychosocial and spiritual counseling
- Assisting with the development of supports in the home or community when none exist

Providing Culturally Sensitive Care at the End-of-Life

Nurses are responsible for educating patients and their caregivers and for supporting them as they adapt to life with the illness. Nurses can assist patients and families with life review, values clarification, treatment decision making, and end-of-life goals. The only way to do this effectively is to try to appreciate and understand the illness from the patient's perspective.

The nurse's role is to assess the values, preferences, and practices of every patient, regardless of ethnicity, gender identity, socioeconomic status, or background. The nurse can share knowledge about a patient's and family's cultural beliefs and practices with the health care team and facilitate the adaptation of the care plan to accommodate these practices.

Although death, grief, and mourning are universally accepted aspects of living, the values, expectations, and practices during serious illness as death approaches and after death are culturally bound and expressed. Health care providers may share similar values concerning end-of-life care and may find that they are inadequately prepared to assess for and implement care plans that support culturally diverse perspectives. Historical mistrust of the health care system and unequal access to even basic medical care may underlie the beliefs and attitudes among ethnically diverse populations. In addition, lack of education or knowledge about end-of-life care treatment options and language barriers may influence decisions among many socioeconomically disadvantaged groups.

Nurses should be both culturally aware and sensitive in their approaches to communication with patients and families about death. To provide effective patient- and family-centered care at the end-of-life, nurses must be willing to set aside their own assumptions and attitudes so that they can discover what type and amount of disclosure is most meaningful to each patient and family within their unique belief systems. For example, a nurse may find that a female patient prefers to have her eldest son make all of her care decisions. Institutional practices and laws governing informed consent are also rooted in

the Western notion of autonomous decision making and informed consent. If a patient wishes to defer decisions to her son, the nurse can work with the team to negotiate informed consent, respecting the patient's right not to participate in decision making and honoring her family's cultural practice.

Every person has unique needs at the end-of-life and deserves to be respected as a person. Those who identify as lesbian, gay, bisexual, transgender, and queer may need special attention to psychological stressors of serious illness and ACP to designate a preferred surrogate, as this may be outside of the biologic family. An additional concern for some transgender patients is loss of identity after death; for instance, not being buried in clothes of their preferred gender or honored with the name they chose (Higgins & Hynes, 2019).

The nurse should assess and document the patient's and family's specific beliefs, preferences, and practices regarding end-of-life care, preparation for death, and after-death rituals. Chart 13-8 identifies suggested language for cultural and spiritual assessment. The discomfort of novice nurses with asking questions and discussing this type of sensitive content can be reduced by prior practice in a classroom or clinical skills laboratory, observation of interviews conducted by experienced nurses, and partnering with experienced nurses during the first few assessments.

Spiritual Care

Attention to the spiritual component of the illness experienced by the patient and the family is not new within the context of nursing care, yet many nurses lack the comfort or skills to assess and intervene in this dimension. Spirituality contains features of religiosity; however, the two concepts are not interchangeable. **Spirituality** includes domains such as how a person derives meaning and purpose from life, one's beliefs and faith, sources of hope, and attitudes toward death (Puchalski, 2015).

The spiritual assessment is a key component of comprehensive nursing assessment for patients who are terminally ill and their families. While the nursing assessment should include religious affiliation, the nurse keeps in mind that spirituality is a broader concept than just religion (see Chart 13-8). In addition to the assessment of the role of religious faith and practices, important religious rituals, and connection to a religious community, the nurse should further explore:

- The harmony or discord between the patient's and the family's beliefs
- Other sources of meaning, hope, and comfort
- The presence or absence of a sense of peace of mind and purpose in life

- Spiritual or religious beliefs about illness, medical treatment, and care of the sick

A four-step spiritual assessment process using the acronym FICA involves asking the following questions (Puchalski & Romer, 2000):

- *F*aith and belief: Do you consider yourself to be a spiritual or religious person? What is your *faith* or belief? What gives your life meaning?

Chart 13-8 **ASSESSMENT**

Cultural and Spiritual Issues at the End-of-Life

Cultural Assessment

- Tell me more about yourself and your family.
- How are decisions made in your family?
- In order to provide you with the best care, are there any customs or practices important to you that should be included in your care plan?

Spiritual Assessment

- How is your spirit?
- Are you at peace?
- What gives you meaning and purpose?
- What are you most hoping for?
- Is anything worrying you?
- Is there anything you have not done that you wish/need to do?

Assessing Cultural and Spiritual Practices Surrounding Death

- What do you believe happens after death?
- Would you like your family to be involved in the care of your body?
- Are there certain people you would like to care for your body after death (e.g., women only or spiritual care provider)?
- Immediately after death are there any rituals, practices, or ceremonies that should be performed? Are there ways that we can help facilitate these?

Culturally Competent Communication Skills

- Respect uniqueness of each patient.
- Listen attentively to patient's narratives.
- Assess values and preferences for care.
- Address concerns.
- Anticipate when communication may be difficult and engage interdisciplinary team to provide support.

Adapted from Cormack, C., Mazanec, P., & Panke, J. T. (2019). Cultural considerations in palliative care. In B. R. Ferrell, N. Coyle, & J. Paice (Eds.). *Oxford textbook of palliative nursing* (5th ed.). New York: Oxford; Taylor, E. J. (2019). Spiritual screening, history, and assessment. In B. R. Ferrell, N. Coyle, & J. Paice (Eds.). *Oxford textbook of palliative nursing* (5th ed.). New York: Oxford.

- *I*mportance and *I*nfluence: What *importance* does faith have in your life? Have your beliefs *influenced* the way you take care of yourself

and your illness? What role do your beliefs play in regaining your health?

- *C*ommunity: Are you a part of a spiritual or religious *community*? Is this of support to you and how? Is there a group of people you really love or who are important to you?
- *A*ddress in care: How would you like me to *address* these issues in your health care?

For most people, contemplating one's own death raises many issues, such as the meaning of existence, the purpose of suffering, and the existence of an afterlife. When faced with a grave prognosis, many patients experience spiritual or existential distress where a sense of meaning or purpose is lost. Other manifestations of spiritual distress include questioning or blaming their god. Nurses may identify distress when patients ask questions like, "Why me?" or "Why is God punishing me?" When hearing such questions, nurses should engage a spiritual care provider. Near the end-of-life, many draw strength from religion and spirituality and may turn to spiritual care providers for support; however, one study showed that 75% of clergy want more education surrounding end-of-life issues (Sanders, Chow, Enzinger, et al., 2017). Nurses may be perfectly poised to deliver point-of-care education to spiritual care providers. Further, the interdisciplinary team can organize a debriefing session to enrich education for all disciplines.

Another phenomenon associated with spirituality at the end-of-life is spiritual pain, defined as a pain deep in one's soul not manifested as physical symptoms, which may be experienced in the seriously ill. Although prevalence is not known in all illnesses, in those with advanced cancer as many as 67% of patients may experience spiritual pain, which is correlated with lower quality of life (Perez-Cruz, Langer, Carrasco, et al., 2019).

Grief, Mourning, and Bereavement

A wide range of feelings and behaviors are normal, adaptive, and healthy reactions to the loss of a loved one. **Grief** refers to the personal feelings that accompany an anticipated or actual loss; see Table 13-7 for types of grief. **Mourning** refers to individual, family, group, and cultural expressions of grief and associated behaviors. **Bereavement** refers to the period of time during which mourning for a loss takes place. Both grief reactions and mourning behaviors change over time as people learn to live with the loss. Although the pain of the loss may be tempered by the passage of time, loss is an ongoing developmental process, and time does not heal the bereaved person completely. That is, the bereaved do not get over a loss entirely, nor do they return to who they were before the loss. Rather, they develop a new sense of who they are and where they fit in a world that has changed dramatically and permanently.

TABLE 13-7 Characteristics of Types of Grief and Nursing Interventions

Type of Grief	Characteristics
Anticipatory	Unconsciously preparing for what might happen *Examples:* Grief at diagnosis at loss of "normal" life; preparing for the loss of a limb for amputation
Uncomplicated	Range of emotions experienced after a loss moving toward adjustment; brief periods of relapse common *Examples:* Missing a deceased grandparent during holidays
Complicated or Prolonged	Intense response after loss where profound emotions persist usually >1 y *Example:* Widow who stops caring for herself after the death of her husband and sobs at any mention of his name a year later
Disenfranchised	Grieving person feels that society does not acknowledge or support person's right to grieve *Examples:* Mistress, homosexual partner, colleagues
Unresolved	Traumatic or unexpected losses *Examples:* Death of a child; suicide; disaster-related death
Nursing Interventions: Assessment of self-care and social supports. Employ assessment tools, such as the Inventory of Complicated Grief. Referral to professional counseling services.	

Adapted from Corless, I. B., & Meisenh, J. B. (2019). Bereavement. In B. R. Ferrell, N. Coyle, & J. Paice (Eds.). *Oxford textbook of palliative nursing* (5th ed.). New York: Oxford; Limbo, R., Kobler, K., & Davies, B. (2019). Grief and bereavement in perinatal and pediatric palliative care. In B. R. Ferrell, N. Coyle, & J. Paice (Eds.). *Oxford textbook of palliative nursing* (5th ed.). New York: Oxford.

Anticipatory Grief and Mourning

People experience grief in different ways. Kübler-Ross (1969) originally described five stages of grief including (1) denial, (2) anger, (3) bargaining, (4) depression, and (5) acceptance. Newer models of grief acknowledge that grieving is not a linear process and many more emotions may be present than originally identified by Kübler-Ross. Additionally, people many feel conflicting emotions, such as hope and guilt when thinking about the future, at the same time. The Dual Process Model (Fig. 13-3) of coping with bereavement allows oscillation between the loss-oriented process and the restoration-oriented process (Stroebe & Schut, 1999). The Dual Process Model assumes fluidity in bereavement and normalizes the individual experience by offering that people will experience competing and complicated emotions after the death of a loved one.

Individual and family coping with the anticipation of death is complicated by the varied and conflicting trajectories that grief and mourning may assume in families. For example, the patient may be experiencing sadness while contemplating role changes that have been brought about by the illness, and the patient's spouse or partner may be expressing or suppressing feelings of anger about the current changes in role and impending loss of the relationship.

Others in the family may cope with fear using withdrawal. Each person copes in their own way as there is no *right* way to cope.

The nurse should assess the characteristics of the family system and intervene in a manner that supports and enhances the cohesion of the family unit. The nurse can suggest that family members talk about their feelings and understand them in the broader context of anticipatory grief and mourning. Acknowledging and expressing feelings, continuing to interact with the patient in meaningful ways, and planning for the time of death and bereavement are adaptive family behaviors. Professional support provided by grief counselors, whether in the community, at a local hospital, in the long-term care facility, or associated with a hospice program, can help both the patient and the family sort out and acknowledge feelings and make the end-of-life as meaningful as possible.

Grief and Mourning After Death

When a loved one dies, family members enter a new phase of grief and mourning as they begin to accept the loss, feel the pain of permanent separation, and prepare to live a life without the deceased. Even if the loved one dies after a long illness, preparatory grief experienced during the terminal illness does not preclude the grief and mourning that follow the death. With a death after a long or difficult illness, family members may experience conflicting feelings of relief that the loved one's suffering has ended, compounded by guilt and grief related to unresolved issues or the circumstances of death. Grief work may be especially difficult if a patient's death was painful, prolonged, accompanied by unwanted interventions, or unattended. Families that had no preparation or support during the period of imminent death may have a more difficult time finding a place for the painful memories.

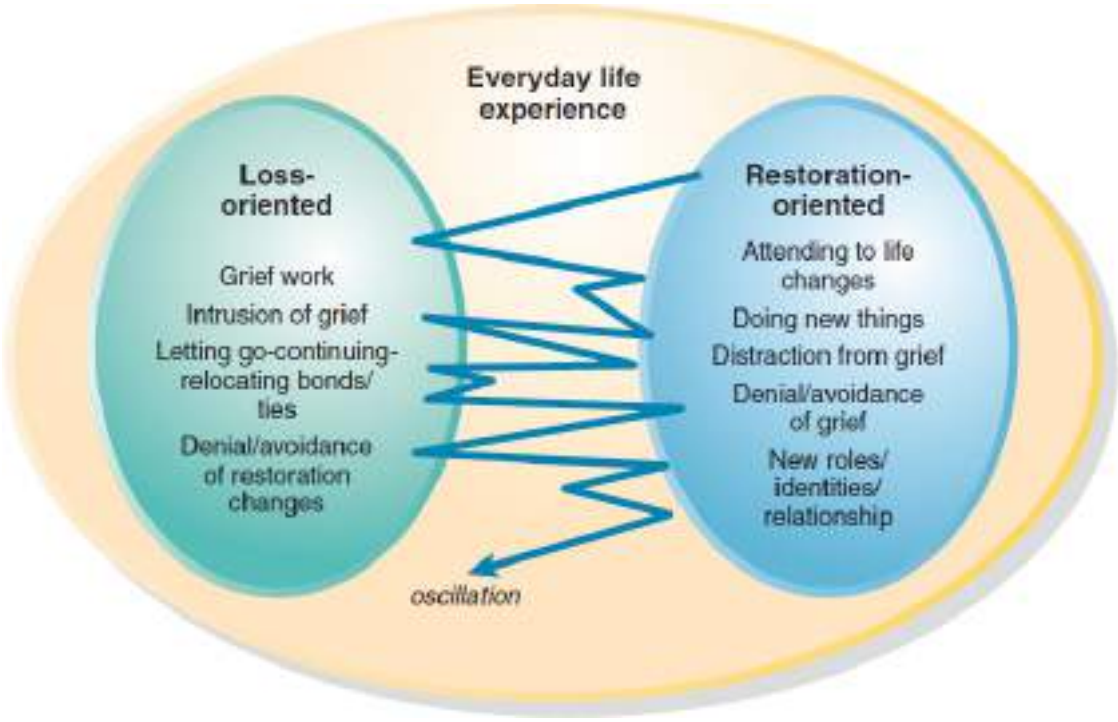

Figure 13-3 • The Dual Process Model of coping with bereavement. Adapted with permission from Stroebe, M. S., & Schut, H. (1999). The Dual Process Model of coping with bereavement: Rationale and description. *Death Studies*, *23*, 197–224, by permission of Taylor & Francis Ltd (http://www.tandfonline.com) and Stroebe MS & Schut H. doi: 10.1080/074811899201046.

Feelings of grief are often profound; however, bereaved people eventually reconcile the loss and find a way to reengage with their lives. Grief and mourning are affected by several factors, including individual characteristics, coping skills, and experiences with illness and death; the nature of the relationship to the deceased; factors surrounding the illness and the death; family dynamics; social support; and cultural expectations and norms.

After-death rituals, including preparation of the body, funeral practices, and burial rituals, are socially and culturally significant ways in which family members begin to accept the reality and finality of death. Preplanning of funerals is common, and hospice professionals, in particular, help the family make plans for death, often involving the patient, who may wish to play an active role. Preplanning of the funeral relieves the family of the burden of making decisions in the intensely emotional period after a death.

In general, the period of mourning is an adaptive response to loss during which mourners come to accept the loss as real and permanent, acknowledge and experience the painful emotions that accompany the loss, experience life without the deceased, overcome impediments to adjustment, and find a new way of living in a world without the loved one. Particularly immediately after

the death, mourners begin to recognize the reality and permanence of the loss by talking about the deceased in past terms and telling and retelling the story of the illness and death. Societal norms in the United States are frequently at odds with the normal grieving processes of people; time excused from work obligations is typically measured in days, and mourners are often expected to get over the loss quickly and get on with life.

In reality, the work of grief and mourning takes time, and avoiding grief work after the death often leads to long-term adjustment difficulties. According to Rando (2000), mourning for a loss involves the "undoing" of psychosocial ties that bind mourners to the deceased, personal adaptation to the loss, and learning to live in the world without the deceased. Six key processes of mourning allow people to accommodate to the loss in a healthy way (Rando, 2000):

- Recognition of the loss
- Reaction to the separation and experiencing and expressing the pain of the loss
- Recollection and reexperiencing the deceased, the relationship, and the associated feelings
- Relinquishing old attachments to the deceased
- Readjustment to adapt to the new world without forgetting the old
- Reinvestment

Although many people complete the work of mourning with the informal support of families and friends, many find that talking with others who have had a similar experience, such as in formal support groups, normalizes the feelings and experiences and provides a framework for learning new skills to cope with the loss and create a new life. Hospitals, hospices, religious organizations, and other community organizations often sponsor bereavement support groups. When a person dies while enrolled in hospice, families receive proactive bereavement from the hospice agency for an average of 13 months after the death. Hospice bereavement programs vary, yet bereavement support usually starts with scheduled calls to deceased primary contact. Bereavement may then be set up as individual counseling or group sessions, such as widow or parents support groups. Hospices may offer specialized child bereavement support services. Bereavement staff may consist of specially trained nurses, child psychologists, counselors, child life specialists, and/or music or art therapists. If a person dies and is not enrolled in hospice, some palliative care teams offer bereavement or help to connect families with a hospice for bereavement resources. When one cancer center implemented a bereavement program, surveyed bereaved family members felt that acknowledgment of their loved one through a formal condolence letter had a positive impact (Morris & Block, 2015).

Complicated Grief and Mourning

Complicated grief and mourning are characterized by prolonged feelings of sadness and feelings of general worthlessness or hopelessness that persist long after the death, prolonged symptoms (depression, anxiety, insomnia, fatigue) that interfere with activities of daily living, or self-destructive behaviors such as alcohol or substance abuse and suicidal ideation or attempts (Mason & Duffy, 2019). Certain risk factors that increase the likelihood of complicated grief include death of a child or spouse, multiple losses, and history of trauma (Tofthagen, Kip, Witt, et al., 2017). Complicated grief and mourning require professional assessment and can be treated with psychological interventions and, in some cases, with medications.

Special Issues for the Nurse in End-of-Life Care

Nursing care often intersects with moral and ethical dilemmas (see Chapter 1 for further discussion of ethics). Nurses are encouraged to personally examine their respective moral compasses in order to provide the best, unbiased care for patients and families. In caring for patients at the end-of-life, questions of *right* and *wrong* may arise in relation to treatment options. The ANA's *Code of Ethics for Nurses* provides a framework for the nurse to support patients, with guiding principles being the patient's right to self-determination and the nurse's adherence to professional nursing standards (ANA, 2015). When approaching an ethical dilemma, the nurse should take the following steps: define the problem, clarify facts and assumptions, compile a list of all options, evaluate options with interdisciplinary team input, and choose the most appropriate option and implement the plan (Prince-Paul & Daly, 2019). The most common ethical dilemmas a nurse will encounter are determining decisional capacity, withholding or withdrawing life-prolonging measures—including, but not limited to, ventilator support, dialysis, artificial nutrition and hydration—requests for hastening death, and concerns related to proxy decision making. Select ethical issues are discussed in greater detail in the following sections.

Medically Administered Nutrition and Hydration

Although nutritional supplementation may be an important part of the treatment plan in early or chronic illness, unintended weight loss and dehydration are expected characteristics of progressive illness. As illness progresses, patients, families, and clinicians may believe that without artificial nutrition and hydration, patients who are terminally ill will *starve,* causing profound suffering and hastened death. The use of artificial nutrition and hydration (tube and intravenous fluids and feeding) carries considerable risks

and generally does not contribute to comfort at the end-of-life (Casarett, Kapo, & Kaplan, 2005; Marcolini, Putnam, & Aydin, 2018). Similarly, survival is not increased when patients who are terminally ill with advanced dementia receive enteral feeding, and no data support an association between tube feeding and improved quality of life in these patients (De & Thomas, 2019). Furthermore, in patients who are close to death, symptoms associated with dehydration such as dry mouth, confusion, and diminished alertness are common and typically do not respond to artificial nutrition and hydration (Danis, Arnold, & Savarese, 2018). Dry mouth can generally be managed through nursing measures such as mouth care, and environmental changes with medications can help to diminish confusion.

Palliative Sedation at the End-of-Life

Effective control of symptoms can be achieved under most conditions; however, some patients may experience distressing, intractable symptoms. Although **palliative sedation** remains controversial, it is offered in some settings to patients who are close to death or who have symptoms that do not respond to conventional pharmacologic and nonpharmacologic approaches, resulting in unrelieved suffering. Palliative sedation is distinguished from euthanasia and physician-assisted suicide (PAS) in that the intent of palliative sedation is to relieve symptoms, not to hasten death (see Chart 13-9). Proportionate palliative sedation uses the minimum drug necessary to relieve the symptom while preserving consciousness, whereas palliative sedation induces unconsciousness, which is more controversial (Quill, Lo, Brock, et al., 2009). Palliative sedation is most commonly used when the patient exhibits intractable pain, dyspnea, seizures, or delirium, and it is generally considered appropriate in only the most difficult situations. Palliative sedation is accomplished through an infusion of one or more pharmacologic agents in doses adequate to eliminate signs of discomfort. Before implementing palliative sedation, the health care team should assess for the presence of underlying and treatable causes of suffering, such as depression or spiritual distress. Finally, the patient and the family should be fully informed about the use of this treatment and alternatives. A retrospective study of Italian hospice patients reported that palliative sedation was documented as discussed in only half of the cases where it was implemented (Ingravallo, de Nooijer, Pucci, et al., 2018).

Published guidelines for pharmacologic management of palliative sedation vary widely internationally (Abarshi, Rietjens, Robijn, et al., 2017) but most mention the use of midazolam, a short-acting benzodiazepine (Lux, Protus, Kimbrel, et al., 2017). Nurses act as collaborating members of the interdisciplinary health care team, providing emotional support to patients and families, facilitating clarification of values and preferences, and providing

comfort-focused physical care. Once sedation has been induced, the nurse should continue to comfort the patient, monitor the physiologic effects of the sedation, support the family during the final hours or days of their loved one's life, and ensure communication within the health care team and between the team and the family.

Requests for Assistance in Dying

A major debate in palliative and end-of-life care is the acceptability of a patient's requests to hasten death. Health care recognizes the right to choose for or against medical treatments when a patient is of sound mind and can relay a rationale for or against treatments. Further, patients may choose to withdraw or withhold life-sustaining treatments and allow natural death if such therapies are not aligned with their wishes. When faced with a progressive life-limiting illness, some cannot fathom suffering at the end-of-life and explore options to hasten death. Language around assistance in dying has evolved over the years and it is important to recognize the following terms:

Chart 13-9 **ETHICAL DILEMMA**

Does Intent Matter When Palliative Care Leads to Death?

Case Scenario

You are a staff nurse working for an outpatient home hospice service. G.R. is a 68-year-old man admitted to home hospice service two months ago with advanced multiple myeloma. As a consequence of his disease he also has extensive destruction of bony matrix resulting in widespread pain, numerous vertebral fractures, and spinal cord compression. For the first six weeks that G.R. was managed in hospice, you and the hospice staff have successfully kept his pain and other symptoms under reasonable control. However, over the past two weeks his pain has been more difficult to control, despite escalating dosages of opioids. He has not been able to sleep, and is restless, dyspneic, and anxious. The hospice physician was consulted, and G.R. and his husband agreed to intravenous opioids, sedatives, and anxiolytics to relieve G.R.'s suffering, knowing that he would also lose consciousness as a consequence of this treatment. However, they stated that though they were not pleased that G.R. would never regain consciousness, that result was offset by their hope was the G.R. might die peacefully. You administer the prescribed intravenous medications, and slowly administer the minimum dosages of these medications to relieve symptoms. G.R. loses consciousness and dies peacefully 48 hours later with his husband holding his hand at his bedside.

Discussion

There is a great deal of apprehension among both clinicians and laypersons around what constitutes comfort care (i.e., palliative care) at end-of-life and what may constitute either assisted suicide or euthanasia. The premise is that palliative care should ameliorate pain and suffering in the patient who is terminally ill, but it should not significantly shorten the patient's life.

The principle of double-effect highlights that some actions have two effects - one good, the other evil. The good and evil consequences are not considered in terms of proportions; if they were, and the evil outcome is death, then the good outcome could never be considered sufficient to justify the action. Rather, the intention behind the action is given paramount consideration. If the intention is to cause death, then the act is not morally justifiable. However, if the intention is to relieve suffering, then the act might be sanctioned.

Analysis

- Describe how the ethical principles of autonomy, beneficence, and nonmaleficence may intersect or be at odds with each other in this case. Discuss how palliative sedation meets the moral justification of the four criteria for the principle of double effect (see Chapter 1, Chart 1-7).

- Would you describe your role in this case as complicit in assisted suicide, euthanasia, or providing palliation? What distinction, if any, might there be among these three acts?
- Note that the ANA (2015) *Code of Ethics* clearly states that nurses should not *intentionally* cause a patient's death. What were your "intentions" in this case? How might intentionality be instrumental in making this act of titrating medications that provided palliation morally defensible? Are there resources you could identify that might be of assistance to you if you were to feel moral distress about your actions?

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Resources

See Chapter 1, Chart 1-10 for Steps of an Ethical Analysis and Ethics Resources.

- *Physician aid in dying (PAD), medical aid in dying (MAD), and physician-assisted dying:* A physician prescribes a lethal dose of oral medication that the patient self-administers, for the purpose of ending someone's life.
- *PAS:* A physician prescribes medications, that the patient self-administers, to end their life at the person's voluntary and competent request.
- *Euthanasia:* Greek for "good death"; has evolved to mean the intentional killing by act or omission of a dependent human being for their alleged benefit.

Although assisted suicide is expressly prohibited under statutory or common law in the majority of states, calls for legalized aid in dying have highlighted inadequacies in end-of-life care. In 1994, Oregon voters approved the Oregon Death with Dignity Act, the first and—until 2009 only such legislative initiative to pass. This law provides for access to PAS by terminally ill patients under very controlled circumstances. After numerous challenges, the law was enacted in 1997. Of 2127 Oregonians who have received written prescriptions under the terms of the law since it was passed in 1997, 1459 have self-administered physician-prescribed lethal medication and have died (Oregon Public Health Division, 2018).

In recent years, additional states have adopted MAD laws, and Montana's Supreme Court has ruled that PAD is not a crime. International MAD is legal in Canada, the Netherlands, Belgium, Luxembourg, Switzerland, Columbia, and Victoria in Australia. Proponents of PAS argue that people who are terminally ill should have a legally sanctioned right to make independent decisions about the value of their lives and the timing and circumstances of their deaths, and its opponents argue for greater access to symptom management and psychosocial support for people approaching the end-of-life.

In its 2013 position statement on *Euthanasia, Assisted Suicide, and Aid in Dying,* the ANA acknowledged the complexity of the assisted suicide debate but clearly stated that nursing participation in assisted suicide is a violation of the Code for Nurses. The ANA position statement further stressed the important role of the nurse in supporting effective symptom management, contributing to the creation of environments for care that honor the patient's and family's wishes, as well as identifying their concerns and fears (ANA, 2013). Per the ANA, "Nurses have an obligation to provide humane, comprehensive, and compassionate care that respects the rights of patients but upholds the standards of the profession in the presence of chronic, debilitating illness and at end-of-life" (ANA, 2013, p. 1).

Similarly, the HPNA favors the value of comprehensive end-of-life care, as opposed to physician-assisted death (HPNA, 2017). The HPNA acknowledges that nurses may care for patients exploring or choosing physician-assisted death and thus concludes that nurses must be able to provide unbiased education yet not take an active role in this end-of-life option. American Academy of Hospice and Palliative Medicine (AAHPM, 2016) has taken a position of "studied neutrality" on assisted death, recommending that clinicians carefully assess the fear and suffering that have led patients to request assisted suicide and to address these without hastening death.

The International Association for Hospice and Palliative Care (IAHPC) released a position statement on euthanasia and PAS, in which they recommend access to palliative care and medication, such as opioids, prior to the legalization of both euthanasia and/or PAS. Further, they recommend that these acts should not be carried out on palliative care units (De Lima, Woodruff, Pettus, et al., 2017).

Voluntary Stopping of Eating and Drinking

Another potential, however quite controversial, option of last resort is voluntary stopping of eating and drinking (VSED) when a person cannot imagine prolonged dying and suffering for a life-limiting illness. Patient inquiry about VSED should be met with thorough assessment of both decisional capacity and presence of mental illness (Quill, Ganzini, Troug, et al., 2018; Wax, An, Koiser, et al., 2018). Aggressive palliative treatments for all types of suffering—physical, psychological, social, spiritual, and existential

—should be explored and offered before pursing VSED. Typically, a person will die 10 to 14 days after starting VSED during which the most distressing symptoms include thirst and delirium (Quill et al., 2018; Wax et al., 2018). Given this expected prognosis, patients may have the opportunity to complete legacy work prior to initiating VSED.

The ANA included VSED in a 2017 position statement on *Nutrition and Hydration at the End of Life* in which the organization upholds respect for autonomy, relief of suffering, and expert care at the end of life. Nurses involved in the care of a patient who self-initiates VSED should support the family while providing expert symptom assessment and management. One example of a patient who may choose to pursue VSED is a patient who has been diagnosed with a progressive disease, such as ALS, and who finds a slow decline intolerable.

COVID-19 Considerations

The coronavirus disease 2019 (COVID-19) pandemic has altered the delivery of palliative and end-of-life care. Patients with severe COVID-19 pneumonia are managed with endotracheal intubation and mechanical ventilation and have a high case fatality rate (see Chapter 19) (Bajwah, Wilcock, Towers, et al., 2020; Richardson, Hirsch, Narasimhan, et al., 2020). Common end-of-life symptoms for those with severe COVID-19 include dyspnea, cough, anxiety, and delirium (Bajwah et al., 2020). During the pandemic, symptom management at the end-of-life has required revisions due to logistical challenges such as medication shortages and preservation of personal protective equipment (Chidiac, Feuer, Naismith, et al., 2020). Due to high risk of infectious transmission, family members may not be permitted to see loved ones at the end-of-life (Richardson et al., 2020; Wakam, Montgomery, Biesterveld, et al., 2020). Furthermore, family meetings are primarily virtual, where proxies must make difficult decisions such as resuscitation and intubation, and even removal of life support (Richardson et al., 2020). Communication guides for proactive goals of care discussions related to possible COVID-19 infection (Back, Tulsky, & Arnold, 2020), recommendations for "webside" manner (Chua, Jackson, & Kamdar, 2020), innovative use of virtual reality to stimulate previously unachieved dreams or allow families to virtually share one last moment together (Wang, Teo, Teo, et al., 2020). Meanwhile, health care providers are struggling from high physical workload demands while simultaneously experiencing moral and psychological distress (Adams & Walls, 2020). Clinicians working with patients with COVID-19 voice concerns about the risk of infecting self and family and stress due to constant change as health care systems evolve to meet patient needs during a pandemic situation (Foxwell, 2020). Health systems have developed innovative processes to support staff at the front lines of

working with patients with COVID-19 and at end-of-life, such as a 24-hour hotlines and pet therapy.

Clinicians' Attitudes toward Death

Clinicians' attitudes toward the terminally ill and dying remain the greatest barrier to improving care at the end-of-life. Kübler-Ross illuminated the concerns of the seriously ill and dying in her seminal work, *On Death and Dying,* first published in 1969. At that time, it was common for patients to be kept uninformed about life-threatening diagnoses, particularly cancer, and for primary providers and nurses to avoid open discussion of death and dying with their patients. Kübler-Ross's work revealed that, given open discussion, adequate time, and some help in working through the process, patients could reach a stage of acceptance in which they were neither angry nor depressed about their fate.

The growth of palliative and hospice care programs has led to greater numbers of health care providers becoming comfortable with and skilled in assessing patients' and families' information needs and disclosing honest information about the seriousness of illness (Brighton & Bristowe, 2016). However, in many settings, clinicians still avoid the topic of death in the hope that patients will ask or find out on their own. Despite progress on many health care fronts, many who work with patients who are seriously ill and dying recognize a persistent conspiracy of silence about dying.

How to communicate truthfully with patients and encourage patient **autonomy** (the right of the person to make choices) in a way that acknowledges where they are on the continuum of acceptance is a challenge. Despite continued reluctance of health care providers to engage in open discussion about end-of-life issues, patients want information about their illness and end-of-life choices and are not harmed by open discussion about death (Hamel, Wu, & Brodie, 2017; The Conversation Project National Survey, 2018). Timing of sensitive discussion takes experience, but speaking the truth can be a relief to patients and families, enhancing their autonomy by making way for truly informed consent as the basis for decision making.

Patient and Family Concerns

Terminal illness is experienced uniquely by each person and their loved ones. Family members are key stakeholders in honoring patients' wishes, caring for patients, and engaging in care planning. Family members are impacted by a loved one's illness and require support throughout the course of caregiving. Recognizing maladaptive coping in family members and providing resources for the family whether through social work staff or palliative care specialists is key to preventing worsening distress at the time of death. Palliative care

interventions have been reported to improve communication, improve person-centeredness and decrease length of ICU stay without significantly impacting caregiver psychological distress (White, Angus, Shields, et al., 2018).

Patient and family awareness of **prognosis** is a key factor in acceptance of and planning for death. For patients who have been informed about terminal illness, their understanding of treatment goals and prognosis is dynamic and may sometimes require reinforcement. Even when patients have been told that the intent of a therapy is palliative, they may think *I'll be the one to beat the odds.* As many as 37% of patients with metastatic cancer receiving palliative therapies misperceive their cancer as potentially curable (Yennurajalingam, Lu, Prado, et al., 2018). Just as patients and families may have differing perspectives on prognosis, they may also have different perceptions of severity of symptoms. Family caregivers tend to report distress and quality of life as worse than patient reports at the end-of-life (Hack, McClement, Chochinov, et al., 2018). This may be due to the family member's distress or anticipatory grief.

Historically, the approach in the United States to serious illness has been described as *death denying*—that is, the health care system has been built on management of acute illness and the use of technology to cure (when possible) and to extend life. As a result, life-threatening illness, life-sustaining treatment decisions, dying, and death occur in a social environment in which illness is largely considered an enemy. Many common expressions reflect this dominant sociocultural view. For example, people talk about the *war* against cancer or *fighting* illness, and when patients choose not to pursue the most aggressive course of medical treatment available, many health care providers and indeed patients and families perceive this as *giving up*. A care/cure dichotomy has persisted in which health care providers may view cure as the ultimate good and care as second best, a good only when cure is no longer possible. In such a model, alleviating suffering is not as valued as curing disease. Patients who cannot be cured feel distanced from the health care team, and when curative treatments have failed, they may feel that they too have failed. Patients and families may fear that any shift from curative goals to comfort-focused care will result in no care or lower-quality care, and that the clinicians on whom they have come to rely will abandon them if they withdraw from a focus on cure.

The statement in late-stage illness that exemplifies this care versus cure dichotomy is *nothing more can be done*. This all-too-frequently used statement communicates the belief of many clinicians that there is nothing of value to offer patients beyond cure; however, in a care-focused perspective, there is always more that can be done. This expanded notion of healing implies that healing can take place throughout life. There are many opportunities for physical, spiritual, emotional, and social healing, even as body systems begin to fail at the end-of-life.

TABLE 13-8 Select Resiliency Skills

Individual Skills	System Level Opportunities
• *Assessing personal strengths* • *Recognizing clinical emotional triggers* • *Applying mindfulness skills at work* • *Establishing health boundaries and reasonable expectations* • *Finding meaning in daily work* • *Continuing to adapt and cultivate resiliency skills*	• *Supporting autonomy* • *Structuring rewards* • *Promoting collaboration among peers and other disciplines* • *Establishing fairness in the workplace* • *Acknowledging that patient-centered care takes time to explore patient's individual values* • *Allowing flexibility*

Adapted from Back, A. L., Stienhauser, K. E., Kamal, A. H., et al. (2017). Why burnout is so hard to fix. *Journal of Oncology Practice*, *13*(6), 348–351.

Professional Caregiver Issues

Issues of importance to professional caregivers include burnout, promoting resiliency, and nurses supporting themselves.

Burnout and Promoting Resiliency

Burnout is defined as the triad of emotional exhaustion, cynicism, and ineffectiveness at work. By the time one notices burnout it is usually too late. In order to prevent burnout, there is a body of work to promote resilience, thereby providing clinicians with the skills needed to have work–life balance and the opportunity to remain productive and satisfied with their career (Back, Steinhauser, Kamal, et al., 2017). See Table 13-8 for select resiliency skills and workplace factors to prevent burnout.

While the prevalence of burnout among nurses working in palliative care and hospice is unknown, researchers have attempted to assess the prevalence of burnout among all clinicians working in palliative care. One study found that physicians were more likely to exhibit signs of burnout; however, factors for both physicians and clinicians from other disciplines (advanced practice provider, nurse, chaplain, social worker) that contributed to burnout are younger age, working weekends or overtime, and feeling isolated (Kamal, Bull, Wolf, et al., 2020). Overall, hospice and palliative clinicians were found to have a burnout rate of approximately 39% (Kamal et al., 2020).

The ANA (2017a) published *A Call to Action: Exploring Moral Resilience toward a Culture of Ethical Practice,* which highlights potential for burnout among nurses and makes recommendations for both individuals and institutions to foster resilience, as well as recommendations for research. This

document also contains a toolkit for resources for the nurse and proposed actions.

Supporting Ourselves

In addition to healthy work environments that promote resiliency, nurses are often encouraged to develop self-care practices. Self-care can be any number of activities or practices that a person maintains while not at work; examples include practicing yoga or meditation, engaging in hobbies, or simply not checking email when away from work. A recent qualitative study found palliative care clinicians (primary providers and nurses) seek practices that promote well-being and allow restoration of self so as to better care for patients (Mills, Wand, & Fraser, 2018). The palliative care clinicians sought meaning through work–life balance and building relationships; they sought self-care during work (such as establishing boundaries, negotiating workload, and reflecting on practice) and outside of work (such as meditation, rest, separating self from work, and positive social relationships) (Mills et al., 2018).

Whether practicing in a trauma center, ICU, or other acute care setting, home care, hospice, long-term care, or the many locations where patients and their families receive ambulatory services, nurses are closely involved with complex and emotionally laden issues surrounding loss of life. To be most effective and satisfied with the care they provide, nurses should attend to their own emotional responses to the losses witnessed every day. In hospice settings, where death, grief, and loss are expected outcomes of patient care, interdisciplinary colleagues rely on one another for support by learning coping skills from one another and speaking about how they were affected by the lives of those patients who have died. In many settings, staff members organize periodic memorial services to support bereaved families and other caregivers, who find comfort in joining one another to remember and celebrate the lives of patients.

CRITICAL THINKING EXERCISES

1 ipc Your patient is a 60-year-old woman with lung cancer who is hospitalized with increasing shortness of breath. She is currently receiving second-line chemotherapy treatment and recently completed palliative radiation to rib metastases. She lives with her husband and has two adult children who live out of state. As you are administering her morning medications, she asks, "Why did God do this to me? What did I do to deserve this?" How will you facilitate an interprofessional discussion to address the patient's spiritual concerns? What members of the interdisciplinary team are essential to include?

2 ebp Your patient is a 52-year-old man with idiopathic pulmonary fibrosis who is being evaluated for a lung transplant. He arrives at the lung transplant clinic with his friend from work. He is a security guard, but has been calling out frequently as he can't make hourly rounds. He lives alone in a two-story home with one bathroom on the second floor. Due to dyspnea on exertion, he has not been able to go upstairs and now sleeps on a recliner and hasn't showered in weeks. He has an estranged daughter whom he has not spoken to in over 10 years. Dyspnea also interferes with his appetite and he has been drinking sports drinks and eats fast food when his friends bring it over. How would you complete an evidence-based symptom assessment? What interventions would you consider to treat his dyspnea based on the evidence?

3 pq You are a new hospice nurse in your third month making home hospice visits. Your patient is a 73-year-old woman who has had multiple strokes. She previously expressed to her family that she would not want to live on prolonged life support. She has four devoted children who have set up a schedule so that someone will be with her 24 hours a day. When you enter the room, the patient is somnolent with periods of apnea. Her daughter at the bedside tells you that her mother was screaming out last night, calling for her parents and trying to get out of bed. The daughter feels that her mother is more comfortable now. She is intermittently tearful as she talks with you. At one point she asks, "Do you think she's angry with us? That must be why she was agitated last night. . . . I knew I shouldn't have listened to my siblings—My mom wants to live!" What stage of dying is this patient experiencing? How would you educate the daughter about stages of dying? How would you assess for bereavement needs?

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*Asterisk indicates nursing research.

**Double asterisk indicates classic reference.

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Resources

American Academy of Hospice and Palliative Medicine (AAHPM), www.aahpm.org
American Hospice Foundation, www.americanhospice.org
Americans for Better Care of the Dying (ABCD), www.abcd-caring.org
Association for Death Education and Counseling (ADEC), www.adec.org/default.aspx
Caring Connections: A program of the National Hospice and Palliative Care Organization, www.caregiver.org/caring-connections-0
Center to Advance Palliative Care (CAPC), www.capc.org
Children's Hospice International (CHI), www.chionline.org
Compassion & Choices, www.compassionandchoices.org
End-of-Life Nursing Education Consortium (ELNEC), www.aacnnursing.org/ELNEC
Family Caregiver Alliance (FCA), www.caregiver.org
Get Palliative Care (Blog and resources for palliative care), www.getpalliativecare.org
Harvard Medical School Center for Palliative Care, Dana Farber Cancer Institute, /pallcare.hms.harvard.edu
Hospice and Palliative Credentialing Center (HPCC), www.advancingexpertcare.org/HPNA/HPNA/About_Us/About.aspx
Hospice and Palliative Nurses Association (HPNA), www.advancingexpertcare.org
Hospice Association of America, http://hospice.nahc.org/
Hospice Compare (Medicare ratings), www.medicare.gov/hospicecompare
Hospice Education Institute, www.guidestar.org/profile/22-2701794
Hospice Foundation of America (HFA), www.hospicefoundation.org
International Association for Hospice & Palliative Care (IAHPC), www.hospicecare.com/home
National Association for Home Care & Hospice, www.nahc.org
National Consensus Project for Quality Palliative Care, www.nationalcoalitionhpc.org/ncp
National Hospice and Palliative Care Organization (NHPCO), www.nhpco.org
National Prison Hospice Association, www.npha.org

Office of End-of-Life and Palliative Care Research (OEPCR), www.ninr.nih.gov/researchandfunding/desp/oepcr
Palliative Care NOW Fast Facts and Concepts, www.mypcnow.org/fast-facts
POLST (Physician Orders for Life-Sustaining Treatment Paradigm), www.polst.org
Promoting Excellence in End-of-Life Care, www.promotingexcellence.org
Supportive Care Coalition, www.supportivecarecoalition.org
TIME: Toolkit of Instruments to Measure End of Life Care (Brown University), www.chcr.brown.edu/pcoc/resourceguide/resourceguide.pdf
We Honor Veterans (Partnership between Veterans Administration and NHPCO), www.wehonorveterans.org
World Health Organization (WHO) Palliative Care, www.who.int/news-room/fact-sheets/detail/palliative-care

UNIT 3 Perioperative Concepts and Nursing Management

Case Study

MAINTAINING A CULTURE OF SAFETY USING THE SURGICAL SAFETY CHECKLIST

A 32-year-old woman is admitted to the hospital with nausea, vomiting, and right upper quadrant pain. She is diagnosed with acute cholecystitis and is scheduled for a laparoscopic procedure to remove her gallbladder. After completing the preoperative procedures and preprocedure verification, the patient is brought to the operating room (OR) where you work. The surgical safety checklist involves members of the team including the surgeon, anesthesia provider, circulating nurse, and OR technician. Prior to induction of anesthesia the team confirms the patient's identity, procedure, and consent. In addition, the incision site is marked, the anesthesia machine and medication check is completed, and the pulse oximeter is placed on the patient and is confirmed to be working. The team also checks if the patient has a known allergy, if there are any airway or aspiration risks, and whether there is risk of a >500 mL blood loss.

QSEN Competency Focus: Safety

The complexities inherent in today's health care system challenge nurses to demonstrate integration of specific interdisciplinary core competencies. These competencies are aimed at ensuring the delivery of safe, quality patient care (Institute of Medicine, 2003). The Quality and Safety Education for Nurses project (Cronenwett, Sherwood, Barnsteiner, et al., 2007; QSEN, 2020) provides a framework for the knowledge, skills, and attitudes (KSAs) required for nurses to demonstrate competency in these key areas, which include ***patient-centered care***, ***interdisciplinary teamwork and collaboration***, ***evidence-based practice***, ***quality improvement***, ***safety***, and ***informatics.***

Safety Definition: Minimizes risk of harm to patients and providers through both system effectiveness and individual performance.

SELECT PRE-LICENSURE KSAs	APPLICATION AND REFLECTION
Knowledge	
Describe factors that create a culture of safety (such as, open communication strategies and organizational error reporting systems)	Describe your role in participating in a surgical safety checklist. Identify the additional checks that need to be conducted before the surgical skin incision is made and further safety measures that must be addressed before the patient leaves the OR to help facilitate a culture of safety.
Skills	
Communicate observations or concerns related to hazards and errors to patients, families, and the health care team	Identify your role in communicating to the members of the OR team important assessments, potential hazards, and errors that may occur because of surgery.
Attitudes	
Value relationship between national safety campaigns and implementation in local practices and practice settings	A goal of the Joint Commission is to ensure the safety of patients by eliminating potential errors. The surgical safety checklist is supported by accrediting bodies such as the Joint Commission and the World Health Organization. What other practices can you implement to ensure safety in the OR setting?

Cronenwett, L., Sherwood, G., Barnsteiner, J., et al. (2007). Quality and safety education for nurses. *Nursing Outlook*, *55*(3), 122–131; Institute of Medicine. (2003). *Health professions education: A bridge to quality*. Washington, DC: National Academies Press; QSEN Institute. (2020). *QSEN competencies: Definitions and pre-licensure KSAs; Safety*. Retrieved on 8/15/2020 at: qsen.org/competencies/pre-licensure-ksas/#safety

14 Preoperative Nursing Management

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Define the phases of perioperative patient care.
2. Perform a comprehensive preoperative assessment to identify pertinent health and surgical risk factors.
3. Describe considerations related to preoperative nursing care of older adult patients, patients with obesity, and patients with disability.
4. Identify the regulatory documents that are required prior to a patient entering surgery.
5. Initiate the immediate preoperative preparation and education of the patient.

NURSING CONCEPTS

Communication
Managing Care
Mobility

GLOSSARY

ambulatory surgery: includes outpatient, same-day, or short-stay surgery that does not require an overnight hospital stay

bariatrics: having to do with patients with obesity

history and physical: mandatory form completed by the surgeon that gives a comprehensive overview of the patient's history, current physical status, and plan of care

informed consent: the patient's autonomous decision about whether to undergo a surgical procedure, based on the nature of the condition, the treatment options, and the risks and benefits involved

intraoperative phase: period of time that begins with transfer of the patient to the operating room area and continues until the patient is admitted to the postanesthesia care unit

minimally invasive surgery: surgical procedures that use specialized instruments inserted into the body either through natural orifices or through small incisions

perioperative phase: period of time that constitutes the surgical experience; includes the preoperative, intraoperative, and postoperative phases of nursing care

postoperative phase: period of time that begins with the admission of the patient to the postanesthesia care unit and ends after follow-up evaluation in the clinical setting or home

preadmission testing: diagnostic testing performed before admission to the hospital

preoperative phase: period of time from when the decision for surgical intervention is made to when the patient is transferred to the operating room table

As techniques to perform surgery have evolved with improved technology and expertise, surgery has become less invasive and less debilitating. The increased use of **minimally invasive surgery** (procedures that use specialized instruments inserted into the body either through natural orifices or through small incisions) enables many procedures to be performed on an outpatient basis. Surgery remains a complex, stressful experience, whether minimally invasive, elective, or emergent. Even healthy patients having elective outpatient surgery may experience unanticipated complications during otherwise benign procedures. Many patients enter the hospital 90 minutes prior to surgery and have necessary medical assessments and analyses preceding the surgical intervention. The surgery is followed by a recovery period in the postanesthesia care unit (PACU). Later that day the patient goes home. When comorbidities exist or procedures are more complex, the patient may have laboratory studies completed prior to admission, and may be admitted to the hospital for postoperative recovery.

Traumatic and emergency surgery most often results in prolonged hospital stays. Patients who are acutely ill or undergoing major surgery and patients with concurrent medical disorders may require supportive supplementary care from other medical disciplines, which can be coordinated more easily within the hospital setting. The high acuity level of surgical inpatients and the greater complexity of procedures have placed greater demands on the practice of nursing in this setting.

Although each setting (ambulatory, outpatient, or inpatient) offers its own unique advantages for the delivery of patient care, all patients require a comprehensive preoperative nursing assessment, patient education, and nursing interventions to prepare for surgery.

Perioperative Nursing

Communication, teamwork, and patient assessment are crucial to ensure good patient outcomes in the perioperative setting. Professional perioperative and perianesthesia nursing standards encompass the domains of behavioral response, physiologic response, and patient safety and are used as guides toward development of nursing diagnoses, interventions, and plans. Perioperative nursing, which spans the entire surgical experience, consists of three phases that begin and end at particular points in the sequence of surgical experience events. The **preoperative phase** begins when the decision to proceed with surgical intervention is made and ends with the transfer of the patient onto the operating room (OR) bed. The **intraoperative phase** begins when the patient is transferred onto the OR bed and ends with admission to the PACU. Intraoperative nursing responsibilities involve acting as scrub nurse, circulating nurse, or registered nurse first assistant (see Chapter 15 for the description of these roles). The **postoperative phase** begins with the admission of the patient to the PACU and ends with a follow-up evaluation in the clinical setting or home (see Chapter 16).

Each **perioperative phase** includes the many diverse activities a nurse performs, using the nursing process, and is based on the recommended practice standards of the Association of periOperative Registered Nurses (AORN), formerly known as the Association of Operating Room Nurses (AORN, 2019) and the American Society of PeriAnesthesia Nurses (ASPAN, 2019). Chart 14-1 presents examples of nursing activities characteristic of the three perioperative phases of care. The phases of the surgical experience are reviewed in more detail in this chapter and in the other chapters in this unit.

A conceptual model of patient care, published by AORN, helps delineate the relationships between various components of nursing practice and patient outcomes into four domains: safety, physiologic responses, behavioral responses, and health care systems. The first three domains reflect phenomena

of concern to perioperative nurses and are composed of nursing diagnoses, interventions, and outcomes. The fourth domain—the health care system—consists of structural data elements and focuses on clinical processes and outcomes. The model is used to depict the relationship of nursing process components to the achievement of optimal patient outcomes (Rothrock, 2019).

Advances in Surgical and Anesthesia Approaches

Technologic advancements continue to lead health care industry providers toward performing more complex procedures that are less invasive, and therefore cause less morbidity during the recovery phase of surgery (Rothrock, 2019). Minimally invasive and robotic surgeries are continuing to replace traditional surgical procedures. Advancements in surgical technology allow for shorter hospital stays and promote patient comfort (Sadler, 2017).

The fastest growing trend in recent years is the use of robotic surgery (see Fig. 14-1). Robotic surgery offers many advantages over laparoscopic surgery including more precise accuracy for dissecting and suturing, better range of motion of the instruments, enhanced ability to access deep structures, and attain three-dimensional visual feedback (Rothrock, 2019). Robotic surgery is used in a wide variety of surgical specialties such as cardiac; gastrointestinal; urologic; gynecologic; ear, nose, and throat (ENT); thoracic; and orthopedic.

Enhanced anesthesia methodology complements advances in surgical technology. Modern methods of achieving airway patency, sophisticated monitoring devices, and new pharmacologic agents, such as short-acting anesthetics, have created a safer atmosphere in which to operate. Effective antiemetics have reduced postoperative nausea and vomiting (PONV). Improved postoperative pain management and shortened procedure and recovery times have improved the operative experience for surgical patients.

Surgical Classifications

The decision to perform surgery may be based on facilitating a diagnosis (a diagnostic procedure such as biopsy, exploratory laparotomy, or laparoscopy), a cure (e.g., excision of a tumor or an inflamed appendix), or repair (e.g., multiple wound repair). It may be reconstructive or cosmetic (such as mammoplasty or a facelift) or palliative (to relieve pain or correct a problem—such as debulking a tumor to achieve comfort, or removal of a dysfunctional gallbladder). In addition, surgery might be rehabilitative (e.g., total joint replacement surgery to correct crippling pain or progression of degenerative osteoarthritis). Surgery can also be classified based upon the degree of urgency involved: emergent, urgent, required, elective, and optional (see Table 14-1).

Preadmission Testing

Concurrent with the increase in **ambulatory surgeries** (surgery that does not require an overnight hospital stay) have been changes in the delivery of and payment for health care. Incentives to reduce hospital stays and contain costs have resulted in diagnostic **preadmission testing** (PAT) and preoperative preparation prior to admission. Many facilities have a presurgical services department to facilitate PAT and to initiate the nursing assessment process, which focuses on admission data such as patient demographics, health history, and other information pertinent to the surgical procedure (i.e., appropriate consent forms, diagnostic and laboratory tests) (Rothrock, 2019). During the PAT visit, patients learn what to expect on the day of surgery and receive answers to questions they may have. Nurses in the PAT department are responsible for communicating information related to the surgical procedure and the effect that the surgical procedure and anesthetic may have on the patient's health status, functional status, and family dynamics (Malley, Kenner, Kim, et al., 2015).

Chart 14-1

Examples of Nursing Activities in the Perioperative Phases of Care

Preoperative Phase

Preadmission Testing

1. Performs initial preoperative assessment
2. Initiates education appropriate to patient's needs
3. Involves family in interview
4. Verifies completion of preoperative diagnostic testing according to patient's needs
5. Confirms understanding of surgeon-specific preoperative prescribed therapies (e.g., bowel preparation, preoperative shower)
6. Discusses and reviews advance directive document
7. Begins discharge planning by assessing patient's need for postoperative transportation and care

Admission to Surgical Center

1. Completes preoperative assessment
2. Assesses for risks for postoperative complications
3. Reports unexpected findings or any deviations from normal
4. Verifies that operative consent has been signed
5. Coordinates patient education and plan of care with nursing staff and other health team members
6. Reinforces previous education
7. Explains phases in perioperative period and expectations
8. Answers patient's and family's questions

In the Preoperative Area

1. Identifies patient
2. Assesses patient's physical and emotional status, baseline pain, and nutritional status
3. Reviews medical record
4. Verifies surgical site and that it has been marked per institutional policy
5. Establishes IV line
6. Administers medications if prescribed
7. Takes measures to ensure patient's comfort
8. Provides psychological support
9. Communicates patient and family's needs to other appropriate members of the health care team

Intraoperative Phase

Maintenance of Safety

1. Maintains aseptic, controlled environment

2. Effectively manages human resources, equipment, and supplies for individualized patient care
3. Transfers patient to operating room bed or table
4. Positions patient based on functional alignment and exposure of surgical site
5. Applies grounding device to patient
6. Ensures that the sponge, needle, and instrument counts are correct
7. Completes intraoperative documentation

Physiologic Monitoring

1. Communicates amount of fluid instillation and blood loss
2. Distinguishes normal from abnormal cardiovascular data
3. Reports changes in patient's vital signs
4. Institutes measures to promote normothermia

Psychological Support (Before Induction and When Patient is Conscious)

1. Provides emotional support to patient
2. Stands near or touches patient during procedures and induction
3. Continues to assess patient's emotional status
4. Notifies the patient's family or significant others of updates throughout the procedure

Postoperative Phase

Transfer of Patient to Postanesthesia Care Unit

1. Communicates intraoperative information:
   a. Identifies patient by name
   b. States type of surgery performed
   c. Identifies type and amounts of anesthetic and analgesic agents used
   d. Reports patient's vital signs and response to surgical procedure and anesthesia
   e. Describes intraoperative factors (e.g., insertion of drains or catheters, administration of blood, medications during surgery, or occurrence of unexpected events)
   f. Describes physical limitations
   g. Reports patient's preoperative level of consciousness
   h. Communicates necessary equipment needs
   i. Communicates presence of family or significant others

Postoperative Assessment Recovery Area

1. Determines patient's immediate response to surgical intervention
2. Monitors patient's vital signs and physiologic status
3. Assesses patient's pain level and administers appropriate pain-relief measures
4. Maintains patient's safety (airway, circulation, prevention of injury)

5. Administers medications, fluid, and blood component therapy, if prescribed
6. Provides oral fluids if prescribed for ambulatory surgery patient
7. Assesses patient's readiness for transfer to inhospital unit or for discharge home based on institutional policy (e.g., Aldrete score, see Chapter 16)

Surgical Nursing Unit

1. Continues close monitoring of patient's physical and psychological response to surgical intervention
2. Assesses patient's pain level and administers appropriate pain-relief measures
3. Provides education to patient during immediate recovery period
4. Assists patient in recovery and preparation for discharge home
5. Determines patient's psychological status
6. Assists with discharge planning

Home or Clinic

1. Provides follow-up care during office or clinic visit or by telephone contact
2. Reinforces previous education and answers patient's and family's questions about surgery and follow-up care
3. Assesses patient's response to surgery and anesthesia and their effects on body image and function
4. Determines family's perception of surgery and its outcome

Figure 14-1 • The daVinci surgical system. Reprinted with permission from ©2022 Intuitive Surgical, Inc.

Special Considerations during the Perioperative Period

In an effort to reduce surgical complications, The Joint Commission and the Centers for Medicare and Medicaid Services (CMS) developed National Patient Safety Goals. The goals are updated yearly and identify performance measures aimed at preventing surgical complications, including venous thromboembolism (VTE), surgical site infections (SSIs), and wrong-site surgery related to positive patient identification (Joint Commission, 2019). On the day of surgery, the preoperative nurse should verify the list of home medications with the patient and, if applicable, confirm which medications the patient discontinued and when they were last taken. This information assists providers in understanding the patient's medical conditions and helps to avoid medication interactions between what patients take at home and what is administered to them during surgery (Ubaldi, 2019). For example, particular beta-blockers taken within 24 hours of surgery are associated with improved perioperative cardiovascular outcomes. If the patient has not taken the usual dosage of this medication, the anesthesiologist or certified registered nurse anesthetist (CRNA) must evaluate whether or not it should be administered prior to surgery or during the perioperative period. The nurse in the perioperative area needs to be alert for appropriate preoperative prescriptions aimed at preventing VTE and SSIs. If these prescriptions are not present, they should be requested so that appropriate treatment begins before the start of surgery.

TABLE 14-1 Categories of Surgery Based on Urgency

Classification	Indications for Surgery	Examples
I. Emergent—Patient requires immediate attention; disorder may be life-threatening	Without delay	Severe bleeding Bladder or intestinal obstruction Fractured skull Gunshot or stab wounds Extensive burns
II. Urgent—Patient requires prompt attention	Within 24–30 h	Closed fractures Infected wound exploration/irrigation
III. Required—Patient needs to have surgery	Plan within a few weeks or months	Prostatic hyperplasia Thyroid disorders Cataracts
IV. Elective—Patient should have surgery	Failure to have surgery not catastrophic	Repair of scars Simple hernia Vaginal repair
V. Optional—Decision rests with patient	Personal preference	Cosmetic surgery

Gerontologic Considerations

The hazards of surgery for older adults are proportional to the number and severity of comorbidities and the nature and duration of the operative procedure. Anesthesia associated with these surgeries can precipitate the dysregulation of older adult physiology. Identification of at-risk older adult patients is important in determining the appropriate operative risk and management (Vernon, Rice, Titch, et al., 2019). Cardiac reserves are lower, renal and hepatic functions are depressed, and gastrointestinal activity is likely to be reduced. Therefore, a comprehensive assessment that focuses on the cardiovascular, respiratory, and renal systems may help improve immediate perioperative outcomes (Odom-Forren, 2018). See Chapter 8, Table 8-1 for additional age-related changes.

In the preoperative period, the nurse pays careful attention to the integumentary system of the patient as it can reveal pertinent data about the patient's health status. Assessment includes the overall condition of the skin, and determination of any bruises, abrasions, and discolorations (Phillips, 2017). Precautions are taken when moving an older adult. Decreased subcutaneous fat makes older adults more susceptible to temperature changes. A lightweight cotton blanket is an appropriate cover when an older patient is moved to and from the OR but never replaces asking patients if they feel sufficiently warm and attending to their needs.

The older adult is at a higher risk of cardiovascular complications. Of all the body systems, the cardiovascular system exerts the most influence on anesthesia. The older adult patient usually has decreased or slow circulation to the rest of the body. A preoperative assessment, including blood tests, blood pressure, and EKG, can identify potential risks including anemia, hypertension, and arrhythmias (Phillips, 2017).

In addition to physical risks, the older adult should be assessed for poor memory and cognition. When older adults are in a vulnerable and stressful state, such as preparing for surgery, they may show poor concentration, confusion, and disorganized thought patterns (Odom-Forren, 2018). Nurses must educate patients and caregivers about appropriate pain management and encourage good communication to obtain greater postoperative pain relief. Older adults may need multiple education formats (verbal and print) along with extra time in order to understand and retain what is communicated (see Providing Patient Education section).

Bariatric Patients

Bariatrics is a specialty that revolves around diagnosing, treating, and managing patients with obesity. The prevalence of obesity is approximately

39.8% and affects about 93.3 million adults in the United States (Centers for Disease Control and Prevention [CDC], 2018). Obesity increases the risk and severity of complications associated with surgery. Preoperative assessment of the patient with obesity should pay careful attention to pulmonary, cardiovascular, psychological, and integumentary systems.

Patients with obesity have more subcutaneous fat. The increase in adipose tissue can result in difficult intravenous (IV) access and delayed wound healing at the incision site (Odom-Forren, 2018). Obesity is also associated with increased SSIs and joint replacement failure. Patients with a body mass index (BMI) of greater than 45 are at a significantly increased risk for total joint replacement failure and postoperative infection (Boudreaux & Simmons, 2019).

The patient with obesity tends to have shallow respirations when supine, increasing the risk of hypoventilation and postoperative pulmonary complications. Additionally, diagnosed and undiagnosed obstructive sleep apnea (OSA) is common among patients with obesity. Since these apnea and hypopnea events occur during sleep, most patients with OSA may not be aware that they have the condition. It has been estimated that up to 80% of individuals with moderate to severe OSA may remain undiagnosed and untreated (Chung, Abdullah, & Liao, 2016). Positive identification of OSA and OSA risks can dramatically reduce intubation and postoperative complications (see Chapter 18).

Patients with Disability

Special considerations for patients with mental or physical disability include the need for appropriate assistive devices, modifications in preoperative education, and additional assistance with and attention to positioning or transferring. Assistive devices include hearing aids, eyeglasses, braces, prostheses, and other devices. People who are hearing impaired may need and are entitled by law to a sign interpreter or some alternative communication system perioperatively. If the patient relies on signing or speech (lip) reading and their eyeglasses or contact lenses are removed or the health care staff wears surgical masks, an alternative method of communication will be needed. These needs must be identified in the preoperative evaluation and clearly communicated to personnel. Specific strategies for accommodating the patient's needs must be identified in advance. Ensuring the security of assistive devices is important, because these devices are expensive and require time to replace if lost.

Nurses in the preoperative area report that patients with mobility limitations have difficulty transferring from a standing position to the transport gurney and then, once on the gurney, to reposition themselves (Link, 2018). Therefore, the surgical team should incorporate a plan of care that ensures safe patient

movement and handling. The patient with a disability that affects body position (e.g., cerebral palsy, postpolio syndrome, and other neuromuscular disorders) may need special positioning during surgery to prevent pain and injury. Patients with disability may be unable to sense painful positioning if their extremities are incorrectly adjusted, or they may be unable to communicate their discomfort. A comprehensive care plan should be developed preoperatively addressing the type of disability and patient specific needs.

Patients with respiratory problems related to a disability (e.g., multiple sclerosis, muscular dystrophy) may experience difficulties unless the problems are made known to the anesthesiologist or CRNA and adjustments are made (Barash, Cullen, Stoelting, et al., 2017). These factors need to be clearly identified in the preoperative period and communicated to the appropriate personnel.

Patients Undergoing Ambulatory Surgery

Ambulatory surgery includes outpatient, same-day, or short-stay surgery not requiring admission for an overnight hospital stay but may entail observation in a hospital setting for 23 hours or less. During the brief time the patient and family spend in the ambulatory setting, the nurse must quickly and comprehensively assess and anticipate the needs of the patient and at the same time begin planning for discharge and follow-up home care.

The nurse needs to be sure that the patient and family understand that the patient will first go to the preoperative area before going to the OR for the surgical procedure and then will spend some time in the PACU before being discharged home with the family member later that day. Other preoperative education content should also be verified and reinforced as needed (see later discussion). The nurse should ensure that any plans for follow-up home care or new assistive devices are in place if needed.

Patients Undergoing Emergency Surgery

Emergency surgeries are unplanned and occur with little time for preparation of the patient or the perioperative team. The unpredictable nature of trauma and emergency surgery poses unique challenges throughout the perioperative period. It is important for the nurse to communicate with the patient and team members as calmly and effectively as possible in these situations. (See Chapter 15 for the duties of the members of the perioperative team.)

Factors that affect patients preparing to undergo surgery also apply to patients undergoing emergency surgery, although usually in a very condensed time frame. The only opportunity for preoperative assessment may take place at the same time as resuscitation in the emergency department. A quick visual

survey of the patient is essential to identify all sites of injury if the emergency surgery is due to trauma (see Chapter 67 for more information). The patient, who may have undergone a traumatic experience, may need extra support and explanation of the surgery. For the patient who is unconscious, essential information, such as pertinent past medical history and allergies, need to be obtained from a family member, if one is available.

Required Preoperative Documents

Informed consent is the patient's autonomous decision about whether to undergo a surgical procedure. Voluntary and written informed consent from the patient is necessary before nonemergent surgery can be performed to protect the patient from unsanctioned surgery and protect the surgeon from claims of an unauthorized operation or battery. Consent is a legal mandate, but it also helps the patient to prepare psychologically, because it helps to ensure that the patient understands the surgery to be performed (Rothrock, 2019).

It is the surgeon's and the anesthesiologist's responsibility to provide a clear and simple explanation of what the surgery will entail prior to the patient giving consent. The surgeon must also inform the patient of the benefits, alternatives, possible risks, complications, disfigurement, disability, and removal of body parts as well as what to expect in the early and late postoperative periods. The nurse clarifies the information provided, verifies the presence of the patient's or designee's signature, and may be asked to sign as a witness. If at any point the patient requests additional information, or if the nurse feels that the patient may not understand, the nurse notifies the physician. The nurse ascertains that the consent form has been signed before administering psychoactive premedication, because consent is not valid if it is obtained while the patient is under the influence of medications that can affect judgment and decision making capacity.

Quality and Safety Nursing Alert

Any signed form required for surgery is placed in a prominent place on the patient's medical record and accompanies the patient to the OR.

Many ethical principles are integral to informed consent. Informed consent is necessary in the following circumstances:

- Invasive procedures, such as a surgical incision, a biopsy, a cystoscopy, or paracentesis

- Procedures requiring sedation or anesthesia (see Chapter 15 for a discussion of anesthesia)
- A nonsurgical procedure, such as an arteriography, that carries more than a slight risk to the patient
- Procedures involving radiation
- Blood product administration

The patient personally signs the consent if of legal age and mentally capable. Permission is otherwise obtained from a surrogate, who most often is a responsible family member (preferably next of kin) or legal guardian (see Chart 14-2 for criteria for valid informed consent). State regulations and agency policy must be followed. In an emergency, it may be necessary for the surgeon to operate as a lifesaving measure without the patient's informed consent. However, every effort must be made to contact the patient's family. In such a situation, contact can be made by telephone, fax, or other electronic means and consent obtained.

Chart 14-2

Valid Informed Consent

Voluntary Consent

Valid consent must be freely given, without coercion. Patient must be at least 18 years of age (unless an emancipated minor), a physician must obtain consent, and a professional staff member must witness patient's signature.

Patient Who Is Incompetent

Legal definition: individual who is *not* autonomous and cannot give or withhold consent (e.g., individuals who are cognitively impaired, mentally ill, or neurologically incapacitated).

Informed Subject

Informed consent should be in writing. It should contain the following:

- Explanation of procedure and its risks
- Description of benefits and alternatives
- An offer to answer questions about procedure
- Instructions that the patient may withdraw consent
- A statement informing the patient if the protocol differs from customary procedure

Patient Able to Comprehend

If the patient is non-English speaking, it is necessary to provide consent (written and verbal) in a language that is understandable to the patient. A trained medical interpreter may be consulted. Alternative formats of communication (e.g., Braille, large print, sign interpreter) may be needed if the patient has a disability that affects vision or hearing. Questions must be answered to facilitate comprehension if material is confusing.

If the patient has doubts and has not had the opportunity to investigate alternative treatments, a second opinion may be requested. No patient should be urged or coerced to give informed consent. Refusing to undergo a surgical procedure is a person's legal right and privilege. Such information must be documented and relayed to the surgeon so that other arrangements can be made. Additional explanations may be provided to the patient and family, or the surgery may be rescheduled. Consents for specific procedures such as sterilization, therapeutic abortion, disposal of severed body parts, organ donation, and blood product administration provide additional protection for the patient (Rothrock, 2019). States and regions may vary in their mandates.

Discussion with patients and their family members may be supplemented with audiovisual materials. Consent forms should be written in easily understandable words and concepts to facilitate the consent process and should use other strategies and resources as needed to help the patient understand the

content (see Chart 14-2). Asking patients to describe in their own words the surgery they are about to have promotes nurses' understanding of patients' comprehension.

A completed, updated and signed **History and Physical** must be present prior to the patient entering the OR. Not more than 30 days before the date of the scheduled surgery, each patient must have a comprehensive medical history and physical assessment. The primary provider is required to update the form within 24 hours of scheduled surgery on all non-inpatient clients (Joint Commission, 2019). The History and Physical consists of the history of present illness; surgical, medical, social, and family histories; allergies; current medications; and plan of care. It is the surgical team's responsibility to make sure the presence of these forms and all other supporting documentation (medication reconciliation, Power of Attorney form, etc.) are current and accurate in the preoperative area.

Preoperative Assessment

The goal in the preoperative period is for the patient to be as healthy as possible. Every attempt is made to assess for and address risk factors that may contribute to postoperative complications and delay recovery (see Chart 14-3). The preoperative assessment provides information regarding underlying conditions that may affect the patient's response to surgery techniques and anesthesia (AORN, 2019). During the physical examination, many factors that have the potential to affect the patient undergoing surgery are considered, such as joint mobility. Genetic considerations are also taken into account during assessment to prevent complications with anesthesia (see Chart 14-4).

Chart 14-3 **SELECT RISK FACTORS**

Surgical Complications

- Arthritis
- Cardiovascular disease:
  - Coronary artery disease or previous myocardial infarction
  - Cardiac failure
  - Cerebrovascular disease
  - Arrhythmias
  - Hemorrhagic disorders
  - Hypertension
  - Prosthetic heart valve
  - Venous thromboembolism (VTE)
- Dehydration or electrolyte imbalance
- Endocrine dysfunction:
  - Adrenal disorders
  - Diabetes
  - Thyroid malfunction
- Extremes of age (very young, very old)
- Extremes of weight (underweight, obese)
- Hepatic disease:
  - Cirrhosis
  - Hepatitis
- Hypovolemia
- Immunologic abnormalities
- Infection and sepsis
- Low socioeconomic status
- Medications
- Nicotine use
- Nutritional deficits
- Pregnancy:
  - Diminished maternal physiologic reserve
- Preexisting cognitive, developmental, intellectual, physical, or sensory disability
- Pulmonary disease:
  - Obstructive disease
  - Restrictive disorder
  - Respiratory infection
- Renal or urinary tract disease:
  - Decreased kidney function
  - Urinary tract infection
  - Obstruction
  - Toxic conditions

Asking the patient about use of prescription and over-the-counter (OTC) medications, including herbal and other supplements, provides useful information. Activity and functional levels should be determined, including that involving regular aerobic exercise. Known allergies and sensitivities to drugs, foods, adhesives, and latex could avert an anaphylactic response (Barash et al., 2017). Patients may have early manifestations of a latex allergy and be unaware of this. If a patient states that he or she is allergic to kiwi, avocado, or banana, or cannot blow up balloons, there may be an association with an allergy to latex.

The patient should be assessed for latex allergy and sensitivities. Latex is found in some food (such as bananas and kiwi) as well as in some hospital materials and equipment. Most hospital products today are latex-free, especially in ORs; however, special precautions are still taken to eliminate the risk of exposure to the patient. These precautions include thorough cleaning of the surgical areas between cases, awareness of allergy among surgical team members, ensuring the materials used are latex-free, and eliminating the use of latex powdered gloves during the case (Mendez, Martinez, Lopez, et al., 2018).

Quality and Safety Nursing Alert

A latex allergy can manifest as a rash, asthma, or anaphylactic shock.

The preoperative assessment should pay attention to the possible presence of undiagnosed OSA. The STOP-Bang is one assessment that may be performed (*S*noring, *T*ired, *O*bserved, *P*ressure, *B*MI, *A*ge, *N*eck, *G*ender) to assess for the presence of OSA (Chung et al., 2016).

Health care providers also should be alert for signs of interpersonal violence, including intimate partner violence, which can occur at any age, in either sex, and in any socioeconomic, ethnic, and cultural group. Findings need to be reported accordingly (see Chapter 4 for further discussion of signs of interpersonal violence). Laboratory tests and other diagnostic tests are prescribed when indicated by information obtained from the history and physical examination. Autologous blood donation or patient self-donation is discussed as needed for the type of surgical procedure planned. See Chapter 28 for further discussion of autologous blood donation.

Nutritional and Fluid Status

Optimal nutrition is an essential factor in promoting healing and resisting infection and other surgical complications. Assessment of a patient's nutritional status identifies factors that can affect the patient's surgical course, such as obesity, weight loss, malnutrition, deficiencies in specific nutrients, metabolic abnormalities, and the effects of medications on nutrition. Nutritional needs may be determined by measurement of BMI and waist circumference. (See Chapter 4 for further discussion of nutritional assessment.)

Any nutritional deficiency should be corrected before surgery to provide adequate protein for tissue repair. The nutrients needed for wound healing are summarized in Table 14-2.

Assessment of a patient's hydration status is also essential. The patient's NPO (Nothing by Mouth or *nil per os*) status should be confirmed preoperatively. Preoperative fasting helps prevent the risk of aspiration but it also induces stress on the body, including the loss of glycogen stores, and the body sacrifices lean muscle to meet the energy needs of the surgery. This may lead to dehydration, which may be exhibited day of surgery by low blood pressure or blood tests revealing fluid and electrolyte imbalances. The depletion of fluids and electrolytes following bowel preparation, especially when combined with prolonged fasting, can result in dehydration and chemical imbalances, even among healthy surgical patients.

Chart 14-4 **GENETICS IN NURSING PRACTICE**

Genetics Concepts and Perioperative Nursing

Nurses who are caring for patients undergoing surgery need to take various genetic considerations into account when assessing patients throughout the operative experience. Genetic disorders can impact pre-, intra-, and postoperative surgical outcomes. In particular, consideration must be given to genetic disorders associated with the delivery of anesthesia as well as other genetic disorders that may increase the risk of postoperative complications. Examples of genetic conditions that may cause complications with anesthesia include the following:

Autosomal Dominant

- Central core disease
- Hyperkalemic periodic paralysis
- Malignant hyperthermia

Examples of other genetic conditions that must be evaluated and are associated with perioperative risks include the following:

- Cystic fibrosis (autosomal recessive)
- Duchenne muscular dystrophy (X-linked recessive)
- Ehlers–Danlos syndrome
- Factor V Leiden (autosomal dominant)
- Hemophilia (X-linked)
- Scleroderma

Nursing Assessments

Refer to Chapter 4, Chart 4-2: Genetics in Nursing Practice: Genetic Aspects of Health Assessment

Family History Assessment Specific to Genetics and Perioperative Nursing

- Obtain a thorough assessment of personal and family history for three generations, inquiring about prior problems with surgery or anesthesia with specific attention to complications, such as fever, rigidity, dark urine, and unexpected reactions.
- Inquire about any history of musculoskeletal complaints, history of heat intolerance, fevers of unknown origin, or unusual drug reactions.
- Assess for family history of any sudden or unexplained death, especially during participation in athletic events.
- Assess whether any family members have been diagnosed with King–Denborough syndrome, as this is a form of congenital myopathy that places the patient at risk for malignant hyperthermia.

Patient Assessment Specific to Genetics and Perioperative Nursing

- Identify the presence of other inherited genetic disorders that may impact surgical outcomes (e.g., inherited connective tissue, metabolic, bleeding, or neurologic disorders).

- Assess for subclinical muscle weakness.
- Assess for other physical features suggestive of an underlying genetic condition, such as contractures, kyphoscoliosis, and pterygium with progressive weakness.

Management Issues Specific to Genetics and Perioperative Nursing

- Inquire as to whether DNA mutation or other genetic testing has been performed on an affected family member.
- If indicated, refer for further genetic counseling and evaluation so that family members can discuss inheritance, risk to other family members, and availability of diagnostic/genetic testing.
- Provide support to families of patients with newly diagnosed malignant hyperthermia.
- Participate in management and coordination of care of patients with genetic conditions and individuals predisposed to develop or pass on a genetic condition.

Genetics Resources

Malignant Hyperthermia Association, www.mhaus.org

See Chapter 6, Chart 6-7: Components of Genetic Counseling for genetics resources.

Dentition

The condition of the mouth is an important health factor to assess. Dental caries, dentures, and partial plates are particularly significant to the anesthesiologist or CRNA, because decayed teeth or dental prostheses may become dislodged during intubation and occlude the airway. This is especially important for older patients as well as those who may not have regular dental care. The condition of the mouth is also important because any bodily infection, even in the mouth, can be a source of postoperative infection.

Drug or Alcohol Use

Excessive alcohol consumption can cause arrhythmias, infections, and withdrawal. These factors can lead to extended hospital stays and increased complications. Identifying patients who have excessive alcohol use presurgically and implementing interventions can reduce the incidence of complications by about 50% (Cuomo, Abate, Springer, et al., 2018). In addition, the use of illicit drugs and alcohol may impede the effectiveness of some medications. Because acutely intoxicated people are susceptible to injury, surgery is postponed if possible. If surgery is required, local, spinal, or regional block anesthesia is used for minor surgery (Norris, 2019). In an

emergency, to prevent vomiting and potential aspiration, a nasogastric tube is inserted before general anesthesia is given.

The person with a history of alcohol abuse often suffers from malnutrition and other systemic problems or metabolic imbalances that increase surgical risk. People who have a substance abuse problem may deny or attempt to hide it. In such situations, the nurse who is obtaining the patient's health history needs to ask frank questions with patience, care, and a nonjudgmental attitude. Such questions should include asking whether the patient has had two drinks per day or more on a regular basis in the 2 weeks prior to surgery (see Chapter 4 for an assessment of alcohol and drug use).

TABLE 14-2 Nutrients Important for Wound Healing

Nutrient	Rationale for Increased Need	Possible Deficiency Outcome
Protein	Allows collagen deposition and wound healing to occur	Collagen deposition leading to impaired/delayed wound healing Decreased skin and wound strength Increased wound infection rates
Arginine (amino acid)	Provides necessary substrate for collagen synthesis and nitric oxide (crucial for wound healing) at wound site Increases wound strength and collagen deposition Stimulates T-cell response Associated with various essential reactions of intermediary metabolism	Impaired wound healing
Carbohydrates and fats	Primary source of energy in the body and consequently in the wound-healing process Meets demand for increased essential fatty acids needed for cellular function after an injury Spares protein Restores normal weight	Signs and symptoms of protein deficiency due to the use of protein to meet energy requirements Extensive weight loss
Water	Replaces fluid lost through vomiting, hemorrhage, exudates, fever, drainage, diuresis Helps maintain homeostasis	Signs, symptoms, and complications of dehydration, such as poor skin turgor, dry mucous membranes, oliguria, anuria, weight loss, increased pulse rate, decreased central venous pressure
Vitamin C	Important for capillary formation, tissue synthesis, and wound healing through collagen formation Needed for antibody formation	Impaired/delayed wound healing related to impaired collagen formation and increased capillary fragility and permeability Increased risk for infection related to decreased antibodies
Vitamin B complex	Indirect role in wound healing through their influence on host resistance	Decreased enzymes available for energy metabolism

Vitamin A	Increases inflammatory response in wounds, reduces anti-inflammatory effects of corticosteroids on wound healing	Impaired/delayed wound healing related to decreased collagen synthesis; impaired immune function Increased risk for infection
Vitamin K	Important for normal blood clotting Impaired intestinal synthesis associated with the use of antibiotics	Prolonged prothrombin time Hematomas contributing to impaired healing and predisposition to wound infections
Magnesium	Essential cofactor for many enzymes that are involved in the process of protein synthesis and wound repair	Impaired/delayed wound healing (impaired collagen production)
Copper	Required cofactor in the development of connective tissue	Impaired wound healing
Zinc	Involved in DNA synthesis, protein synthesis, cellular proliferation needed for wound healing Essential to immune function	Impaired immune response

DNA, deoxyribonucleic acid.

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Respiratory Status

The patient is educated about breathing exercises and the use of an incentive spirometer, if indicated, to achieve optimal respiratory function prior to surgery. The potential compromise of ventilation during all phases of surgical treatment necessitates a proactive response to respiratory infections. Surgery is usually postponed for elective cases if the patient has a respiratory infection. Patients with underlying respiratory disease (e.g., asthma, chronic obstructive pulmonary disease) are assessed carefully for current threats to their pulmonary status.

Preoperative smoking cessation interventions can be effective in changing smoking behavior and reducing the incidence of postoperative complications. Patients who smoke are more likely to experience poor wound healing, a higher incidence of SSI, and complications that include VTE and pneumonia.

During the preoperative assessment, patients should be asked about current and previous tobacco use. The PAT visit is an optimal time to advocate for smoking cessation (Cuomo et al., 2018). Patients undergoing elective cases may have their surgery delayed or cancelled due to the potential complications associated with smoking. Those at highest risk of complications are patients scheduled to receive artificial implants such as grafts, total joint replacements, or breast enhancements (Devlin & Smeltzer, 2017).

Cardiovascular Status

Patient preparation for surgical intervention includes ensuring that the cardiovascular system can support the oxygen, fluid, and nutritional needs of the perioperative period. Patients are assessed for cardiac comorbidities including congestive heart failure, shortness of breath upon movement, and arrhythmias (Clifford, 2018). Preoperatively, patients may receive a chest x-ray and electrocardiogram (ECG) to rule out any undiagnosed cardiac condition. Before surgery, the patient's baseline vital signs and blood pressure are taken. In elective situations, surgery may be postponed if there is evidence of cardiac decomposition or unexplained elevated blood pressure (Phillips, 2017).

Hepatic and Renal Function

The presurgical goal is optimal function of the liver and urinary systems so that medications, anesthetic agents, body wastes, and toxins are adequately metabolized and removed from the body. The liver, lungs, and kidneys are the routes for elimination of drugs and toxins.

The liver is important in the biotransformation of anesthetic compounds. Disorders of the liver may substantially affect how anesthetic agents are metabolized. Acute liver disease is associated with high surgical mortality; preoperative improvement in liver function is a goal. Careful assessment may include various liver function tests (see Chapter 43).

The kidneys are involved in excreting anesthetic medications and their metabolites; therefore, surgery is contraindicated if a patient has acute nephritis, acute renal insufficiency with oliguria or anuria, or other acute renal problems (see Chapter 48). Exceptions include surgeries performed as lifesaving measures, surgery to enable easier access for dialysis, or those necessary to improve urinary function (e.g., obstructive uropathy or hydronephrosis).

Endocrine Function

Dysfunction of the endocrine system is associated with overproduction or underproduction of a hormone or hormones. This dysfunction may be the primary reason for surgery or it may coexist in patients who need surgery on other organ systems (Odom-Forren, 2018). Patients who have received corticosteroids are at risk for adrenal insufficiency. The use of corticosteroids for any purpose during the preceding year must be reported to the anesthesiologist or CRNA and surgeon. The patient is monitored for signs of adrenal insufficiency (see Chapter 45).

Patients with uncontrolled thyroid disorders are at risk for thyrotoxicosis (with hyperthyroid disorders) or respiratory failure (with hypothyroid disorders). The patient with an associated history of a thyroid disorder is assessed preoperatively (see Chapter 45).

The patient with diabetes who is undergoing surgery is at risk for both hypoglycemia and hyperglycemia. Hypoglycemia may develop during anesthesia or postoperatively from inadequate carbohydrates or excessive administration of insulin. Hyperglycemia, which can increase the risk of SSI, may result from the stress of surgery, which can trigger increased levels of catecholamine. Other risks are acidosis and glucosuria. Although the surgical risk in the patient with controlled diabetes is no greater than in the patient without diabetes, strict glycemic control leads to better outcomes (ASPAN, 2019). Frequent monitoring of blood glucose levels is important before, during, and after surgery. (See Chapter 46 for a discussion of the patient with diabetes.)

Immune Function

An important function of the preoperative assessment is to determine the presence of infection or allergies. Routine laboratory tests used to detect infection include the white blood cell (WBC) and the urinalysis. Surgery may be postponed in the presence of infection or elevated temperature.

It is important to identify and document any sensitivity to medications, solutions, adhesives, and past adverse reactions (ASPAN, 2019). The patient is asked to identify any substances that precipitated previous allergic reactions, including medications, blood transfusions, contrast agents, latex, and food products, and to describe the signs and symptoms produced by these substances. A sample latex allergy screening questionnaire is shown in Figure 14-2.

Latex Allergy Assessment

Ask the patient the following questions. Check "Yes" or "No" in the box.	YES	NO
1. Has a doctor ever told you that you are allergic to latex?		
2. Do you have on-the-job exposure to latex?		
3. Were you born with problems involving your spinal cord?		
4. Have you ever had allergies, asthma, hay fever, eczema, or problems with rashes?		
5. Have you ever had respiratory distress, rapid heart rate, or swelling?		
6. Have you ever had swelling, itching, hives, or other symptoms after contact with a balloon?		
7. Have you ever had swelling, itching, hives, or other symptoms after a dental examination or procedure?		
8. Have you ever had swelling, itching, hives, or other symptoms following a vaginal or rectal examination or after contact with a diaphragm or condom?		
9. Have you ever had swelling, itching, hives, or other symptoms during or within 1 hour after wearing rubber gloves?		
10. Have you ever had a rash on your hands that lasted longer than 1 week?		
11. Have you ever had swelling, itching, hives, runny nose, eye irritation, wheezing, or asthma after contact with any latex or rubber product?		
12. Have you ever had swelling, itching, hives, or other symptoms after being examined by someone wearing rubber or latex gloves?		
13. Are you allergic to bananas, avocados, kiwi, or chestnuts?		
14. Have you ever had an unexplained anaphylactic episode?		

Preop RN Signature: _____

Patient Name: _____

Procedure: _____

Scheduled Date / Time: _____

Surgeon: _____

Figure 14-2 • Example of a latex allergy assessment form. Courtesy of Inova Fair Oaks Hospital, Fairfax, VA.

TABLE 14-3 Examples of Medications with the Potential to Affect the Surgical Experience

Agent	Effect of Interaction with Anesthetics
Corticosteroids	
Dexamethasone	Cardiovascular collapse can occur if discontinued suddenly. Therefore, a bolus of corticosteroids may be administered IV immediately before and after surgery.
Diuretics	
Hydrochlorothiazide	During anesthesia, may cause excessive respiratory depression resulting from an associated electrolyte imbalance.
Phenothiazines	
Chlorpromazine hydrochloride	May increase the hypotensive action of anesthetics.
Tranquilizers	
Diazepam	May cause anxiety, tension, and even seizures if withdrawn suddenly.
Insulins	
Insulin	Interaction between anesthetics and insulin must be considered when a patient with diabetes is undergoing surgery. IV insulin may need to be given to keep the blood glucose within the normal range.
Anticoagulants	
Warfarin	Can increase the risk of bleeding during the intraoperative and postoperative periods; should be discontinued in anticipation of elective surgery. The surgeon will determine how long before the elective surgery the patient should stop taking an anticoagulant, depending on the type of planned procedure and the medical condition of the patient.
Anticonvulsant Medications	
Carbamazepine	IV administration of medication may be needed to keep the patient seizure-free in the intraoperative and postoperative periods.
Thyroid Hormone	
Levothyroxine sodium	IV administration may be needed during the postoperative period to maintain thyroid levels.
Opioids	
Morphine sulfate	Long-term use of opioids for chronic pain (≥6 mo) in the preoperative period may alter the patient's response to analgesic agents.

IV, intravenous.

Adapted from Comerford, K. C., & Durkin, M. T. (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer.

Immunosuppression is common with corticosteroid therapy, organ transplantation, radiation therapy, chemotherapy, and disorders affecting the immune system, such as acquired immunodeficiency syndrome and leukemia. The mildest symptoms or slightest temperature elevation must be investigated.

Previous Medication Use

A medication history is obtained because of the possible interactions with medications that might be given during surgery and the effects of any of these medications on the patient's perioperative course. Any medications the patient is using or has used in the past are documented, including OTC preparations and herbal agents, as well as the frequency with which they are used. Many medications have an effect on physiologic functions; interactions of such medications with anesthetic agents can cause serious problems, such as hypotension and circulatory collapse. Medications that cause particular concern are listed in Table 14-3.

Aspirin, clopidogrel, and other medications that inhibit platelet aggregation should be prudently discontinued 7 to 10 days before surgery; otherwise, the patient may be at increased risk for bleeding (Rothrock, 2019). Any use of aspirin or other OTC medications is noted in the patient's medical record and conveyed to the intraoperative team. The anesthesia provider evaluates the potential effects of prior medication therapy, considering the length of time the patient has used the medication, the physical condition of the patient, and the nature of the proposed surgery.

Quality and Safety Nursing Alert

The possible adverse interactions of some medications require the nurse to assess and document the patient's use of prescription medications, OTC medications (especially aspirin), herbal agents, and the frequency with which medications are used. The nurse must clearly communicate this information to the intraoperative team.

Preprocedure evaluation needs to include dietary and herbal supplements that may increase surgical risks (Odom-Forren, 2018). Commonly used herbal medications and supplements along with their indications for use and possible surgical risks can be found in Table 14-4. Additional herbal medications may include echinacea and licorice extract (*Glycyrrhizic acid*). Many patients fail to report the use of herbal medicines to health care service providers; therefore, the nurse must ask surgical patients specifically about the use of these agents. The American Society of Anesthesiologists (ASA) issued a statement cautioning patients who take herbal products to refrain from taking them for at

least 2 weeks before surgery (American Society of Anesthesiologists [ASA], 2017).

TABLE 14-4 Herbs or Supplements and Possible Surgical Risks

Herb or Supplement	Indication for Use	Possible Surgical Risk
Ephedra (Ma-Huang)	Appetite suppressant	May interact with medications to cause increased BP and HR
Garlic (*Allium sativum*)	Reported to lower BP and cholesterol levels	Can increase bleeding
Ginkgo biloba	Used to improve memory	Can increase bleeding
Ginseng	Used to increase concentration	Can increase HR and risk of bleeding
Kava kava (*Piper methysticum*)	Used to decrease anxiety	Can increase the effect of anesthesia
St. John's wort (*Hypericum perforatum*)	Used to decrease anxiety, help with depression and sleep problems	May prolong the effects of anesthesia
Valerian (*Valeriana officinalis*)	Used as a sleep aid	May prolong the effects of some types of anesthesia
Vitamin E	Thought to slow the aging process	Can increase bleeding and may cause BP problems

BP, blood pressure; HR, heart rate.

Adapted from American Society of Anesthesiologists. (2017). Herbal and dietary supplements and anesthesia. Retrieved on 6/3/2019 at: www.asahq.org/whensecondscount/wp-content/uploads/2017/10/asa_supplements-anesthesia_final.pdf.

Psychosocial Factors

The nurse anticipates that most patients have emotional reactions prior to surgery—obvious or veiled, normal or abnormal. Fear may be related to the unknown, lack of control, or of death and may be influenced by anesthesia, pain, complications, cancer, or prior surgical experience. Preoperative anxiety can be a preemptive response to a threat to the patient's role in life, a permanent incapacity or body integrity, increased responsibilities or burden on family members, or life itself. Less obvious concerns may occur because of previous experiences with the health care system and people the patient has known with the same condition. Psychological distress directly influences body functioning. Identification of anxiety by the health care team using

supportive guidance at every juncture of the perioperative process helps to ease anxiety. Research suggests that negative postoperative outcomes can result from fear and anxiety preoperatively. Anxiety triggers a physical response, stimulating the release of epinephrine and norepinephrine, which in turn raises blood pressure and increases heart rate, cardiac output, and blood glucose levels. Therefore, overall healing may be impaired while pain and risk of infection may increase postoperatively (Bagheri, Ebrahimi, Abbasi, et al., 2019).

People express fear in different ways. Some patients may ask repeated questions, regardless of information already shared with them. Others may withdraw, deliberately avoiding communication by reading, watching television, or talking about trivialities. Consequently, the nurse must be empathetic, listen well, and provide information that helps alleviate concerns.

An important outcome of the psychosocial assessment is the determination of the extent and role of the patient's support network. The value and reliability of available support systems are assessed. Other information, such as knowledge of the usual level of functioning and typical daily activities, may assist in the patient's care and recovery. Assessing the patient's readiness to learn and determining the best approach to maximize comprehension provide the basis for preoperative patient education. This is of particular importance in patients who are developmentally delayed and those who are cognitively impaired, where the approach to patient education and consent will include the legal guardian.

Spiritual and Cultural Beliefs

Showing respect for a patient's cultural values and beliefs facilitates rapport and trust. Assessment includes identifying the ethnic group to which the patient relates and the customs and beliefs the patient holds about illness and health care providers. Knowledge of the patient's physiologic, psychosocial, cultural, spiritual, and educational needs allows the perioperative nurse to provide a holistic approach to care. A holistic picture of the patient allows the perioperative nurse the opportunity to identify patient care issues that extend beyond the medical diagnosis and planned surgical procedure and choose a nursing diagnosis based on key elements of the patient's needs and goals. The nurse advocates for the patient and develops a holistic care plan that is communicated to members of the intraoperative and postoperative team. Perioperative patient advocacy entails paying respect to other human beings, preserving the patient's expressed values, and treating all patients equally (Sundqvist, Holmefur, Nilsson, et al., 2016).

Certain ethnic groups are unaccustomed to expressing feelings openly with strangers, and nurses need to consider this pattern of communication when assessing pain. In some cultural groups, it is seen as impolite to make direct

eye contact with others and doing so is seen as disrespectful. The nurse should know that this lack of eye contact is not avoidance nor does it reflect a lack of interest. Other ethnicities view the top of the head as sacred; therefore, a nurse would not put the surgical cap on the patient but would ask the patient to don the cap.

Perhaps the most valuable skill at the nurse's disposal is listening carefully to the patient and observing body language, especially when obtaining the history. Invaluable information and insights may be gained through effective communication and interviewing skills. An unhurried, understanding, and caring nurse promotes confidence on the part of the patient.

Preoperative Nursing Interventions

A wide range of interventions are used to prepare the patient physically and psychologically and to maintain safety. Beginning with the nursing history and physical examination, listing of medications taken routinely, history of allergies, and surgical and anesthetic histories, the patient's overall health status and level of experience and understanding may be established.

Providing Patient Education

Nurses have long recognized the value of preoperative education (Rothrock, 2019). Each patient's education is individualized, with consideration for any unique concerns or learning needs. Multiple education strategies should be used (e.g., verbal, written, return demonstration), depending on the patient's needs and abilities.

Preoperative education is initiated as soon as possible, beginning in the physician's office, in the clinic, or at the time of PAT when diagnostic tests are performed. During PAT, the nurse or health care provider makes resources available related to patient education, such as written instructions (designed to be copied and given to patients), audiovisual and online resources, and telephone numbers, to ensure that education continues until the patient arrives for the surgical intervention. When possible, education is spaced over a period of time to allow the patient to assimilate information and ask questions as they arise.

Frequently, education sessions are combined with various preparation procedures to allow for an easy and timely flow of information. The nurse should guide the patient through the experience and allow ample time for questions. Education should go beyond descriptions of the procedure and should include explanations of the sensations the patient will experience. Telling the patient that a preoperative medication will cause relaxation before

the operation is not as effective as also noting that a medication will act quickly and may result in lightheadedness, dizziness, and drowsiness. Knowing what to expect will help the patient anticipate these reactions and attain a superior degree of relaxation. Overly detailed descriptions may increase anxiety in some patients; therefore, the nurse should be sensitive to this, by watching and listening, and provide less detail based on the individual patient's needs.

Unfolding Patient Stories: Vernon Watkins • Part 1

Vernon Watkins, a 69-year-old male, came to the emergency department with severe abdominal pain, and a bowel perforation was diagnosed. He is being prepared for surgery. Significant medical history includes controlled hypertension and smoking for 50 years. What preoperative education should the nurse discuss with Mr. Watkins prior to his emergent surgery? (Vernon Watkins' story continues in Chapter 58.)

Care for Vernon and other patients in a realistic virtual environment: vSim (**thepoint.lww.com/vSimMedicalSurgical**). Practice documenting these patients' care in DocuCare (**thepoint.lww.com/DocuCareEHR**).

Deep Breathing, Coughing, and Incentive Spirometry

One goal of preoperative nursing care is to educate the patient how to promote optimal lung expansion and resulting blood oxygenation after anesthesia. The patient assumes a sitting position to enhance lung expansion. The nurse then demonstrates how to take a deep, slow breath and how to exhale slowly. After practicing deep breathing several times, the patient is instructed to breathe deeply, exhale through the mouth, take a short breath, and cough deeply in the lungs (see Chart 14-5). The nurse or respiratory therapist also demonstrates how to use an incentive spirometer, a device that provides measurement and feedback related to breathing effectiveness (see Chapter 19). In addition to enhancing respiration, these exercises may help the patient relax.

If a thoracic or abdominal incision is anticipated, the nurse demonstrates how to splint the incision to minimize pressure and control pain. The patient should put the palms of both hands together, interlacing the fingers snugly. Splinting or placing the hands across the incision site acts as an effective support when coughing. The patient is informed that medications are available to relieve pain and should be taken regularly for pain relief so that effective deep-breathing and coughing exercises can be performed comfortably. The goal in promoting coughing is to mobilize secretions so that they can be

removed. Deep breathing before coughing stimulates the cough reflex. If the patient does not cough effectively, atelectasis (collapse of the alveoli), pneumonia, or other lung complications may occur.

Mobility and Active Body Movement

The goals of promoting mobility postoperatively are to improve circulation, prevent venous stasis, and promote optimal respiratory function. The patient should be taught that early and frequent ambulation postoperatively, as tolerated, will help prevent complications.

The nurse explains the rationale for frequent position changes after surgery and then shows the patient how to turn from side to side and how to assume the lateral position without causing pain or disrupting IV lines, drainage tubes, or other equipment. Any special position the patient needs to maintain after surgery (e.g., adduction or elevation of an extremity) is discussed, as is the importance of maintaining as much mobility as possible despite restrictions. Reviewing the process before surgery is helpful, because the patient may be too uncomfortable or drowsy after surgery to absorb new information.

Exercise of the extremities includes extension and flexion of the knee and hip joints (similar to bicycle riding while lying on the side) unless contraindicated by type of surgical procedure (e.g., hip replacement). The great toe is pointed and rotated as though tracing a large circle (see Chart 14-5). The elbow and shoulder are also put through their range of motion. At first, the patient is assisted and reminded to perform these exercises. Later, the patient is encouraged to do them independently. Muscle tone is maintained so that ambulation will be easier. The nurse should remember to use proper body mechanics and to instruct the patient to do the same. Whenever the patient is positioned, their body needs to be properly aligned.

Chart 14-5 PATIENT EDUCATION

Diaphragmatic Breathing

Diaphragmatic breathing refers to a flattening of the dome of the diaphragm during inspiration, with resultant enlargement of the upper abdomen as air rushes in. During expiration, the abdominal muscles contract.

1. Practice in the same position you would assume in bed after surgery: a semi-Fowler position, propped in bed with the back and shoulders well supported with pillows.
2. Feel the movement with your hands resting lightly on the front of the lower ribs and fingertips against the lower chest.

Diaphragmatic breathing

3. Breathe out gently and fully as the ribs sink down and inward toward midline.
4. Then take a deep breath through your nose and mouth, letting the abdomen rise as the lungs fill with air.
5. Hold this breath for a count of five.
6. Exhale and let out *all* the air through your nose and mouth.
7. Repeat this exercise 15 times with a short rest after each group of five.
8. Practice this twice a day preoperatively.

Coughing

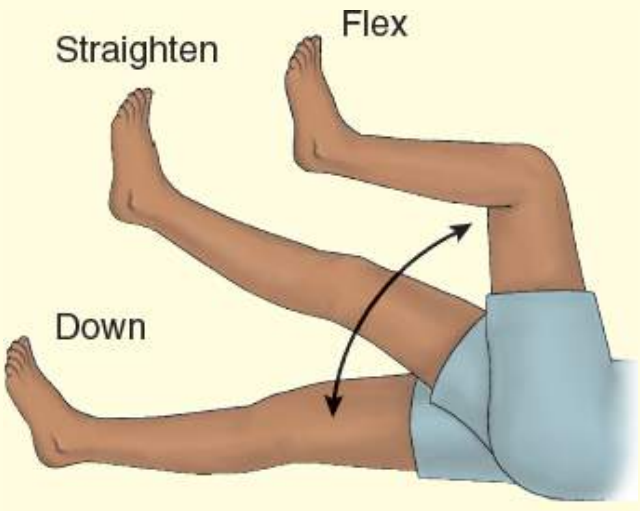
1. Lean forward slightly from a sitting position in bed, interlace your fingers together, and place your hands across the incision site to act as a splint for support when coughing.

Splinting of chest when coughing

2. Breathe with the diaphragm as described under “Diaphragmatic Breathing.”
3. With your mouth slightly open, breathe in fully.
4. “Hack” out sharply for three short breaths.
5. Then, keeping your mouth open, take in a quick deep breath and immediately give a strong cough once or twice. This helps clear secretions from your chest. It may cause some discomfort but will not harm your incision.

Leg Exercises

1. Lie in a semi-Fowler position and perform the following simple exercises to improve circulation.
2. Bend your knee and raise your foot—hold it a few seconds, then extend the leg and lower it to the bed.

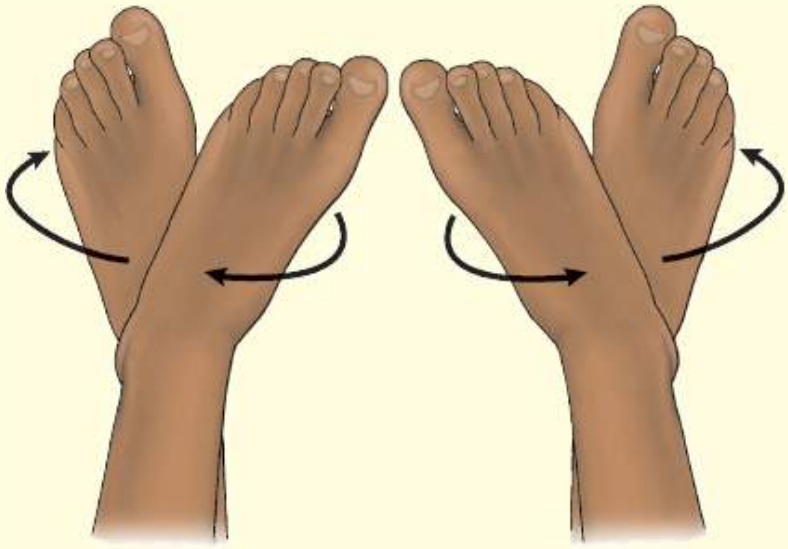


Leg exercises

3. Do this five times with one leg and then repeat with the other leg.
4. Then trace circles with the feet by bending them down, in toward each other, up, and then out.
5. Repeat these movements five times.

Turning to the Side

1. Turn on your side with the uppermost leg flexed most and supported on a pillow.
2. Grasp the side rail as an aid to maneuver to the side.
3. Practice diaphragmatic breathing and coughing while on your side.



Foot exercises

Getting Out of Bed

1. Turn on your side.
2. Push yourself up with one hand as you swing your legs out of bed.

Pain Management

A pain assessment should include differentiation between acute and chronic pain. A pain intensity scale should be introduced and explained to the patient to promote more effective postoperative pain management. (See Chapter 9 for examples of pain scales.) Preoperative patient education also needs to include the difference between acute and chronic pain so that the patient is prepared to differentiate acute postoperative pain from a chronic condition such as back pain. Preoperative pain assessment and education for the older patient may require additional attention (see Chart 14-6).

Chart 14-6

Preoperative Assessment and Education for Older Adults

Assessment

- Assess for allergies and medical comorbidities.
- Assess the patient's cognitive and sensory function before the surgeon begins the informed consent process.
- Perform a Fall Risk Assessment including the following factors:
  - History of previous falls
  - Medication use (e.g., preoperative sedatives)
  - Level of consciousness (e.g., alert, lethargic)
  - Ability to follow directions (e.g., cognitive impairment, language barrier)
  - Sensory impairments (e.g., vision, hearing)
  - Level of coordination or balance
  - Toileting needs (e.g., incontinence, frequency, need for assistance)
  - Presence of external devices (e.g., catheters, drains)
- Determine the need for a designated support person or power of attorney to complete the informed consent process.
- Review medications to identify potential polypharmaceutical risks to include the following:
  - Multiple medications
  - Multiple prescribers
  - Several filling pharmacies
  - Too many forms of medications
  - Over-the-counter medications
  - Multiple dosing schedules
- Document baseline physical assessment parameters, including pain, cardiac rhythm, and oxygen saturation level.
- Document a detailed skin assessment with notation of areas of dryness, lesions, or bruising.
- Document preoperative fasting status and assess for dehydration, malnutrition, and hypoglycemia.
- Perform a psychosocial assessment that addresses fears, anxiety, and feelings of loneliness.
- Identify social support to determine whether the patient has home assistance to complete ADLs.

Education

- Discuss advanced directives and code status to identify the patient's wishes.
- Educate the patient about the benefits of controlling pain.
- Be prepared to spend additional time, increase the amount of therapeutic touch utilized, and encourage family members to be present to decrease anxiety.

ADLs, activities of daily living.

Adapted from Ogg, M. (2018). Clinical issues. *AORN Journal, 108*(2), 195–203; Phillips, N. (2017). *Berry and Kohn's operating room technique*. St. Louis, MO: Elsevier.

Postoperatively, medications are given to relieve pain and maintain comfort without suppressing respiratory function. The patient is instructed to take the medication as frequently as prescribed during the initial postoperative period for pain relief. Anticipated methods of administration of analgesic agents for inpatients include patient-controlled analgesia (PCA), epidural catheter bolus or infusion, or patient-controlled epidural analgesia (PCEA; see Chapter 9 for discussion of PCA and PCEA). A patient who is expected to go home will likely receive oral analgesic agents. These methods are discussed with the patient before surgery, and the patient's interest and willingness to use them are assessed.

Cognitive Coping Strategies

Although some anxiety is common in the surgical setting, untreated or undertreated high preoperative anxiety can lead to complications. Tachycardia, arrhythmias, hypertension, and increased levels of pain have been reported postoperatively in patients with increased preoperative anxiety (Jaruzel, Gregoski, Mueller, et al., 2019). Cognitive strategies may be useful for relieving tension, overcoming anxiety, decreasing fear, and achieving relaxation. Examples of general strategies include:

- *Guided Imagery:* The patient concentrates on a pleasant experience or restful scene.
- *Distraction:* The patient thinks of an enjoyable story or recites a favorite poem or song.
- *Optimistic Self-Recitation:* The patient recites optimistic thoughts ("I know all will go well").
- *Music Therapy:* The patient listens to soothing music (an easy-to-administer, inexpensive, noninvasive intervention).
- *Aromatherapy:* The patient inhales aromatic oils to trigger emotional and physical relaxation responses through the olfactory system and brain.
- *Reiki:* The practitioner places hands over the patient to (theoretically) transfer energy to promote healing and relaxation.

Alternative interventions may include acupuncture, yoga therapy, muscle relaxation, and therapeutic touch.

Education for Patients Undergoing Ambulatory Surgery

Preoperative education for the same-day or ambulatory surgical patient comprises all previously discussed patient education as well as collaborative planning with the patient and family for discharge and follow-up home care. The major difference in outpatient preoperative education is the environment.

Preoperative education content may be presented in a group class, in a media presentation, at PAT, or by telephone in conjunction with the preoperative interview. In addition to answering questions and describing what to expect, the nurse tells the patient when and where to report, what to bring (insurance card, list of medications and allergies), what to leave at home (jewelry, watch, medications, contact lenses), and what to wear (loose-fitting, comfortable clothes; flat shoes). The nurse in the surgeon's office may initiate education before the perioperative telephone contact.

During the final preoperative telephone call, education is completed or reinforced as needed and last-minute instructions are given. The patient is reminded not to eat or drink for a specified period of time and about skin cleansing techniques prior to surgery (see later section on preparing the skin).

Providing Psychosocial Interventions

The nurse assesses for and provides interventions to enhance coping mechanisms to deal effectively with anxiety and fears, and thus provide emotional comfort (Phillips, 2017). Preoperatively, the nurse assesses any patient specific needs that may affect the emotional, psychosocial, or physical surgical experience.

Reducing Anxiety and Decreasing Fear

Perioperative nurses in the preoperative department have a limited amount of time to acquire information and establish trust. Nurses must introduce themselves, giving their title and a brief synopsis of their professional role and background. Each preoperative patient should be acknowledged as an individual, and each patient's needs and desires must be assessed. The patient should be thanked for choosing that particular hospital or surgical center. These methods facilitate establishing a positive nurse–patient relationship. Discussion of the surgical experience, its length, and explanation of what will happen may diminish the patient's anxiety.

During the preoperative assessment of psychological factors and spiritual and cultural beliefs, the nurse assists the patient to identify coping strategies that he or she has previously used to decrease fear. Discussions with the patient to help determine the source of fears can help with expression of concerns. The patient benefits from knowing when family and friends will be able to visit after surgery and that a spiritual advisor will be available if desired. Knowing ahead of time about the possible need for a ventilator, drainage tubes, or other types of equipment helps decrease anxiety related to the postoperative period.

Careful attention should be placed on patients who experience a delay in surgery as prolonged wait times in the preoperative area can lead to increased fear and anxiety.

Respecting Cultural, Spiritual, and Religious Beliefs

The nurse assesses for any patient specific needs that may affect the spiritual, emotional, or physical surgical experience. In some cultures, for example, people are stoic in regard to pain, whereas in others they are more expressive. These responses should be recognized as normal for those patients and families and should be respected by perioperative personnel. If patients decline blood transfusions for religious reasons (Jehovah's Witnesses), this information needs to be clearly identified in the preoperative period, documented, and communicated to the appropriate personnel. Although minimally invasive surgery has significantly lowered blood loss, any surgical procedure has the potential for hemorrhage.

Maintaining Patient Safety

Protecting patients from injury is one of the major roles of the perioperative nurse. Adherence to AORN-recommended practices and The Joint Commission's National Patient Safety Goals (see Chart 14-7) are crucial (Rothrock, 2019). These apply to hospitals as well as to ambulatory surgery centers and office-based surgery facilities (Joint Commission, 2019).

Chart 14-7

Summary of the 2019 National Patient Safety Goals

- Identify patients correctly
- Improve staff communication
- Use medicines safely
- Use alarms safely
- Prevent infection
- Identify patient safety risks
- Prevent mistakes in surgery

Adapted from Joint Commission (2019). 2019 National Patient Safety Goals. Retrieved on 5/22/19 at: www.jointcommission.org/assets/1/6/2019_HAP_NPSGs_final2.pdf

Managing Nutrition and Fluids

The purpose of withholding food and fluid before surgery is to prevent aspiration. Specific recommendations for restrictions depend on the age of the patient and the type of food eaten. For example, adults may be advised to fast for 8 hours after eating fatty food and 6 hours after ingesting milk products. Healthy patients are allowed clear liquids up to 2 hours before an elective procedure. New methods of "carbohydrate loading" have been implemented preoperatively in surgeries that do not involve the gastrointestinal system (i.e., thoracic, urologic, obstetric, orthopedic). A carbohydrate-rich drink has been used as a safe fasting process before surgery. It has been reported that these solutions do not pose a risk for aspiration and decrease insulin resistance when the duration of gastric emptying and the amount of liquid intake are controlled (Cakar, Yilmaz, Cakar, et al., 2017). Preoperative carbohydrate loading in patients undergoing surgery as part of an enhanced recovery after surgery protocol has demonstrated positive outcomes including decreased LOS, decreased incidence of PONV, and decreased pain (Pachella, Mehran, Curtin, et al., 2019).

Preparing the Bowel

Enemas are not commonly prescribed preoperatively unless the patient is undergoing abdominal or pelvic surgery. In this case, a cleansing enema or laxative may be prescribed the evening before surgery and may be repeated the morning of surgery. The goals of this preparation are to allow satisfactory visualization of the surgical site and to prevent trauma to the intestine or contamination of the peritoneum by fecal material. Unless the condition of the patient presents some contraindication, the toilet or bedside commode, rather than the bedpan, is used for evacuating the enema if the patient is hospitalized during this time. In addition, antibiotics may be prescribed to reduce intestinal flora.

Preparing the Skin

The goal of preoperative skin preparation is to decrease bacteria without injuring the skin. If the surgery is not performed as an emergency, most health care facilities and ambulatory surgical centers have implemented preoperative antiseptic skin cleansing protocols. At a minimum, preoperative bathing should consist of a full-body wash using antimicrobial soap the night before the planned surgery (Berríos-Torres, Umscheid, Bratzler, et al., 2018). Additional body cleansing with chlorhexidine wipes may occur in the preoperative area via the nurse or by the patient under the direction of the nurse. Surgical site hair removal should occur in the preoperative area. Electric clippers, not skin razors, are the preferred method for hair removal. Special consideration is given to those undergoing gynecologic, urologic, and cranial

surgeries. To ensure the correct site, the surgical site is typically marked by the patient and the surgeon prior to the procedure.

Immediate Preoperative Nursing Interventions

The nurse confirms the patient identity upon entry and dons "alert" bracelets on the patient when applicable: medication allergies, fall risk, extremity precautions (for needle sticks and blood pressures), and code status. The patient changes into a hospital gown, covers the head with a disposable bouffant, and nail polish is removed (if present) as it may interfere with hemodynamic monitoring. The mouth is inspected, and dentures or plates are removed. If left in the mouth, these items could easily fall to the back of the throat during induction of anesthesia and cause respiratory obstruction.

Jewelry is not worn to the OR; wedding rings and jewelry or body piercings should be removed to prevent injury. If a patient objects to removing jewelry, the patient must be notified of the risks associated with it. All articles of value, including assistive devices, dentures, glasses, and prosthetic devices, are given to family members or are labeled clearly with the patient's name and stored in a safe and secure place according to the institution's policy.

Preoperative Checklist

1. Patient's name: _____ Date: _____ Height: _____ Weight: _____
   Identification band present: _____
2. Informed consent signed: _____ Special permits signed: _____
3. Surgical site: _____ (Ex: Sterilization)
4. History & physical examination report present: _____ Date: _____
5. Laboratory records present: _____
   CBC: _____ Hgb: _____ Urinalysis: _____ Hct: _____
6. Traveled Outside of the United States in the last 14 days: Yes/No
7. NPO Status: Date/Time last liquid: _____ Date/Time last solid: _____
8.

Item	Present	Removed
a. Natural teeth		
Dentures: upper, lower, partial		
Bridge, fixed; crown		
b. Contact lenses		
c. Other prostheses—type: _____		
d. Jewelry:		
Wedding band (taped/tied)		
Rings		
Earrings: pierced, clip-on		
Neck chains		
Any other body piercings		
e. Make-up		
Nail polish		
9. Clothing		
a. Clean patient gown		
b. Cap		
c. Sanitary pad, etc.		

10. Family instructed where to wait? _____
11. Valuables secured? _____
12. Blood available? _____ Ordered? _____ Where? _____
13. Preanesthetic medication given: _____
    Type: _____ Time: _____
14. Voided: _____ Amount: _____ Time: _____ Catheter: _____
    Mouth care given: _____
15. Vital signs: Temperature: _____ Pulse: _____ Resp: _____ Blood Pressure: _____
16. Special problems/precautions: (Allergies, deafness, etc.): _____
17. Area of skin preparation: _____
18. _____ Date: _____ Time: _____
    Signature: Nurse releasing patient

Figure 14-3 • Example of a preoperative checklist.

All patients (except those with urologic disorders) should void immediately before going to the OR. This is particularly important in promoting visibility of anatomy and continence during low abdominal surgery. Urinary catheterization is performed in the OR only as necessary.

Administering Medication

The use of preanesthetic medication is minimal with ambulatory or outpatient surgery but may be used to help some patients remain calm and comfortable (Phillips, 2017). If a preanesthetic medication is given, the patient is kept in bed with the side rails raised, because the medication can cause lightheadedness or drowsiness. During this time, the nurse observes the patient for any untoward reaction to the medications.

Antibiotics are given preoperatively, as needed, to help reduce the risk of SSIs. The antibiotic is typically prescribed prior to the patient arriving and is prepared by the pharmacy so that it can be administered in a timely fashion

prior to surgery. Administration of the appropriate antibiotic should occur so that the peak efficacy of the medication is in the patient's tissues and bloodstream immediately before incision (Bashaw & Keister, 2018).

Maintaining the Preoperative Record

Preoperative checklists contain critical elements that must be checked and verified before the procedure (Rothrock, 2019). The nurse completes a preoperative checklist (see Fig. 14-3). The completed medical record (with the preoperative checklist and verification form) accompanies the patient to the OR with the surgical consent form attached, along with all laboratory reports and nurses' records. These documents may also be found in the patient's electronic health record; however, they must be easily accessed and verified by the surgical team. Any patient alerts (allergies, safety precautions) and individual needs are "flagged" on either the paper or electronic record.

Chart 14-8 **NURSING RESEARCH PROFILE**

The Efficacy of Prewarming in the Preoperative Setting

Rosenkilde, C., Vamosi, M., Lauridsen, J. T., et al. (2017). Efficacy of prewarming with a self-warming blanket for the prevention of unintended perioperative hypothermia in patients undergoing hip or knee arthroplasty. *Journal of PeriAnesthesia Nursing, 32*(5), 419–428.

Purpose

Unintended perioperative hypothermia (UPH) is defined as a core temperature of less than 36°C (96.8°F) in patients in the surgical setting when cooling is not associated with the procedure. Many risks are associated with UPH including increased wound infections, pain, coagulation disorders, and cardiac complications. The purpose of this study was to evaluate UPH rates when a self-warming blanket was utilized by patients undergoing hip or knee joint replacement surgeries.

Design

This was a secondary analysis of two cross-sectional studies. A control group of patients did not receive any warming methods, and another group of patients received a prewarming intervention. Core temperatures of both groups were taken preoperatively, every 30 minutes throughout the procedure, and postoperatively.

Findings

Sixty patients were included in the study, 30 in each group. The incidence of UPH was identified in 13% of the patients in the prewarmed group and 43% of the patients in the control group. Mean core temperature in the prewarmed group was significantly higher and remained above 36°C in the perioperative period.

Nursing Implications

Careful attention needs to be paid to maintaining normothermia in the patient throughout the entire perioperative phase of care. The findings of this study showed a reduction in UPH rates when patients were prewarmed with a self-warming blanket. Nurses at both outpatient and inpatient surgical settings could use this study to help develop interdisciplinary prewarming techniques and protocols.

Preoperative Patient Warming

Preoperative patient warming for a period of at least 30 minutes can be beneficial to prevent hypothermia development after anesthesia induction. Various techniques include warm blankets, forced air warming, and warmed IV fluid administration. Unintended hypothermia is associated with increased adverse patient outcomes, including bleeding, delayed surgical wound healing,

increased length of stay (LOS) in the PACU, cardiac dysfunction, and longer inpatient hospital stay (Williams, 2018). Patients should be educated about the purpose of the warming intervention and should be assessed for abnormal temperatures, profuse sweating, and discomfort (Williams, 2018). Research suggests that nurses play a crucial part in the reduction of unintended hypothermia, below 36°C (96.8°F), by applying prewarming techniques in the preoperative area (Rosenkilde, Vamosi, Lauridsen, et al., 2017). See the Nursing Research Profile in Chart 14-8.

The patient is taken to the preoperative area, greeted by name, and positioned comfortably on the stretcher or bed. The surrounding area should be kept quiet if the preoperative medication is to have maximal effect. Unpleasant sounds or conversation should be avoided, because a patient who is sedated may misinterpret them.

Attending to Family Needs

Most hospitals and ambulatory surgery centers have a waiting room where family members and significant others can wait while the patient is undergoing surgery. This room may be equipped with comfortable chairs, televisions, telephones, and light refreshments. Volunteers may remain with the family, offer them coffee, and keep them informed of the patient's progress. After surgery, the surgeon may meet the family in the waiting room and discuss the outcome.

The family and significant others should never judge the seriousness of an operation by the length of time the patient is in the OR. A patient may be in the OR much longer than the actual operating time for several reasons:

- Patients are routinely transported well in advance of the actual operating time.
- The anesthesiologist or CRNA often makes additional preparations that may take 30 to 60 minutes.
- The preceding case may take longer than expected, which delays the start of the next surgical procedure.

After surgery, the patient is taken to the PACU to ensure safe emergence from anesthesia. Family members and significant others waiting to see the patient after surgery should be informed that the patient may have certain equipment or devices (e.g., IV lines, indwelling urinary catheter, nasogastric tube, oxygen lines, monitoring equipment, blood transfusion lines) in place when he or she returns from surgery. When the patient returns to the room, the nurse provides explanations regarding the frequent postoperative observations that will be made. However, it is the responsibility of the surgeon, not the nurse, to relay the surgical findings and the prognosis, even when the findings are favorable.

Expected Patient Outcomes

Expected patient activities to decrease anxiety and fear, as well as increase knowledge in the preoperative phase of care are summarized in Chart 14-9. Nurse-sensitive outcomes often include central line–associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI), hospital-acquired pressure ulcers and unit-acquired pressure ulcers.

Chart 14-9

Expected Patient Activities in the Preoperative Phase of Care

Relief of anxiety, evidenced when the patient:

- Discusses with the anesthesiologist or CRNA concerns related to types of anesthesia and induction
- Verbalizes an understanding of the preanesthetic medication and general anesthesia
- Discusses last-minute concerns with the nurse or physician
- Discusses financial concerns with the social worker, when appropriate
- Requests visit with spiritual advisor, when appropriate
- Appears relaxed when visited by health care team members

Decreased fear, evidenced when the patient:

- Discusses fears with health care professionals or a spiritual advisor, or both
- Verbalizes an understanding of any expected bodily changes, including expected duration of bodily changes

Understanding of the surgical intervention, evidenced when the patient:

- Participates in preoperative preparation as appropriate (e.g., bowel preparation, shower)
- Demonstrates and describes exercises that he or she is expected to perform postoperatively
- Reviews information about postoperative care
- Accepts preanesthetic medication, if prescribed
- Remains in bed once premedicated
- Relaxes during transportation to the operating room or unit
- States rationale for use of side rails
- Discusses postoperative expectations

CRNA, certified registered nurse anesthetist.

CRITICAL THINKING EXERCISES

1 pq A 55-year-old man who is a patient on the surgical unit where you work is scheduled for a prostatectomy; he is showing signs of increased anxiety, fear, and insomnia. What are the priorities of the perioperative nurse? What further assessments are priorities? What are your priorities for nursing intervention?

2 ebp A 60-year-old woman with obesity has been admitted for a minimally invasive hysterectomy. She was diagnosed during her PAT visit with severe OSA. What resources would you use to identify evidence-based practices for prevention of complications during the perioperative period? Identify the evidence, as well as the criteria used to evaluate the strength of the evidence, for the practices identified.

3 ipc A 38-year-old man is admitted for knee surgery following a horse riding accident. He is in good physical condition but reports a family history of "problems with anesthesia." What are your immediate preoperative assessments? What should you include in the interprofessional handoff to the surgical team?

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*Asterisk indicates nursing research.

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Resources

American Academy of Ambulatory Care Nursing (AACN), www.aaacn.org
American Association of Gynecologic Laparoscopy (AAGL), www.aagl.org
American Society for Metabolic and Bariatric Surgery (ASMBS), asmbs.org
American Society of Anesthesiologists (ASA), www.asahq.org
American Society of PeriAnesthesia Nurses (ASPAN), www.aspan.org
Association of periOperative Registered Nurses (AORN), www.aorn.org
Joint Commission, www.jointcommission.org

15 Intraoperative Nursing Management

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the roles of the surgical team members during the intraoperative phase of care.
2. Identify adverse effects of surgery and anesthesia.
3. Describe ways to decrease the risk of surgical site infections.
4. Compare types of anesthesia with regard to uses, advantages, disadvantages, and nursing responsibilities.
5. Use the nursing process to optimize patient outcomes during the intraoperative period.

NURSING CONCEPTS

Assessment
Comfort
Managing Care
Safety

GLOSSARY

anesthesia: a state of narcosis or severe central nervous system depression produced by pharmacologic agents

anesthesiologist: physician trained to deliver anesthesia and to monitor the patient's condition during surgery

anesthetic agent: the substance, such as a chemical or gas, used to induce anesthesia

certified registered nurse anesthetist (CRNA): advanced practice registered nurse who delivers anesthesia care under the direction of an anesthesiologist

circulating nurse : registered nurse who coordinates and documents patient care in the operating room (*synonym*: circulator)

laparoscope: a thin endoscope inserted through a small incision into a cavity or joint using fiber-optic technology to project live images of structures onto a video monitor; other small incisions allow additional instruments to be inserted to facilitate laparoscopic surgery

malignant hyperthermia: a rare life-threatening condition triggered by exposure to most anesthetic agents inducing a drastic and uncontrolled increase in skeletal muscle oxidative metabolism that can overwhelm the body's capacity to supply oxygen, remove carbon dioxide, and regulate body temperature, eventually leading to circulatory collapse and death if untreated; often inherited as an autosomal dominant disorder

moderate sedation: previously referred to as conscious sedation, involves the use of sedation to depress the level of consciousness without altering the patient's ability to maintain a patent airway and to respond to physical stimuli and verbal commands

monitored anesthesia care: moderate sedation given by an anesthesiologist or CRNA

multimodal anesthesia: the intentional practice of using a combination of nonopioid pharmaceuticals and regional anesthesia techniques

registered nurse first assistant: a member of the operating room team whose responsibilities may include handling tissue, providing exposure at the operative field, suturing, and maintaining hemostasis

restricted zone: area in the operating room where scrub attire and surgical masks are required; includes operating room and sterile core areas

scrub role: registered nurse, licensed practical nurse, or surgical technologist who scrubs and dons sterile surgical attire, prepares instruments and supplies, and hands instruments to the surgeon during the procedure

semirestricted zone: area in the operating room where scrub attire is required; may include areas where surgical instruments are processed

sterile technique: measures taken to maintain an area free from living microorganisms, including all spores

surgical asepsis: absence of microorganisms in the surgical environment to reduce the risk of infection

unrestricted zone: area in the operating room that interfaces with other departments; includes patient reception area and holding area

The intraoperative experience has undergone many changes and advances that make it safer and less disturbing to patients. Even with these advances, anesthesia and surgery still place the patient at risk for several complications or adverse events. Consciousness or full awareness, mobility, protective biologic functions, and personal control are totally or partially relinquished by the patient when entering the operating room (OR). Staff from the departments of anesthesia, nursing, and surgery work collaboratively to implement professional standards of care, to control iatrogenic and individual risks, to prevent complications, and to promote high-quality patient outcomes.

The Surgical Team

The surgical team consists of the patient, the anesthesiologist (physician) or certified registered nurse anesthetist (CRNA), the surgeon, nurses, surgical technicians, and registered nurse first assistants (RNFAs) or certified surgical technologists (assistants). The anesthesiologist or CRNA administers the **anesthetic agent** (substance used to induce anesthesia) and monitors the patient's physical status throughout the surgery. The surgeon, nurses, technicians, and assistants scrub and perform the surgery. The person in the scrub role, either a nurse or a surgical technician, provides sterile instruments and supplies to the surgeon during the procedure by anticipating the surgical needs as the surgical case progresses. The circulating nurse coordinates the care of the patient in the OR. Care provided by the circulating nurse includes planning for and assisting with patient positioning, preparing the site for surgery, managing surgical specimens, anticipating the needs of the surgical team, documenting intraoperative events, and updating the plan of care. Collaboration of the core surgical team using evidence-based practices tailored to the specific case results in optimum patient care and improved outcomes (see Chart 15-1).

Chart 15-1 ETHICAL DILEMMA

Can Lack of Civility in the OR Threaten Patient Safety?

Case Scenario

You are a registered nurse who has worked in the operating room (OR) for the past five years. You have enjoyed an ancillary role precepting students for the past two years. Recently, you volunteered to serve as a preceptor for a nurse who is transferring to the OR after working as a registered nurse on a general medical-surgical unit for the past two years since graduating from nursing school. The new nurse was accepted into the hospital's onsite perioperative nursing internship program three months ago and has completed most of the classroom portion of the program, reportedly receiving excellent test scores. Today, she is assigned to the role of scrub nurse. A staff nurse with 20 years of experience in the OR is the circulating nurse assigned to the OR suite where the new nurse is assigned. As you are preparing to enter the OR suite to check on the new nurse and to verify that she has setup the instruments properly, the circulating nurse storms angrily out of the room, rolls her eyes and tells you "that newbie badly bungled" and did not set up instruments correctly for the case. You immediately walk into the OR suite to investigate and find the surgeon and the CRNA are there, as well as the new nurse, who is blinking back tears. The new nurse tells you that the circulating nurse "chewed me out in front of everyone." The surgeon requests to have a different nurse assigned to be the scrub nurse.

Discussion

In the *Code of Ethics for Nurses*, the American Nurses Association (ANA; 2015) stresses that it is the responsibility of the nurse to treat colleagues with civility, dignity, and respect and that doing so creates an ethical work environment. By contrast, incivility, which can be evidenced by harassment, intimidation, and bullying, is considered morally unacceptable behaviors for the nurse to exhibit. Clark and Kenski (2017) take these tenets further, and note that incivility, which can consist of both overt behaviors (e.g., yelling, making disparaging remarks) as well as covert behaviors (e.g., eye rolling, withholding communication) can disrupt important professional transactions and communication, which may then threaten patient safety. They assert that "nurses have an ethical responsibility to foster healthy work environments in which conflict is managed in a respectful way and communication is clear, direct, and concise." (p. 62).

Analysis

- Identify the ethical principles that are in conflict in this case (see Chapter 1, Chart 1-7). Who are the stakeholders who might have been adversely affected by this event? Do nurses have a moral obligation to foster beneficent relationships? Can incivility threaten nonmaleficence?
- Describe how you would proceed and what you would say to the nurse you are precepting. Would your communication with her be different if you were to find that she had set up the instruments correctly or

incorrectly? Would you honor the surgeon's request and ask the charge nurse to change the new nurse's assignment?

- What resources might be of help to you so that a civil work environment may be cultivated? Should the nurse manager or other administrators be consulted to help resolve this conflict?

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Resources

See Chapter 1, Chart 1-10 for Steps of an Ethical Analysis and Ethics Resources.

The Patient

As the patient enters the OR, they may feel either relaxed and prepared or fearful and highly stressed. These feelings depend to a large extent on the amount and timing of preoperative sedation, preoperative education, and the individual patient. Fears about loss of control, the unknown, pain, death, changes in body structure, appearance, or function, and disruption of lifestyle all contribute to anxiety. These fears can increase the amount of anesthetic medication needed, the level of postoperative pain, and overall recovery time (see Chapter 5 for more information on stress).

The patient is subject to several risks. Infection, failure of the surgery to relieve symptoms or correct a deformity, temporary or permanent complications related to the procedure or the anesthetic agent, and death are uncommon but potential outcomes of the surgical experience (see Chart 15-2). In addition to fears and risks, the patient undergoing sedation and anesthesia temporarily loses both cognitive function and biologic self-protective mechanisms. Loss of the sense of pain, reflexes, and the ability to communicate subjects the intraoperative patient to possible injury. The OR nurse is the patient's advocate while surgery proceeds.

Chart 15-2

Potential Adverse Effects of Surgery and Anesthesia

Anesthesia and surgery disrupt all major body systems. Although most patients can compensate for surgical trauma and the effects of anesthesia, all patients are at risk during the operative procedure. These risks include the following:

- Agitation or disorientation, especially in older adult patients
- Allergic reactions
- Anesthesia awareness
- Bleeding
- Cardiac arrhythmia from electrolyte imbalance or adverse effect of anesthetic agents
- Central nervous system agitation, seizures, and respiratory arrest
- Drug toxicity, faulty equipment, and other types of human error
- Electrical shock or burns
- Hypotension from blood loss or adverse effect of anesthesia
- Hypothermia from cool operating room temperatures, exposure of body cavities, and impaired thermoregulation secondary to anesthetic agents
- Hypoxemia or hypercarbia from hypoventilation and inadequate respiratory support during anesthesia
- Infection
- Laryngeal trauma, oral trauma, and broken teeth from difficult intubation
- Laser burns
- Malignant hyperthermia secondary to adverse effect of anesthesia
- Myocardial depression, bradycardia, and circulatory collapse
- Nerve damage and skin breakdown from prolonged or inappropriate positioning
- Oversedation or undersedation
- Retained foreign body or object
- Thrombosis from compression of blood vessels or stasis

Adapted from Association of PeriOperative Registered Nurses (AORN). (2019a). *Association of PeriOperative Registered Nurses (AORN) standards, recommended practice, and guidelines.* Denver, CO: Author.

Gerontologic Considerations

One in 10 patients undergoing surgery is age 65 or older (American Society of Anesthesiologists [ASA], 2019). Older adult patients are at higher risk for complications from anesthesia and surgery compared with younger adult patients due to several factors (Rothrock, 2019). One factor is age-related decline in physiologic reserve that weakens the normal response to stressors, acute illness, anesthesia, and surgery (Vernon, Rice, Titch, et al., 2019). Risks include delirium, hypothermia, positioning injury, deep vein thrombosis (DVT) formation, electrolyte imbalance, and circulatory compromise. Further discussion of age-related physiologic changes can be found in Chapter 8.

Biologic variations of particular importance include age-related cardiovascular and pulmonary changes. The aging heart and blood vessels have decreased ability to respond to stress. Cardiac output and pulmonary capacity diminish with age, with a decline in maximal oxygen uptake. Slow circulation and hypotension predispose the patient to thrombus formation and emboli (Phillips, 2017). Excessive or rapid administration of intravenous (IV) solutions can cause pulmonary edema. A sudden or prolonged decline in blood pressure may lead to cerebral ischemia, thrombosis, embolism, infarction, and anoxia. Reduced gas exchange can result in cerebral hypoxia.

Lower doses of anesthetic agents are required in older adults due to decreased tissue elasticity (lung and cardiovascular systems) and reduced lean tissue mass. Older patients often experience an increase in the duration of clinical effects of medications. With decreased plasma proteins, more of the anesthetic agent remains free or unbound, and the result is more potent action (Barash, Cullen, Stoelting, et al., 2017).

In addition, body tissues of the older adult are made up predominantly of water, and those tissues with a rich blood supply, such as skeletal muscle, liver, and kidneys, shrink as the body ages. Reduced liver size decreases the rate at which the liver can inactivate many anesthetic agents, and decreased kidney function slows the elimination of waste products and anesthetic agents. Nursing management for the older surgical patient in the intraoperative period includes the following (Phillips, 2017):

- Application of intraoperative warming techniques to reduce unintentional hypothermia
- Careful transfer and positioning on the OR bed. Protect pressure points and bony prominences with extra padding. Support the back and neck to prevent stiffness while maintaining respiratory and circulatory support
- Use of antiembolic stockings or a sequential compression device to prevent VTE formation
- Careful fluid and electrolyte monitoring via accurate blood loss measurement, urinary output, and blood gases

Nursing Care

Throughout surgery, nursing responsibilities include providing for the safety and well-being of the patient, coordinating the OR personnel, and performing scrub and circulating activities. Because the patient's emotional state remains a concern, the intraoperative nursing staff provides the patient with information and reassurance, continuing the care initiated by preoperative nurses. The nurse supports coping strategies and reinforces the patient's ability to influence outcomes by encouraging active participation in the plan of care, incorporating cultural, ethnic, and religious considerations as appropriate. The establishment of an environment of trust and relaxation through visualization techniques is

another method of patient reassurance that can be used as the patient is anesthetically induced.

As patient advocates, intraoperative nurses monitor factors that have the potential to cause injury, such as patient position, equipment malfunction, and environmental hazards. Nurses also protect the patient's dignity and interests while the patient is under anesthesia. Additional nursing responsibilities include maintaining surgical standards of care, identifying risks, and minimizing complications.

Cultural Diversity

Cultural, ethnic, and religious diversities are important considerations for all health care professionals. Nurses in the perioperative area should be aware of medications that may be prohibited by certain groups (e.g., Muslims and those of the Jewish faith may not wish to use porcine-based products [heparin (porcine or bovine)]; Buddhists may choose not to use bovine products). In certain cultures, the head is a sacred area, and staff should allow patients to apply their own surgical cap in this case. When English is the second language of the patient having surgery under local anesthesia, certified medical translators can be provided to maintain understanding and comprehension by the patient. Translator devices are also available at most hospitals. Family members may have the ability to translate but should not be used as medical translators, as they may wish to save the patient anxiety and not provide an accurate translation, resulting in the patient not receiving complete information.

Figure 15-1 • Surgical safety checklist. Reproduced with permission from the World Health Organization. WHO Bulletin, 86[7]. New checklist to help make surgery safer, 496–576. © 2015. Retrieved on 5/22/19 at: whqlibdoc.who.int/publications/2009/9789241598590_eng_Checklist.pdf

The Circulating Nurse

The **circulating nurse (or circulator)**, a qualified registered nurse, works in collaboration with surgeons, anesthesia providers, and other health care providers to plan the best course of action for each patient (Rothrock, 2019). In this leadership role, the circulating nurse manages the OR and protects the patient's safety and health by monitoring the activities of the surgical team, checking the OR conditions, and continually assessing the patient for signs of injury and implementing appropriate interventions. A foremost responsibility includes verifying consent; if not obtained, surgery may not commence. The team is coordinated by the circulating nurse, who ensures cleanliness, proper temperature, humidity, appropriate lighting, safe function of equipment, and the availability of supplies and materials.

The circulating nurse monitors aseptic practices to avoid breaks in technique while coordinating the movement of related personnel (medical, x-ray, and laboratory), as well as implementing fire safety precautions. The circulating nurse also monitors the patient and documents specific activities throughout the operation to ensure the patient's safety and well-being.

In addition, the circulating nurse is responsible for ensuring that the second verification of the surgical procedure and site takes place and is documented (see Fig. 15-1). In some institutions, this is referred to as a time-out, surgical pause, or universal protocol that takes place among the surgical team prior to induction of anesthesia with a briefing about anticipated problems, potential complications, allergies, and comorbidities. Every member of the surgical team verifies the patient's name, procedure, and surgical site using objective documentation and data before beginning the surgery. Identifying patients correctly is a 2019 National Patient Safety Goal (see Chapter 14, Chart 14-7). The Surgical Safety Checklist (SSC) (see Fig. 15-1) has been adopted in ORs worldwide to reduce medical errors, increase patient safety, and improve interprofessional communication (Ziman, Espin, Grant, et al., 2018). A team debriefing session, led by the circulating nurse, often follows the completion of surgery to identify potential problems with the postsurgical care of the patient and potential areas for improvement (American Society of PeriAnesthesia Nurses [ASPAN], 2019).

Quality and Safety Nursing Alert

It is imperative that the correct patient identity, surgical procedure, and surgical site be verified prior to surgery. The surgical site should be marked by the physician and confirmed by the patient prior to coming to the OR suite during the consent process. The marking should be visible after the sterile drapes are applied and verified by the surgical team members during the time-out.

The Scrub Role

The registered nurse, licensed practical nurse, or surgical technologist (or assistant) performs the activities of the **scrub role**, including performing hand hygiene; setting up the sterile equipment, tables, and sterile field; preparing sutures, ligatures, and special equipment (e.g., a **laparoscope**, which is a thin endoscope inserted through a small incision into a cavity or joint using fiber-optic technology to project live images of structures onto a video monitor); and assisting the surgeon and the surgical assistants during the procedure by anticipating the instruments and supplies that will be required, such as sponges, drains, and other equipment. As the surgical incision is closed, the scrub person and the circulating nurse count all needles, sponges, and instruments to be sure that they are accounted for and not retained as a foreign body in the patient (Association of PeriOperative Registered Nurses [AORN], 2019a; Rothrock, 2019). Standards call for all sponges used in surgery to be visible on x-ray and for sponge counts to take place at the beginning of surgery and twice at the end (when wound closure begins and again as the skin is being closed). Tissue specimens obtained during surgery are labeled by the person in the scrub role

and sent to the laboratory by the circulating nurse. Medications and solutions are transferred to the sterile table by the circulating nurse and the name, strength, dosage, and expiration date are labeled by the person in the scrub role. Implants are handled in a similar fashion whereby the name, type, size, expiration date, and sterility are verified prior to handoff to the person in the scrub role.

The Surgeon

The surgeon performs the surgical procedure, heads the surgical team, and is a licensed physician (MD or DO), oral surgeon (DDS or DMD), or podiatrist (DPM) who is specially trained and qualified. Qualifications and training must adhere to The Joint Commission standards, hospital standards, and local and state admitting practices and procedures (Rothrock, 2019).

The Registered Nurse First Assistant

The **registered nurse first assistant (RNFA)** is another member of the OR team. Although the scope of practice of the RNFA depends on each state's nurse practice act, the RNFA practices under the direct supervision of the surgeon. RNFA responsibilities may include handling tissue, providing exposure at the operative field, suturing, and maintaining hemostasis (Rothrock, 2019). The role requires a thorough understanding of anatomy and physiology, tissue handling, and the principles of surgical asepsis. The RNFA must be aware of the objectives of the surgery, must have the knowledge and ability to anticipate needs and to work as a skilled member of a team, and must be able to handle any emergency situation in the OR.

The Anesthesiologist and CRNA

An **anesthesiologis**t is a physician specifically trained in the art and science of anesthesiology. A **certified registered nurse anesthetist (CRNA)** is a qualified and specifically trained health care professional who administers anesthetic agents, has graduated from an accredited nurse anesthesia program, and has passed examinations sponsored by the American Association of Nurse Anesthetists. The anesthesiologist or CRNA assesses the patient before surgery, selects the anesthesia, administers it, intubates the patient if necessary, manages any technical problems related to the administration of the anesthetic agent, and supervises the patient's condition throughout the surgical procedure. Before the patient enters the OR, often at preadmission testing, the anesthesiologist or CRNA visits the patient to perform an assessment, supply information, and answer questions. The type of anesthetic agent to be given, previous reactions to anesthetic medications, and known anatomic abnormalities that would make airway management difficult are among topics addressed.

The anesthesiologist or CRNA uses the American Society of Anesthesiologists (ASA) Physical Classification System to determine the patient's status. A patient who is classified as P2, P3, or P4 has a systemic disease that may or may not be related to the cause of surgery. If a patient with a classification of P1, P2, P3, P4, or P5 requires emergency surgery, an E is added to the physical status designation (e.g., P1E, P2E). P6 refers to a patient who is brain dead and is undergoing surgery as an organ donor. The abbreviations ASA1 through ASA6 are often used interchangeably with P1 to P6 to designate physical status (Rothrock, 2019).

When the patient arrives in the OR, the anesthesiologist or CRNA reassesses the patient's physical condition immediately prior to initiating anesthesia. The anesthetic agent is given, and the patient's airway is maintained through an intranasal intubation (if the surgeon is using an oral approach to surgery), intubation with an endotracheal tube (ET), or a laryngeal mask airway (LMA). During surgery, the anesthesiologist or CRNA monitors the patient's blood pressure, pulse, and respirations, as well as the electrocardiogram (ECG), blood oxygen saturation level, tidal volume, blood gas levels, blood pH, alveolar gas concentrations, and body temperature. End tidal CO_2 monitoring by electroencephalography (EEG) is sometimes required. Levels of anesthetic medications in the body can also be determined; a mass spectrometer can provide instant readouts of critical concentration levels on display terminals. This information is used to assess the patient's ability to breathe unassisted or the need for mechanical assistance if ventilation is poor and the patient is not breathing well independently.

Safety and Infection Prevention

Within the OR, many factors prevent the spread of microorganisms that may cause surgical site infections (SSIs). These factors involve a combination of facility structure and personnel practices, which are regulated by professional guidelines and overseen by facility members.

The Surgical Environment

The surgical suite is behind double doors, and access is limited to authorized, appropriately clad personnel. The OR is considered a restricted area where careful attention to infection prevention is at the highest standard. In the OR environment, microbial contamination can occur through an airborne or contact route; as a result, the OR has special air filtration devices to screen out contaminating particles, dust, and pollutants. ORs are designed with laminar flow ventilation to circulate particles away from the patient and surgical field. Personnel also follow strict aseptic practices, including hand scrubbing, machine and room cleaning, sterile supply and instrumentation use, and limited

movement. Reducing traffic and door openings has been linked to maintaining optimal airflow with minimal circulating particles and contaminants (Armellino, 2017). Policies governing this environment address such issues as the health of the staff; the cleanliness of the rooms; the sterility of equipment and surfaces; processes for scrubbing, gowning, and gloving; and OR attire (AORN, 2019a).

The surgical environment is known for its stark appearance and cool temperature. Therefore, it is important to maintain patient normothermia. Research supports warming the patient starting in the preoperative area, and throughout all perioperative phases of care. Examples of intraoperative warming techniques are raising room temperature, using forced-air warming blankets, and administering warmed irrigation and IV solutions (Phillips, 2017; Williams, 2018).

To provide the best possible conditions for surgery, the OR is situated in a location that is central to all supporting services (e.g., pathology, x-ray, and laboratory).

Many National Patient Safety Goals pertain to the perioperative areas (see Chapter 14, Chart 14-7); however, the one with the most direct relevance to the OR is to identify patient safety risks. A unique risk is the risk of fire in the OR due to three factors: a source of fuel, an oxygen source, and a mechanism to ignite a fire (AORN, 2019b; ASPAN, 2019).

Prevention of OR Fires

AORN recommends the use of the Fire Risk Assessment Tool to assess the dangers of fires for each surgical case (see Fig. 15-2). The fire risk is discussed during the surgical time-out, and an indication of whether or not the patient has a fire risk is placed on the team communication board in the OR. A regulatory requirement endorsed by The Joint Commission is that every OR perform an annual fire drill to ensure staff familiarity with evacuation plans and to test facility safeguards in the event of a fire (Joint Commission, 2019). To further improve safety, electrical hazards, emergency exit clearances, and storage of equipment and anesthetic gases are monitored periodically by official agencies, such as the respective state Department of Health and The Joint Commission.

Surgical Attire

To help decrease microbes, the surgical area is divided into three zones: the **unrestricted zone**, where street clothes are allowed; the **semirestricted zone**, where attire consists of scrub clothes and caps; and the **restricted zone**, where scrub clothes, shoe covers, caps, and masks are worn. The surgeons and other surgical team members wear additional sterile clothing and protective devices during surgery.

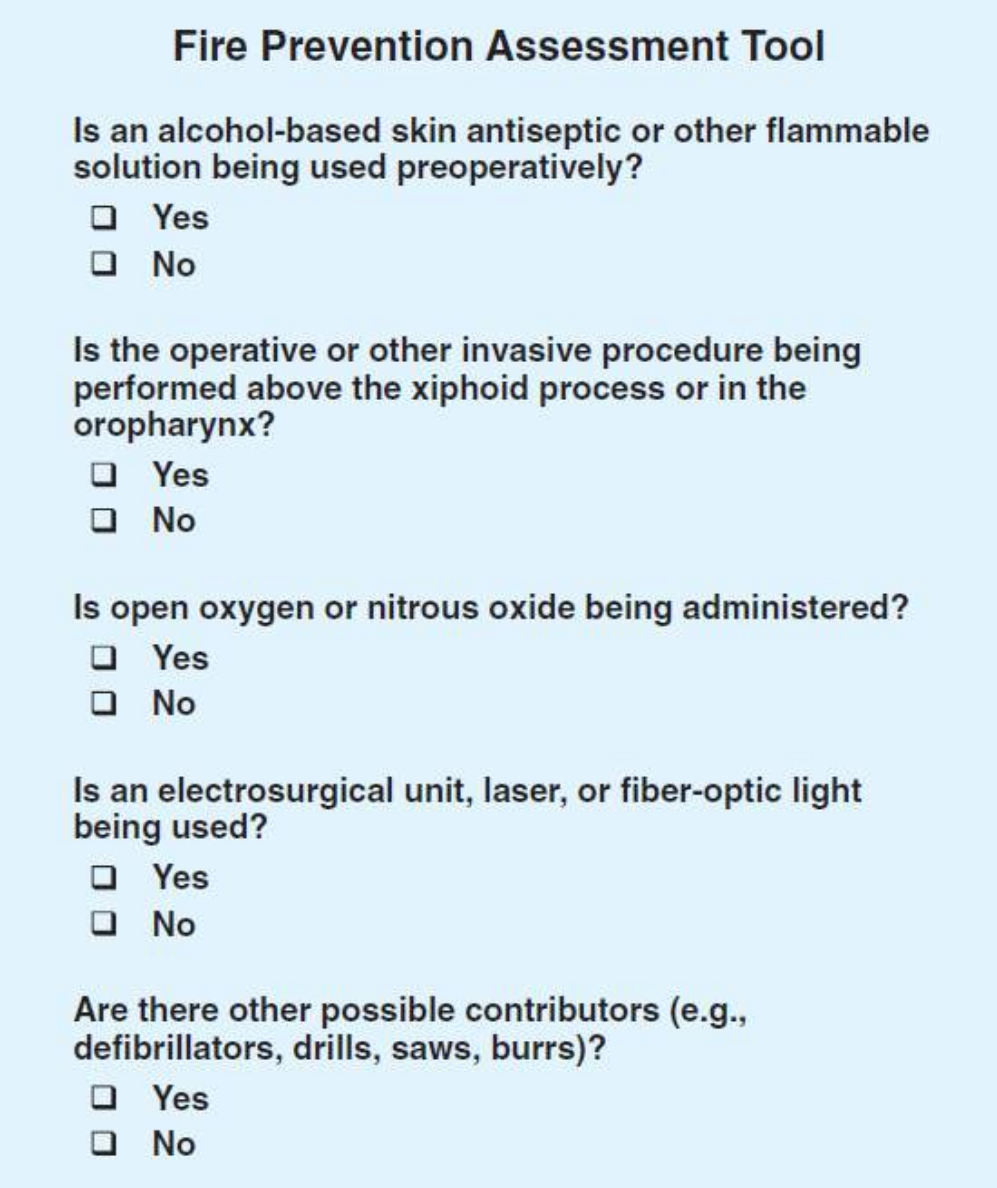

Figure 15-2 • AORN fire risk assessment tool. Reprinted with permission from Association of PeriOperative Registered Nurses (AORN). (2019b). Fire safety tool kit: Fire prevention assessment tool. Retrieved on 5/29/19 at: www.aorn.org/guidelines/clinical-resources/tool-kits/fire-safety-tool-kit

The AORN recommends specific practices for personnel wearing surgical attire to promote a high level of cleanliness in a particular practice setting (AORN, 2019a). OR attire includes close-fitting cotton scrub shirts and pants, gowns, and jackets. Knitted cuffs on sleeves prevent organisms from shedding and being released into the immediate surroundings. Shirts and waist drawstrings should be tucked inside the pants to prevent accidental contact with sterile areas and to contain skin shedding. Wet or soiled garments should be changed.

Masks are worn at all times in the restricted zone of the OR. High-filtration masks decrease the risk of postoperative wound infection by containing and

filtering microorganisms from the oropharynx and nasopharynx. Masks should fit tightly; should cover the nose and mouth completely; and should not interfere with breathing, speech, or vision. Masks must be adjusted to prevent venting from the sides. Disposable masks have a filtration efficiency exceeding 95%. Masks are changed between patients and should not be worn outside the surgical department. The mask must be either on or off; it must not be allowed to hang around the neck.

Headgear should completely cover the hair (head and neckline, including beard) so that hair, bobby pins, clips, and particles of dandruff or dust do not fall on the sterile field.

Shoes designated for use inside the OR (not worn home) should be comfortable and supportive. Shoe covers are used when spills or splashes are anticipated. If worn, the covers should be changed whenever they become wet, torn, or soiled (AORN 2019a; Rothrock, 2019).

Barriers such as scrub attire and masks do not entirely protect the patient from microorganisms. Upper respiratory tract infections, sore throats, and skin infections in staff and patients are sources of pathogens and must be reported.

Because artificial fingernails harbor microorganisms and can cause nosocomial infections, a ban on artificial nails by OR personnel is supported by the Centers for Disease Control and Prevention (CDC), AORN, and the Association for Professionals in Infection Control and Epidemiology (APIC). Research provides support for policies prohibiting artificial nails for health care workers (AORN, 2019a). Short, natural fingernails are encouraged.

Principles of Surgical Asepsis and Sterile Technique

Surgical asepsis prevents the contamination of surgical wounds. **Sterile technique** implies that the area is free of living microorganisms. The patient's natural skin flora or a previously existing infection may cause postoperative SSI. Rigorous adherence to the principles of sterility by OR personnel is basic to preventing SSIs.

All surgical supplies, instruments, needles, sutures, dressings, gloves, covers, and solutions that may come in contact with the surgical wound or exposed tissues must be sterilized before use (Rothrock, 2019). The surgeon, surgical assistants, scrub personnel, and nurses prepare themselves by scrubbing their hands and arms with antiseptic soap and water or alcohol-based (waterless) product. OR personnel must follow the product manufacturer's recommendations in order to achieve hand antisepsis (AORN, 2019a).

The skin of patients, OR team members, and visitors constitutes a microbiologic hazard. In an average individual, an estimated 4000 to 10,000 viable contaminated particles are shed by the skin each minute. *Staphylococcus aureus*, a bacterium, is the most common type of particle on dispersed skin cells (Phillips, 2017). Surgical team members wear long-sleeved, sterile gowns and gloves. Head and hair are covered with a cap, and a mask is worn over the nose

and mouth to minimize the possibility that bacteria from the upper respiratory tract will enter the wound. During surgery, only personnel who have scrubbed, gloved, and gowned touch sterilized objects. Nonscrubbed personnel refrain from touching or contaminating anything sterile.

An area of the patient's skin larger than that requiring exposure during the surgery is meticulously cleansed, and an antiseptic solution is applied (Rothrock, 2019). Close attention is paid to the application dry time of the agent, in particular chlorhexidine and other alcohol-based products. If hair removal needs to take place and this was unable to be performed before the patient arrived in the OR suite, this is done immediately before the procedure with electric clippers (not shaved) to minimize the risk of infection (AORN, 2019a). The remainder of the patient's body is covered with sterile drapes.

Environmental Controls

In addition to the protocols described previously, surgical asepsis requires meticulous cleaning and maintenance of the OR environment. Floors and horizontal surfaces are cleaned between cases with detergent, soap, and water or a detergent germicide. Sterilized equipment is inspected regularly to ensure optimal operation and performance.

All equipment that comes into direct contact with the patient must be sterile. Sterilized linens, drapes, and solutions are used. Instruments are cleaned and sterilized in a unit near the OR. Individually wrapped sterile items are used when additional individual items are needed.

Airborne bacteria are a concern. To decrease the amount of bacteria in the air, standard OR ventilation provides 15 air exchanges per hour, at least three of which are fresh air (AORN, 2019a; Rothrock, 2019). A room temperature of 20° to 24°C (68° to 73°F), humidity between 30% and 60%, and positive pressure relative to adjacent areas are maintained. With the standard air exchanges, air counts of bacteria are reduced to 50 to 150 colony-forming units (CFUs) per cubic foot per minute. Systems with high-efficiency particulate air (HEPA) filters are needed to remove particles larger than 0.3 μm (Rothrock, 2019). Unnecessary personnel and physical movement may be restricted to minimize bacteria in the air and achieve an OR infection rate no greater than 3% to 5% in clean, infection-prone surgery.

Some ORs have laminar airflow units. These units provide 400 to 500 air exchanges per hour (Rothrock, 2019). When used appropriately, laminar airflow units result in fewer than 10 CFUs per cubic foot per minute during surgery. The goal for a laminar airflow–equipped OR is an infection rate of less than 1%. An OR equipped with a laminar airflow unit is frequently used for total joint replacement or organ transplant surgery.

Even using all precautions, wound contamination may inadvertently occur. Constant surveillance and conscientious technique in carrying out aseptic practices are necessary to reduce the risk of contamination and infection.

Basic Guidelines for Maintaining Surgical Asepsis

All practitioners involved in the intraoperative phase have a responsibility to provide and maintain a safe environment. Adherence to aseptic practice is part of this responsibility. The basic principles of aseptic technique follow (AORN, 2019a):

- All materials in contact with the surgical wound or used within the sterile field must be sterile. Sterile surfaces or articles may touch other sterile surfaces or articles and remain sterile; contact with unsterile objects at any point renders a sterile area contaminated.
- Gowns of the surgical team are considered sterile in front from the chest to the level of the sterile field. The sleeves are also considered sterile from 2 inches above the elbow to the stockinette cuff.
- Sterile drapes are used to create a sterile field (see Fig. 15-3). Only the top surface of a draped table is considered sterile. During draping of a table or patient, the sterile drape is held well above the surface to be covered and is positioned from front to back.
- Items are dispensed to a sterile field by methods that preserve the sterility of the items and the integrity of the sterile field. After a sterile package is opened, the edges are considered unsterile. Sterile supplies, including solutions, are delivered to a sterile field or handed to a scrubbed person in such a way that the sterility of the object or fluid remains intact.

Figure 15-3 • Proper draping exposes only the surgical site, which decreases the risk of infection.

- The movements of the surgical team are from sterile to sterile areas and from unsterile to unsterile areas. Scrubbed people and sterile items contact only sterile areas; circulating nurses and unsterile items contact only unsterile areas.
- Movement around a sterile field must not cause contamination of the field. Sterile areas must be kept in view during movement around the area. At least a 1-ft distance from the sterile field must be maintained to prevent inadvertent contamination.
- Whenever a sterile barrier is breached, the area must be considered contaminated. A tear or puncture of the drape permitting access to an unsterile surface underneath renders the area unsterile. Such a drape must be replaced.
- Every sterile field is constantly monitored and maintained. Items of doubtful sterility are considered unsterile. Sterile fields are prepared as close as possible to the time of use.
- The routine administration of hyperoxia (high levels of oxygen) is *not* recommended to reduce SSIs.

Health Hazards Associated with the Surgical Environment

Faulty equipment, improper use of equipment, exposure to toxic substances, surgical plume (smoke generated by electrosurgical cautery), as well as infectious waste, cuts, needlestick injuries, and lasers are some of the associated hazards in the surgical environment (Rothrock, 2019). Internal monitoring of the OR includes the analysis of surface swipe samples and air samples for infectious and toxic agents. In addition, policies and procedures for minimizing exposure to body fluids and reducing the dangers associated with lasers and radiation are identified in AORN standards (AORN, 2019a).

Regardless of the size or location of an incision, unintentional retention of an object (e.g., sponge, instrument) can occur. A retained object can cause wound infection or disruption, an abscess can form, and fistulas may develop between organs (Rothrock, 2019). Safety measures should be in place to reduce the risk of a retained object. Best practices include minimized distractions during the counting process, radiofrequency (RF) technology, and clear communication that includes the willingness to raise concerns among the surgical team members. RF technology acts as a "back-up method" for sponge counting using low-frequency RF chips inside sponges that can be detected via a wand or other scanning detection device. The technology is used in many institutions and can increase patient safety by detecting retained sponges before the surgeon closes the incision (Steelman, Schaapveld, Storm, et al., 2019).

Laser Risks

The AORN has recommended practices for laser safety (AORN, 2019a). When lasers are in use, warning signs must be posted on the doors and safety goggles must be available for staff to don prior to room entry. Personnel must also wear a protective mask to prevent inhalation of the plume emitted from the laser. The type of laser in use and the safety precautions in place are verified by all team members during the time-out (Burlingame, 2017). Several types of lasers are available for clinical use; perioperative personnel should be familiar with the unique features, specific operation, and safety measures for each type of laser used in the practice setting and wear appropriate laser goggles for the type of laser beam in use. Registered nurses trained and certified in laser safety maintain the established standards in the OR (AORN, 2019a).

Surgical Smoke

Approximately 500,000 health care workers are exposed to surgical smoke each year. This smoke is created from thermal destruction of tissue. Smoke plumes may contain toxic gases and vapors such as benzene, hydrogen cyanide, formaldehyde, bioaerosols, dead and live cellular material, and viruses. It is estimated that in an average day, the effect of breathing surgical smoke could be comparable to smoking 30 unfiltered cigarettes. Perioperative nurses are twice as likely as the general population to report experiencing respiratory problems (Davis, 2018; US Department of Labor, Occupational Safety and Health Administration, 2018).

Smoke evacuators are used in some procedures to remove the plume from the operative field. If a smoke evacuator is not available, surgical team members should don an N95 respirator mask rather than a surgical mask, which does not prevent smoke from entering the airway orifices. In recent years, this technology has been extended to all surgical cases to protect the surgical team from the potential hazards associated with the generalized smoke plume generated by standard electric cautery units. Evacuating surgical smoke not only protects the perioperative team, but also patients (Spruce, 2018).

Exposure to Blood and Body Fluids

Basic scrub attire worn by sterile "scrubbed-in" OR personnel include double sterile gloves, eye protection, surgical mask, a sterile gown, and shoe covers. These help to protect against splashing, drilling, and blood loss exposure. In hospitals where numerous total joint procedures are performed, a complete bubble mask may be used. This mask provides full-barrier protection from bone fragments and splashes. Ventilation is accomplished through an accompanying hood with a separate air filtration system.

An estimated 380,000 sharps injuries occur in health care per year, and roughly one third of these occur in the OR setting. Interventions such as using sharps with safety engineered devices, passing sharps using a "neutral zone" or "safe zone," and placing used sharps in puncture-resistant containers can help to reduce these incidents (Davis, 2018). The "neutral zone" or "safe zone"

techniques are designated spaces established for sharps to be put down and picked up (AORN, 2019).

Robotics

Several types of surgical robots are used to facilitate the performance of minimally invasive procedures. These techniques were first introduced in the 1980s in an effort to overcome the disadvantages of traditional laparoscopic surgery, such as limited arm movement and view (Carlos & Saulan, 2018). Many surgical specialties have the ability to use robotic technology for surgical cases, particularly those in the cardiac, urologic, thoracic, and gynecologic specialties. Several types of robotic-driven tools assist in making surgery more precise and less invasive for patients. Technologic advancements of the robot include 3D high-definition imaging and better motion control of instrumentation. The articulated arms offer a 360-degree wristlike movement for precision grasping, manipulation, dissection, and suturing of tissue (Phillips, 2017).

The Surgical Experience

During the surgical procedure, the patient will need sedation, anesthesia, or some combination of these. There are many low-risk anesthesia agents to choose from.

Types of Anesthesia and Sedation

Research estimates anesthesia-related death rates in the United States to be less than 1 per 10,000 surgeries (Barash et al., 2017). For the patient, the anesthesia experience consists of having an IV line inserted, if it was not inserted earlier; receiving a sedating agent prior to induction with an anesthetic agent; losing consciousness; being intubated, if indicated; and then receiving a combination of anesthetic agents. Typically, the experience is a smooth one, and the patient has no recall of the events. The main types of anesthesia are general anesthesia (inhalation, IV), regional anesthesia (epidural, spinal, and local conduction blocks), moderate sedation (monitored anesthesia care [MAC]), and local anesthesia.

General Anesthesia

Anesthesia is a state of narcosis (severe central nervous system depression produced by pharmacologic agents), analgesia, relaxation, and reflex loss. Patients under general anesthesia are not arousable, not even to painful stimuli. They lose the ability to maintain ventilatory function and require assistance in maintaining a patent airway. Cardiovascular function may be impaired as well.

General anesthesia consists of four stages, each associated with specific clinical manifestations (Rothrock, 2019). Understanding of these stages is necessary for nurses because of the emotional support that the patient might need as anesthesia progresses. These stages occur in reverse as the patient wakes up at the end of surgery, so the nurse must be aware of the need for appropriate patient support.

- *Stage I: beginning anesthesia.* Dizziness and a feeling of detachment may be experienced during induction. The patient may have a ringing, roaring, or buzzing in the ears and, although still conscious, may sense an inability to move the extremities easily. These sensations can result in agitation. During this stage, noises are exaggerated; even low voices or minor sounds seem loud and unreal. For these reasons, unnecessary noises and motions are avoided when anesthesia begins.
- *Stage II: excitement.* The excitement stage, characterized variously by struggling, shouting, talking, singing, laughing, or crying, is often avoided if IV anesthetic agents are given smoothly and quickly. The pupils dilate, but they constrict if exposed to light; the pulse rate is rapid; and respirations may be irregular. Because of the possibility of uncontrolled movements of the patient during this stage, the anesthesiologist or CRNA must always be assisted by someone ready to help restrain the patient or to apply cricoid pressure in the case of vomiting to prevent aspiration. Manipulation increases circulation to the operative site and thereby increases the potential for bleeding.
- *Stage III: surgical anesthesia.* Surgical anesthesia is reached by administration of anesthetic vapor or gas and supported by IV agents as necessary. The patient is unconscious and lies quietly on the table. The pupils are small but constrict when exposed to light. Respirations are regular, the pulse rate and volume are normal, and the skin is pink or slightly flushed. With proper administration of the anesthetic agent, this stage may be maintained for hours in one of several planes, ranging from light (1) to deep (4), depending on the depth of anesthesia needed.
- *Stage IV: medullary depression.* This stage is reached if too much anesthesia has been given. Respirations become shallow, the pulse is weak and thready, and the pupils become widely dilated and no longer constrict when exposed to light. Cyanosis develops and, without prompt intervention, death rapidly follows. If this stage develops, the anesthetic agent is discontinued immediately and respiratory and circulatory support is initiated to prevent death. Stimulants, although rarely used, may be given; narcotic antagonists can be used if the overdose is due to opioids. It is not a planned stage of surgical anesthesia.

When opioid agents (narcotics) and neuromuscular blockers (relaxants) are given, several of the stages are absent. During smooth administration of an

anesthetic agent, there is no sharp division between stages. The patient passes gradually from one stage to another, and it is through close observation of the signs exhibited by the patient that an anesthesiologist or CRNA controls the situation. The responses of the pupils, the blood pressure, and the respiratory and cardiac rates are among the most reliable guides to the patient's condition.

Anesthetic medications produce anesthesia because they are delivered to the brain at a high partial pressure that enables them to cross the blood–brain barrier. Relatively large amounts of anesthetic medication must be given during induction and the early maintenance phases because the anesthetic agent is recirculated and deposited in body tissues. As these sites become saturated, smaller amounts of the anesthetic agent are required to maintain anesthesia because equilibrium or near-equilibrium has been achieved between brain, blood, and other tissues. When possible, the anesthesia induction (initiation) begins with IV anesthesia and is then maintained at the desired stage by inhalation methods, achieving a smooth transition and eliminating the obvious stages of anesthesia (see Table 15-1). All are given in combination with oxygen and usually nitrous oxide as well.

TABLE 15-1 Inhalation Anesthetic Agents

Agent	Administration	Advantages	Disadvantages	Implications/Considerations
Volatile Liquids				
Halothane	Inhalation; special vaporizer	Not explosive or flammable Induction rapid and smooth Useful in almost every type of surgery Low incidence of postoperative nausea and vomiting	Requires skillful administration to prevent overdose May cause liver damage May produce hypotension Requires special vaporizer for administration	In addition to observation of pulse and respiration postoperatively, blood pressure must be monitored frequently
Enflurane	Inhalation	Rapid induction and recovery Potent analgesic agent Not explosive or flammable	Respiratory depression may develop rapidly, along with electrocardiogram abnormalities Not compatible with epinephrine	Observe for possible respiratory depression. Administration with epinephrine may cause ventricular fibrillation
Isoflurane	Inhalation	Rapid induction and recovery Muscle relaxants are markedly potentiated	A profound respiratory depressant	Monitor respirations closely, support when necessary, and monitor for malignant hyperthermia
Sevoflurane[a]	Inhalation	Rapid induction and excretion; minimal side effects	Coughing and laryngospasm; trigger for malignant hyperthermia	Monitor for malignant hyperthermia
Desflurane	Inhalation	Rapid induction and emergence; rare organ toxicity	Respiratory irritation; trigger for malignant hyperthermia	Monitor for malignant hyperthermia and arrhythmias
Gases				
Nitrous oxide (N_2O)	Inhalation (semiclosed method)	Induction and recovery rapid Nonflammable Useful with oxygen for short procedures Useful with other agents for all types of surgery	Poor relaxant Weak anesthetic May produce hypoxia	Most useful in conjunction with other agents with longer action Monitor for chest pain, nausea and vomiting, hypertension, and stroke
Oxygen (O_2)	Inhalation	Can increase O_2 available to tissues	High concentrations are hazardous	Increased fire risk when used with lasers

[a]Currently most popular choice.
Adapted from Association of PeriOperative Registered Nurses (AORN). (2019a). *Association of PeriOperative Registered Nurses (AORN) standards, recommended practice, and guidelines*. Denver, CO: Author.

Any condition that diminishes peripheral blood flow, such as vasoconstriction or shock, may reduce the amount of anesthetic medication required. Conversely, when peripheral blood flow is unusually high, as in a muscularly active or apprehensive patient, induction is slower, and greater quantities of anesthetic agents are required because the brain receives a smaller quantity of anesthetic agent.

Inhalation

Inhaled anesthetic agents include volatile liquid agents and gases. Volatile liquid anesthetic agents produce anesthesia when their vapors are inhaled. Some commonly used inhalation agents are included in Table 15-1. All are given in combination with oxygen and usually nitrous oxide as well.

Gas anesthetic agents are given by inhalation and are always combined with oxygen. Nitrous oxide, sevoflurane, and desflurane are the most commonly used gas anesthetic agents. When inhaled, the anesthetic agents enter the blood through the pulmonary capillaries and act on cerebral centers to produce loss of consciousness and sensation. When anesthetic administration is discontinued, the vapor or gas is eliminated through the lungs.

The vapor from inhalation anesthetic agents can be given to the patient by several methods. The inhalation anesthetic agent may be given through an LMA—a flexible tube with an inflatable silicone ring and cuff that can be inserted into the larynx (see Fig. 15-4A). The endotracheal technique for administering anesthetic medications consists of introducing a soft rubber or plastic ET into the trachea, usually by means of a laryngoscope. The ET may be inserted through either the nose (see Fig. 15-4B) or mouth (see Fig. 15-4C). When in place, the tube seals off the lungs from the esophagus so that if the patient vomits, stomach contents do not enter the lungs.

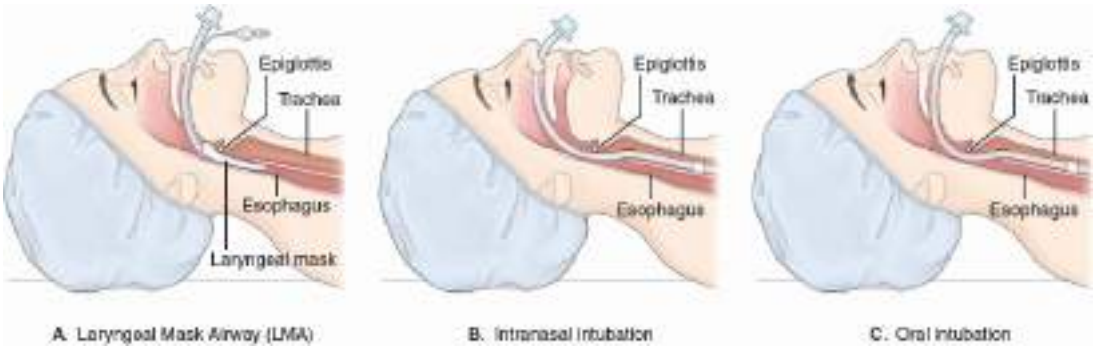

Figure 15-4 • Anesthetic delivery methods. **A.** Laryngeal mask airway (LMA). **B**. Nasal endotracheal catheter used when oral access will be required by the surgeon (in position with cuff inflated). **C.** Oral endotracheal intubation (tube is in position with cuff inflated).

Intravenous Administration

General anesthesia can also be produced by the IV administration of various anesthetic and analgesic agents, such as barbiturates, benzodiazepines, nonbarbiturate hypnotics, dissociative agents, and opioid agents. Table 15-2 lists commonly used IV anesthetic and analgesic agents, including IV medications used as muscle relaxants in the intraoperative period. These medications may be given to induce or maintain anesthesia. Although they are often used in combination with inhalation anesthetic agents, they may be used alone. They may also be used to produce moderate sedation, as discussed later in this chapter.

TABLE 15-2 Commonly Used Intravenous Medications

Medication	Common Usage	Advantages	Disadvantages	Comments
Opioid Analgesic Agents				
Alfentanil	Surgical analgesia in ambulatory patients	Ultra-short-acting (5–10 min) analgesic agent; duration of action 0.5 h; bolus or infusion	—	Potency: 750 μg half-life 1.6 h
Fentanyl	Surgical analgesia; epidural infusion for postoperative analgesia; add to SAB	Good cardiovascular stability; duration of action 0.5 h	May cause muscle or chest wall rigidity	Most commonly used opioid; potency: 100 μg = 10 mg morphine sulfate; elimination half-life 3.6 h
Morphine sulfate	Preoperative pain; premedication; postoperative pain	Inexpensive; duration of action 4–5 h; euphoria; good cardiovascular stability	Nausea and vomiting; histamine release; postural ↓ BP and ↓ SVR	Epidural and intrathecal administration for postoperative pain; elimination half-life 3 h
Remifentanil	IV infusion for surgical analgesia; small boluses for brief, intense pain	Easily titrated; very short duration; good cardiovascular stability. Ultiva is rapidly metabolized by hydrolysis of the propanoic acid–methyl ester linkage by nonspecific blood and tissue esterases	Expensive; requires nursing; may cause muscle rigidity	Potency: 25 μg = 10 mg morphine sulfate; 20–30 times potency of alfentanil; elimination half-life 3–10 min
Sufentanil	Surgical analgesia	Duration of action 0.5 h; prolonged analgesia exceptionally potent (5–10 times more than fentanyl); provides good stability in cardiovascular surgery	Prolonged respiratory depression	Potency: 15 μg = 10 mg morphine sulfate; elimination half-life 2.7 h
Depolarizing Muscle Relaxants				
Succinylcholine	Relax skeletal muscles for surgery and orthopedic manipulations; short procedures; intubation	Short duration; rapid onset	No known effect on consciousness, pain threshold, or cerebration; fasciculations, postoperative myalgias, arrhythmias, raises serum K^+ in tissue trauma, muscular disease, paralysis, burns; histamine release is slight; requires refrigeration	Prolonged muscle relaxation with serum cholinesterase deficiency and some antibiotics; may trigger malignant hyperthermia
Nondepolarizing Muscle Relaxants—Intermediate Onset and Duration				
Atracurium besylate	Intubation; maintenance of skeletal muscle relaxation	No significant cardiovascular or cumulative effects; good with kidney injury	Requires refrigeration; slight histamine release; pregnancy risk category C; do not mix with lactated Ringer's solution or alkaline solutions such as barbiturates	Rapid IV bolus; use cautiously with older adult patients and those who are debilitated
Cisatracurium besylate	Intubation; maintenance of skeletal muscle relaxation	Similar to atracurium	No histamine release	Similar to atracurium
Mivacurium	Intubation; maintenance of skeletal muscle relaxation	Short acting; rapid metabolism by plasma cholinesterase; used as bolus or infusion	Expensive in longer cases	Competes with acetylcholine for receptor sites at the motor end plate, blocking neuromuscular transmission; new; rarely need to reverse; prolonged effect with plasma cholinesterase deficiency
Rocuronium	Intubation; maintenance of relaxation	Rapid onset (dose dependent); elimination via kidney and liver	No known effect on consciousness, pain threshold, or cerebration; vagolytic; may ↑ HR	Duration similar to atracurium and vecuronium
Vecuronium	Intubation; maintenance of relaxation	No significant cardiovascular or cumulative effects; no histamine release	Requires mixing	Mostly eliminated in bile, some in urine

Nondepolarizing Muscle Relaxants—Longer Onset and Duration				
d-Tubocurarine	Adjunct to anesthetic maintenance of relaxation	—	No known effect on consciousness, pain threshold, or cerebration; might cause histamine release and transient ganglionic blockade	Mostly used for pretreatment with succinylcholine
Metocurine	Maintenance of relaxation	Good cardiovascular stability	Slight histamine release	Most commonly used opioid; potency: 100 µg = 10 mg morphine sulfate; elimination half-life 3.6 h
Pancuronium	Maintenance of relaxation	—	May cause ↑ HR and ↑ BP	Used intrathecally and epidurally for postoperative pain; elimination half-life 3 h
Intravenous Anesthetic Agents				
Diazepam	Amnesia; hypnotic; relieves anxiety; preoperative	Good sedation	Long acting	Residual effects for 20–90 h; increased effect with alcohol
Etomidate	Induction of general anesthesia; indicated to supplement low-potency anesthetic agents	Short-acting hypnotic; good cardiovascular stability; fast, smooth induction and recovery	May cause brief period of apnea; pain with injection and myotonic movements	—
Ketamine	Induction; occasional maintenance (IV or IM)	Short acting; profound analgesia; patient maintains airway; good in small children and burn patients	Large doses may cause hallucinations and respiratory depression; chest wall rigidity; laryngeal spasm	Need darkened, quiet room for recovery; often used in trauma cases
Midazolam	Hypnotic; anxiolytic; sedation; often used as adjunct to induction	Excellent amnesia; water soluble (no pain with IV injection); short acting	Slower induction than thiopental	Often used for amnesia with insertion of invasive monitors or regional anesthesia; depresses all levels of CNS, including limbic and reticular formation, probably through increased action of GABA, which is major inhibitory neurotransmitter in brain
Propofol	Induction and maintenance; sedation with regional anesthesia or MAC	Rapid onset; awakening in 4–8 min; produces sedation/hypnosis rapidly (within 40 s) and smoothly with minimal excitation; decreases intraocular pressure and systemic vascular resistance; rarely is associated with malignant hyperthermia and histamine release	May cause pain when injected; suppresses cardiac output and respiratory drive	Short elimination half-life (34–64 min)
Methohexital sodium	Induction; methohexital slows the activity of brain and nervous system	Ultra-short-acting barbiturate	May cause hiccups	Can be given rectally
Thiopental sodium	Induction; stops seizures	—	May cause laryngospasm	Large doses may cause apnea and cardiovascular depression; can be given rectally

BP, blood pressure; CNS, central nervous system; GABA, gamma-aminobutyric acid; HR, heart rate; IM, intramuscular; IV, intravenous; K^+, potassium; MAC, monitored anesthesia care; SAB, subarachnoid block; SVR, stroke volume rate.

Adapted from Association of PeriOperative Registered Nurses (AORN). (2018a). *Association of PeriOperative Registered Nurses (AORN) standards, recommended practice, and guidelines*. Denver, CO: Author.

An advantage of IV anesthesia is that the onset of anesthesia is pleasant; there is none of the buzzing, roaring, or dizziness known to follow administration of an inhalation anesthetic agent. The duration of action is brief, and the patient awakens with little nausea or vomiting.

The IV anesthetic agents are nonexplosive, require little equipment, and are easy to administer. The low incidence of postoperative nausea and vomiting (PONV) makes the method useful in eye surgery, because in this setting vomiting would increase intraocular pressure and endanger vision in the operated eye. IV anesthesia is useful for short procedures but is used less often for the longer procedures of abdominal surgery. It is not indicated for those who require intubation because of their susceptibility to respiratory obstruction. The combination of IV and inhaled anesthetic agents produces an effective and smooth experience for the patient, with a controlled emergence following surgery.

IV neuromuscular blockers (muscle relaxants) block the transmission of nerve impulses at the neuromuscular junction of skeletal muscles. Muscle relaxants are used to relax muscles in abdominal and thoracic surgery, relax eye muscles in

certain types of eye surgery, facilitate endotracheal intubation, treat laryngospasm, and assist in mechanical ventilation.

Multimodal Anesthesia

Multimodal analgesia regimens in surgical patients often use a combination of scheduled, nonopioid analgesic agents and regional anesthesia techniques (Wolfe, 2018). Multimodal analgesia aims to reduce opioid requirements and associated risks such as sedation, respiratory depression, nausea, vomiting, and potential of overuse of opioids. Multimodal anesthesia is a growing trend in the enhanced recovery after surgery (ERAS) pathways, as it decreases the risks of general anesthesia and aids in opioid reduction strategies. Analysis of opioid-naive surgical patients and opioid-naive nonsurgical patients found that those undergoing surgery had an increased risk of chronic opioid use during the first year after surgery (Sun, Darnall, Baker, et al., 2016). ERAS pathways are evidence based and facility specific; the patient follows these pathways from pre-, intra-, postoperative, and home phases of care. ERAS pathways are developed by multidisciplinary teams to optimize the recovery from surgery by reducing the patient's stress response. Instead of general anesthesia, regional/local anesthesia (LA) (discussed below) is administered. Nonopioid medications such as acetaminophen and nonsteroidal anti-inflammatory drugs (NSAIDs), ketamine, and gabapentinoids are preferred pain control methods in ERAS pathways (American Association of Nurse Anesthetists [AANA], 2019b).

Regional Anesthesia

In regional anesthesia, an anesthetic agent is injected around nerves so that the region supplied by these nerves is anesthetized. The effect depends on the type of nerve involved. Motor fibers are the largest fibers and have the thickest myelin sheath. Sympathetic fibers are the smallest and have a minimal covering. Sensory fibers are intermediate. A local anesthetic agent blocks motor nerves least readily and sympathetic nerves most readily. An anesthetic agent is not considered metabolized until all three systems (motor, sensory, and autonomic) are no longer affected.

The patient receiving regional anesthesia is awake and aware of their surroundings unless medications are given to produce mild sedation or to relieve anxiety. The health care team must avoid careless conversation, unnecessary noise, and unpleasant odors; these may be noticed by the patient in the OR and may contribute to a negative response to the surgical experience. A quiet environment is therapeutic. The diagnosis must not be stated aloud if the patient is not to know it at this time.

Epidural Anesthesia

Epidural anesthesia is achieved by injecting a local anesthetic agent into the epidural space that surrounds the dura mater of the spinal cord (see Fig. 15-5).

The given medication diffuses across the layers of the spinal cord to provide anesthesia and pain relief (AORN, 2019; ASPAN, 2019). In contrast, spinal anesthesia involves injection through the dura mater into the subarachnoid space surrounding the spinal cord. Epidural anesthesia blocks sensory, motor, and autonomic functions; it differs from spinal anesthesia by the site of the injection and the amount of anesthetic agent used. Epidural doses are much higher because the epidural anesthetic agent does not make direct contact with the spinal cord or nerve roots (AORN, 2019a; ASPAN, 2019).

An advantage of epidural anesthesia is the absence of headache that can result from spinal anesthesia. A disadvantage is the greater technical challenge of introducing the anesthetic agent into the epidural space rather than the subarachnoid space. If inadvertent puncture of the dura occurs during epidural anesthesia and the anesthetic agent travels toward the head, high spinal anesthesia can result; this can produce severe hypotension and respiratory depression and arrest. Treatment of these complications includes airway support, IV fluids, and the use of vasopressors.

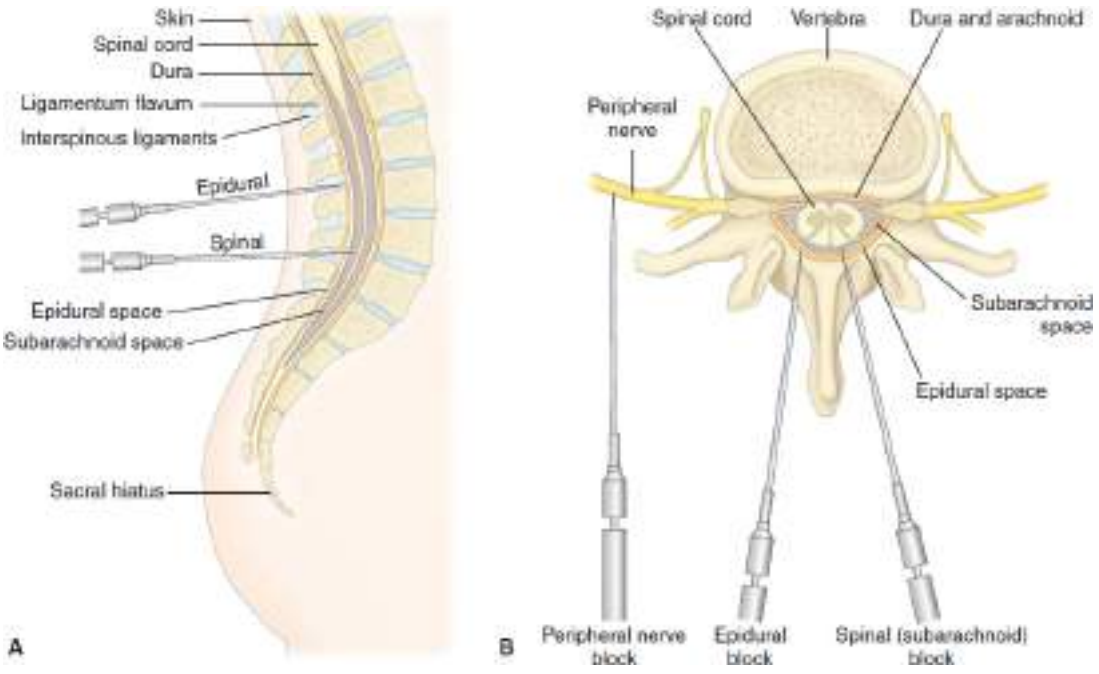

Figure 15-5 • **A.** Injection sites for spinal and epidural anesthesia. **B.** Cross-section of injection sites for peripheral nerve, epidural, and spinal blocks.

TABLE 15-3 Select Regional and Local Anesthetic Agents

Agent	Administration	Advantages	Disadvantages	Implications/Considerations
Lidocaine	Epidural, spinal, peripheral IV anesthesia, and local infiltration	Rapid Longer duration of action (compared with procaine) Free of local irritative effect	Occasional allergic reaction	Useful topically for cystoscopy Observe for untoward reactions—drowsiness, depressed respiration, seizures
Bupivacaine	Epidural, spinal, peripheral IV anesthesia, and local infiltration	Duration is 2–3 times longer than lidocaine	Use cautiously in patients with known drug allergies or sensitivities	A period of analgesia persists after return of sensation; therefore, the need for strong analgesic agents is reduced Greater potency and longer action than lidocaine
Tetracaine	Topical, infiltration, and nerve block	Long acting, produces good relaxation	Occasional allergic reaction	>10 times as potent as procaine
Procaine	Local infiltration	—	Occasional allergic reaction	Commonly used in oral or dental surgery

IV, intravenous.

Spinal Anesthesia

Spinal anesthesia is an extensive conduction nerve block that is produced when a local anesthetic agent is introduced into the subarachnoid space at the lumbar level, usually between L4 and L5 (see Fig. 15-5). It produces anesthesia of the lower extremities, perineum, and lower abdomen. For the lumbar puncture procedure, the patient usually lies on the side in a knee–chest position. Sterile technique is used as a spinal puncture is made and the medication is injected through the needle. As soon as the injection has been made, the patient is positioned on their back. If a relatively high level of block is sought, the head and shoulders are lowered.

The spread of the anesthetic agent and the level of anesthesia depend on the amount of agent injected, the speed with which it is injected, the positioning of the patient after the injection, and the specific gravity of the agent. If the specific gravity is greater than that of cerebrospinal fluid (CSF), the agent moves to the dependent position of the subarachnoid space. If the specific gravity is less than that of CSF, the anesthetic agent moves away from the dependent position. The anesthesiologist or CRNA controls the administration of the agent. Table 15-3 presents select regional anesthesia agents.

A few minutes after induction of a spinal anesthetic agent, anesthesia and paralysis affect the toes and perineum and then gradually the legs and abdomen.

Headache may be an aftereffect of spinal anesthesia. Several factors are related to the incidence of headache: the size of the spinal needle used, the leakage of fluid from the subarachnoid space through the puncture site, and the patient's hydration status. Measures that increase cerebrospinal pressure are helpful in relieving headache. These include maintaining a quiet environment, keeping the patient lying flat, and keeping the patient well hydrated.

In continuous spinal anesthesia, the tip of a plastic catheter remains in the subarachnoid space during the surgical procedure so that more anesthetic medication may be injected as needed. This technique allows greater control of the dosage; however, there is greater potential for postanesthetic headache because of the large-gauge needle used.

Peripheral Nerve Blocks

Peripheral nerve blocks (PNBs) are used in conjunction with general or MAC anesthesia, or as a stand-alone method. Instead of a single nerve being targeted, a bundle of nerves is located via ultrasound and injected with an anesthetic, opioid, or steroid. Traditionally, anesthesia would place the block in the OR setting. However, current research and best practices indicate that placing regional blocks in the preoperative department has greater efficacy. Patients emerge from anesthesia with less pain, decreasing the need for opioids. Research also suggests that patients spend less time in the postanesthesia care unit (PACU) and inpatients are discharged earlier (Gutierrez, Biehn, Eluna, et al., 2018).

Examples of common local conduction blocks include:

- Brachial plexus block, which produces anesthesia of the arm
- Paravertebral anesthesia, which produces anesthesia of the nerves supplying the chest, abdominal wall, and extremities
- Transsacral (caudal) block, which produces anesthesia of the perineum and, occasionally, the lower abdomen

Moderate Sedation

Moderate sedation, previously referred to as conscious sedation, is a form of anesthesia that involves the IV administration of sedatives or analgesic medications to reduce patient anxiety and control pain during diagnostic or therapeutic procedures. It is commonly used for many short-term surgical procedures in hospitals and ambulatory care centers (Rothrock, 2019). The goal is to depress a patient's level of consciousness to a moderate level to enable surgical, diagnostic, or therapeutic procedures to be performed while ensuring the patient's comfort during and cooperation with the procedures. With moderate sedation, the patient is able to maintain a patent airway, retain protective airway reflexes, and respond to verbal and physical stimuli.

Moderate sedation can be given by an anesthesiologist, CRNA, or other specially trained and credentialed physician or nurse. The practitioner who administers the sedation must be trained in resuscitative efforts as these patients are at risk for slipping into a deeper level of sedation (AORN, 2017). The continual assessment of the patient's vital signs, level of consciousness, and cardiac and respiratory function is an essential component of moderate sedation. Pulse oximetry, a continuous ECG monitor, and frequent measurement of vital signs are used to monitor the patient. Regulations for the use and administration of moderate sedation differ from state to state, and its administration is governed by standards issued by The Joint Commission and by institutional policies and nursing specialty organizations (AORN, 2017; ASPAN, 2018).

Monitored Anesthesia Care

Monitored anesthesia care (MAC), also referred to as monitored sedation, is moderate sedation given by an anesthesiologist or CRNA who must be prepared

and qualified to convert to general anesthesia if necessary. The skills of an anesthesiologist or CRNA may be necessary to manage the effects of a level of deeper sedation to return the patient to the appropriate level of sedation (Barash et al., 2017). MAC may be used for healthy patients undergoing relatively minor surgical procedures and for some critically ill patients who may be unable to tolerate anesthesia without extensive invasive monitoring and pharmacologic support (Rothrock, 2019).

Local Anesthesia

LA is the injection of a solution containing the anesthetic agent into the tissues at the planned incision site. Often it is combined with a local regional block by injecting around the nerves immediately supplying the area. A monitoring nurse (in addition to a circulating nurse) must be present during these cases. The monitoring nurse is responsible for documenting the patient's condition, pain level, level of consciousness, and vital signs throughout the procedure (AORN, 2019a). Advantages of LA are as follows:

- It is simple, economical, and nonexplosive.
- Equipment needed is minimal.
- Postoperative recovery is brief.
- Undesirable effects of general anesthesia are avoided.
- It is ideal for short and minor surgical procedures.

LA is often given in combination with epinephrine. Epinephrine constricts blood vessels, which prevents rapid absorption of the anesthetic agent and thus prolongs its local action and prevents seizures. Select local anesthetic agents are listed in Table 15-3; some of the same agents used in regional anesthesia are used as local anesthetic agents.

The skin is prepared as for any surgical procedure, and a small-gauge needle is used to inject a modest amount of the anesthetic medication into the skin layers. This produces blanching or a wheal. Additional anesthetic medication is then injected into the skin until an area surrounding the proposed incision is anesthetized. A larger, longer needle then is used to infiltrate deeper tissues with the anesthetic agent. The action of the agent is almost immediate, so surgery may begin shortly after the injection is complete. The anesthetic may be mixed with a fast-acting analgesic of short duration to circumvent the burning felt when the longer-acting anesthetics are injected.

Local Anesthetic Systemic Toxicity

Local Anesthetic Systemic Toxicity (LAST) is a potentially life-threatening event. LAST occurs when a bolus of LA is inadvertently injected into peripheral tissue or venous or arterial circulation during a PNB or spinal nerve block procedure and is rapidly absorbed into systemic circulation, resulting in cardiovascular or neurologic collapse (Ferguson, Coogle, Leppert, et al., 2019).

Signs and symptoms of LAST are:

- Metallic taste
- Oral numbness
- Auditory changes
- Slurred speech
- Arrhythmias
- Seizure
- Respiratory arrest

LAST is a rare event that occurs in approximately 1 of every 1000 patients (Wadlund, 2017). Early detection and treatment may prevent symptom progression and can lead to a better outcome for the patient. Initial treatment of LAST should focus on airway management. Hypoxemia and acidosis intensify the effects of LAST. The nurse calls for help and maintains the patient's airway while administering 100% oxygen and confirming IV access. Additional resources include members of the anesthesia team and critical-care nurses in the event that CPR or airway interventions take place. An IV infusion of lipid emulsions (an emulsion of soybean oil, egg phospholipids, and glycerin) can reverse the effects of LAST on the heart and central nervous system (AORN, 2019a; Wadlund, 2017).

Potential Intraoperative Complications

The surgical patient is subject to several risks. The major potential intraoperative complications include anesthesia awareness, nausea and vomiting, anaphylaxis, hypoxia, hypothermia, and malignant hyperthermia (MH). Targeted areas include SSIs as well as cardiac, respiratory, and venous thromboembolic complications (Joint Commission, 2019).

Anesthesia Awareness

It is important to discuss concerns about intraoperative awareness with patients preoperatively so that they realize that only general anesthesia is meant to create a state of oblivion. All other forms of anesthesia will eliminate pain, but sensation of pushing and pulling tissues may still be recognized and they may hear conversations among the operative team. In many cases, patients may be able to respond to questions and involve themselves in the discussion. This is normal and is not what is referred to as anesthesia awareness.

Unintended intraoperative awareness refers to a patient becoming cognizant of surgical interventions while under general anesthesia and then recalling the incident. Neuromuscular blocks, sometimes required for surgical muscle relaxation, intensify the fear of the patient experiencing awareness because they are then unable to communicate during the episode. Patients may or may not feel pain, and some patients experience a feeling of pressure. It has been estimated

that roughly 1 patient per 1000 receiving general anesthesia experiences some level of awareness that is most commonly fleeting (AANA, 2019a).

Indications of the occurrence of anesthesia awareness include an increase in the blood pressure, rapid heart rate, and patient movement. However, hemodynamic changes can be masked by paralytic medication, beta-blockers, and calcium channel blockers, thus the awareness may remain undetected. Premedication with amnesic agents and avoidance of muscle paralytics except when essential help to preclude its occurrence.

Nausea and Vomiting

Nausea and vomiting, or regurgitation, may affect patients during the intraoperative period. The patient should be assessed preoperatively for risk factors of PONV so that the surgical team can formulate a plan for intraoperative prevention. Risk factors include female gender, age less than 50 years, history of PONV, and opioid administration (Finch, Parkosewich, Perrone, et al., 2019).

If gagging occurs, the patient is turned to the side, the head of the table is lowered, and a basin is provided to collect the vomitus. Suction is used to remove saliva and vomited gastric contents. In some cases, the anesthesiologist or CRNA administers antiemetics preoperatively or intraoperatively to counteract possible aspiration. If the patient aspirates vomitus, an attack with severe bronchial spasms and wheezing is triggered. Pneumonitis and pulmonary edema can subsequently develop, leading to extreme hypoxia. Increasing medical attention is being paid to silent regurgitation of gastric contents (not related to preoperative fasting times), which occurs more frequently than previously realized. The volume and acidity of the aspirate determine the extent of damage to the lungs. Patients may be given citric acid and sodium citrate, a clear, nonparticulate antacid to increase gastric fluid pH or a histamine-2 (H_2) receptor antagonist such as cimetidine, or famotidine to decrease gastric acid production (Rothrock, 2019).

Anaphylaxis

Any time the patient comes into contact with a foreign substance, there is potential for an anaphylactic reaction. An anaphylactic reaction can occur in response to many medications, latex, or other substances. The reaction may be immediate or delayed. Anaphylaxis can be a life-threatening reaction.

Latex allergy—the sensitivity to natural rubber latex products—has become more prevalent, creating the need for alert responsiveness among health care professionals. If patients state that they have allergies to latex, even if they are wearing latex in their clothing, treatment must be latex free. In the OR, many products are latex free with the notable exception of softer latex catheters. Surgical cases should use latex-free gloves in anticipation of a possible allergy, and if no allergy is present, then personnel can switch to other gloves after the case starts if desired.

Fibrin sealants are used in various surgical procedures, and cyanoacrylate tissue adhesives are used to close wounds without the use of sutures. These sealants have been implicated in allergic reactions and anaphylaxis (Rothrock, 2019). Although these reactions are rare, the nurse must be alert to the possibility and observe the patient for changes in vital signs and symptoms of anaphylaxis when these products are used. In the OR, the team should remove potential causative agents promptly—within 3 minutes or less—of becoming aware of an anaphylactic reaction. The surgical team should be aware of the importance of prompt intervention to prevent cardiovascular and respiratory collapse (Seifert, 2017). (Chapters 11 and 33 provide more details about the signs, symptoms, and treatment of anaphylaxis and anaphylactic shock.)

Hypoxia and Other Respiratory Complications

Inadequate ventilation, occlusion of the airway, inadvertent intubation of the esophagus, and hypoxia are significant potential complications associated with general anesthesia. Many factors can contribute to inadequate ventilation. Respiratory depression caused by anesthetic agents, aspiration of respiratory tract secretions or vomitus, and the patient's position on the operating table can compromise the exchange of gases. Anatomic variation can make the trachea difficult to visualize and result in insertion of the artificial airway into the esophagus rather than into the trachea. In addition to these dangers, asphyxia caused by foreign bodies in the mouth; spasm of the vocal cords; relaxation of the tongue; or aspiration of vomitus, saliva, or blood can occur. Brain damage from hypoxia occurs within minutes; therefore, vigilant monitoring of the patient's oxygenation status is a primary function of the anesthesiologist or CRNA and the circulating nurse. Peripheral perfusion is checked frequently, and capnography readings are monitored continuously. Capnography provides instantaneous information about carbon dioxide production, pulmonary perfusion, and respiratory patterns that detect hypoventilation and apnea (Odom-Forren, 2018).

Hypothermia

During anesthesia, the patient's temperature may fall. Glucose metabolism is reduced, and as a result, metabolic acidosis may develop. This condition is called *hypothermia* and is indicated by a core body temperature that is lower than normal (36.6°C [98°F] or less). Risks of intraoperative hypothermia include cardiovascular events, SSIs, bleeding, and delayed arousal from anesthesia (Williams, 2018). Unintended hypothermia may occur as a result of a low temperature in the OR, infusion of cold fluids, inhalation of cold gases, open body wounds or cavities, decreased muscle activity, advanced age, or the pharmaceutical agents used (e.g., vasodilators, phenothiazines, general anesthetic medications). Hypothermia can depress neuronal activity and decrease cellular oxygen requirements below the minimum levels normally required for

continued cell viability. As a result, it is used to protect function during some surgical procedures (e.g., carotid endarterectomy, cardiopulmonary bypass) (Barash et al., 2017).

Unintended hypothermia needs to be avoided. If it occurs, it must be minimized or reversed. If hypothermia is intentional, the goal is safe return to normal body temperature. Environmental temperature in the OR can temporarily be set at 25° to 26.6°C (78° to 80°F). IV and irrigating fluids are warmed to 37°C (98.6°F). Wet gowns and drapes are removed promptly and replaced with dry materials, because wet materials promote heat loss. Warm air blankets and thermal blankets can also be used on the areas not exposed for surgery, and minimizing the area of the patient that is exposed will help maintain core temperature. Whatever methods are used to rewarm the patient, warming must be accomplished gradually, not rapidly. Conscientious monitoring of core temperature, urinary output, ECG, blood pressure, arterial blood gas levels, and serum electrolyte levels is required.

Malignant Hyperthermia

Malignant hyperthermia is a rare inherited muscle disorder that is chemically induced by anesthetic agents (Rothrock, 2019). This disorder can be triggered by myopathies, emotional stress, heatstroke, neuroleptic malignant syndrome, strenuous exercise exertion, and trauma. The incidence rate is 1 in every 170,698 general anesthetic cases (Phi, Carvalho, Sun, et al., 2018). MH occurs because of a genetic autosomal dominant disorder involving a mutation on the ryanodine receptor that causes an atypical increase in release of calcium in muscle cells (Mullins, 2018). Susceptible people include those with strong and bulky muscles, a history of muscle cramps or muscle weakness and unexplained temperature elevation, and an unexplained death of a family member during surgery that was accompanied by a febrile response (Ho, Carvalho, Sun, et al., 2018).

Pathophysiology

During anesthesia, potent agents such as inhalation anesthetic agents (i.e., halothane, enflurane, isoflurane) and muscle relaxants (succinylcholine) may trigger the symptoms of malignant hyperthermia (Rothrock, 2019). Stress and some medications, such as sympathomimetics (epinephrine), theophylline, aminophylline, anticholinergics (atropine), and cardiac glycosides (digitalis), can induce or intensify a reaction.

The pathophysiology of MH is related to a hypermetabolic condition that involves altered mechanisms of calcium function in skeletal muscle cells. This disruption of calcium causes clinical symptoms of hypermetabolism, which in turn increases muscle contraction (rigidity) and causes hyperthermia and subsequent damage to the central nervous system.

Clinical Manifestations

The initial symptoms of MH are often cardiovascular, respiratory, and abnormal musculoskeletal activity. Tachycardia (heart rate greater than 150 bpm) may be an early sign. Sympathetic nervous stimulation also leads to ventricular arrhythmia, hypotension, decreased cardiac output, oliguria, and, later, cardiac arrest. Hypercapnia, an increase in carbon dioxide (CO_2), may be an early respiratory sign. With the abnormal transport of calcium, rigidity or tetanuslike movements occur, often in the jaw. Generalized muscle rigidity is one of the earliest signs. The rise in temperature is actually a late sign that develops rapidly; body temperature can increase 1° to 2°C (2° to 4°F) every 5 minutes, and core body temperature can exceed 42°C (107°F) (Rothrock, 2019).

Medical Management

Goals of treatment are to decrease metabolism, reverse metabolic and respiratory acidosis, correct arrhythmias, decrease body temperature, provide oxygen and nutrition to tissues, and correct electrolyte imbalance. The treatment for MH is well known. Use of dantrolene has lowered mortality rates to 10% in current practice (Ho et al., 2018). The Malignant Hyperthermia Association of the United States (MHAUS) publishes a treatment protocol that should be posted in the OR and be readily available on a MH cart (see Resources section).

Anesthesia and surgery should be postponed. However, if end-tidal CO_2 monitoring and dantrolene sodium are available and the anesthesiologist is experienced in managing MH, the surgery may continue using a different anesthetic agent (Barash et al., 2017). Although MH usually manifests about 10 to 20 minutes after induction of anesthesia, it can also occur during the first 24 hours after surgery.

Nursing Management

Although MH is uncommon, the nurse must identify patients at risk, recognize the signs and symptoms, have the appropriate medication and equipment available, and be knowledgeable about the protocol to follow. Preparation and early intervention may be lifesaving for the patient.

NURSING PROCESS

The Patient during Surgery

Intraoperative nurses focus on nursing diagnoses, interventions, and outcomes that surgical patients and their families experience. Additional priorities include collaborative problems and expected goals.

Assessment

Nursing assessment of the intraoperative patient involves obtaining data from the patient and the patient's medical record to identify factors that can affect care. These serve as guidelines for an individualized plan of patient care. The intraoperative nurse uses the focused preoperative nursing assessment documented on the patient record. This includes assessment of physiologic status (e.g., health–illness level, level of consciousness), psychosocial status (e.g., anxiety level, verbal communication problems, coping mechanisms), physical status (e.g., surgical site, skin condition, and effectiveness of preparation; mobility of joints), and ethical concerns.

Diagnosis

NURSING DIAGNOSES

Based on the assessment data, major nursing diagnoses may include the following:

- Anxiety associated with surgical or environmental concerns
- Risk for latex allergy
- Risk for perioperative positioning injury associated with positioning in the OR
- Risk for injury associated with anesthesia and surgical procedure
- Risk for compromised dignity associated with general anesthesia or sedation

COLLABORATIVE PROBLEMS/POTENTIAL COMPLICATIONS

Based on the assessment data, potential complications may include the following:

- Anesthesia awareness
- Nausea and vomiting
- Anaphylaxis
- Hypoxia
- Unintentional hypothermia
- Malignant hyperthermia
- Infection

Planning and Goals

The major goals for care of the patient during surgery include reduced anxiety, absence of latex exposure, absence of positioning injuries, freedom

from injury, maintenance of the patient's dignity, and absence of complications.

Nursing Interventions

Reducing Anxiety

Preoperatively, the intraoperative nurse visiting the patient can help decrease anxiety and promote a relationship of communication and trust. The effect of familiarizing patients revealed significant decreased preoperative and postoperative anxiety (Bagheri, Ebrahimi, Abbasi, et al., 2019). The patient should be notified of what to expect when entering the operating room, and the nurse should inquire about any patient-specific relaxation preferences. The OR environment can seem cold, stark, and frightening to the patient, who may be feeling isolated and apprehensive. Introducing yourself, addressing the patient by name warmly and frequently, verifying details, providing explanations, and encouraging and answering questions provide a sense of professionalism and friendliness that can help the patient feel safe and secure. When discussing what the patient can expect in surgery, the nurse uses basic communication skills, such as touch and eye contact, to reduce anxiety. Attention to physical comfort (warm blankets, padding, position changes) helps the patient feel more comfortable. Telling the patient who else will be present in the OR, how long the procedure is expected to take, and other details helps the patient prepare for the experience and gain a sense of control.

The circulating nurse may assist to decrease anxiety during induction by using techniques such as guided imagery, decreasing room stimuli by dimming the lights, having the patient's favorite music playing, or by talking in a soft voice and using eye contact, if culturally appropriate.

Reducing Latex Exposure

Patients with latex allergies require early identification and communication to all personnel about the presence of the allergy according to standards of care for patients with latex allergy (AORN, 2019a). In most ORs, there are few latex items currently in use, but because there still remain some instances of latex use, maintenance of latex allergy precautions throughout the perioperative period must be observed. For safety, manufacturers and hospital materials managers need to take responsibility for identifying the latex content in items used by patients and health care personnel. (See Chapters 14 and 33 for assessment for latex allergy.)

Quality and Safety Nursing Alert

It is the responsibility of all nurses, and particularly perianesthesia and perioperative nurses, to be aware of latex allergies, necessary precautions, and products that are latex free. Hospital staff are also at risk for development of a latex allergy secondary to repeated exposure to latex products.

Preventing Perioperative Positioning Injury

The patient's position on the operating table depends on the surgical procedure to be performed as well as the patient's physical condition (see Fig. 15-6). One type of injury, peripheral nerve injury, is defined as the interruption of electrical activity that affects either the sensory, motor, or both nerve functions resulting in a deficit. Studies suggest a correlation between total OR time and tissue breakdown (Grap, Schubert, Munro, et al., 2019). See Chart 15-3 for a Nursing Research Profile that investigated these occurrences. The potential for transient discomfort or permanent injury is present because many surgical procedures require awkward anatomical positions. Hyperextending joints, compressing arteries, or pressing on nerves and bony prominences usually results in discomfort simply because the position must be sustained for a long period of time (Rothrock, 2019). Factors to consider include the following:

Chart 15-3 NURSING RESEARCH PROFILE

Sacral Tissue Pressure Injury Prevalence in Surgical Patients

Grap, M. J., Schubert, C., Munro, C. L., et al. (2019). OR time and sacral pressure injuries in critically ill surgical patients. *AORN Journal, 109*(2), 229–239.

Purpose

The ability to identify early changes associated with pressure injury and OR time may enhance pressure injury prevention strategies. The purpose of this study was to explore the relationship between OR time and sacral pressure injuries in critically ill patients using high-frequency ultrasound (HFU) to identify early tissue changes.

Design

A secondary analysis was used to evaluate the effect of backrest elevation on 150 ventilated patients in the ICU post surgery. All of the patients had recorded OR time and the Braden Score was collected to identify patients at risk for surgical pressure injury.

Findings

One hundred and fifty participants were enrolled and 132 had skin evaluations. The majority of participants were middle-aged White males (58%), overweight, and had a Braden Scale score showing moderate risk for pressure injury. Total OR time ranged from just under 1 hour to more than 13 hours, with an average time of more than 4 hours. For those participants who developed pressure injuries, time between the OR and injury observed was approximately 2 to 3 days on average. Approximately 63% of participants did not have sacral pressure injuries at any point during the observation period. Using multivariable models, the model containing OR bed time, BMI, and Braden Scale score produced the best prediction of pressure injury. A higher BMI, shorter OR bed time, and lower Braden Scale score were associated with a greater chance of pressure injury.

Nursing Implications

Preventing pressure injuries are a priority for nurses in all setting and is particularly challenging for critical-care patients. These preliminary results demonstrate that the use of HFU may help nurses identify the development of tissue changes before observable skin changes, leading to earlier pressure injury prevention strategies.

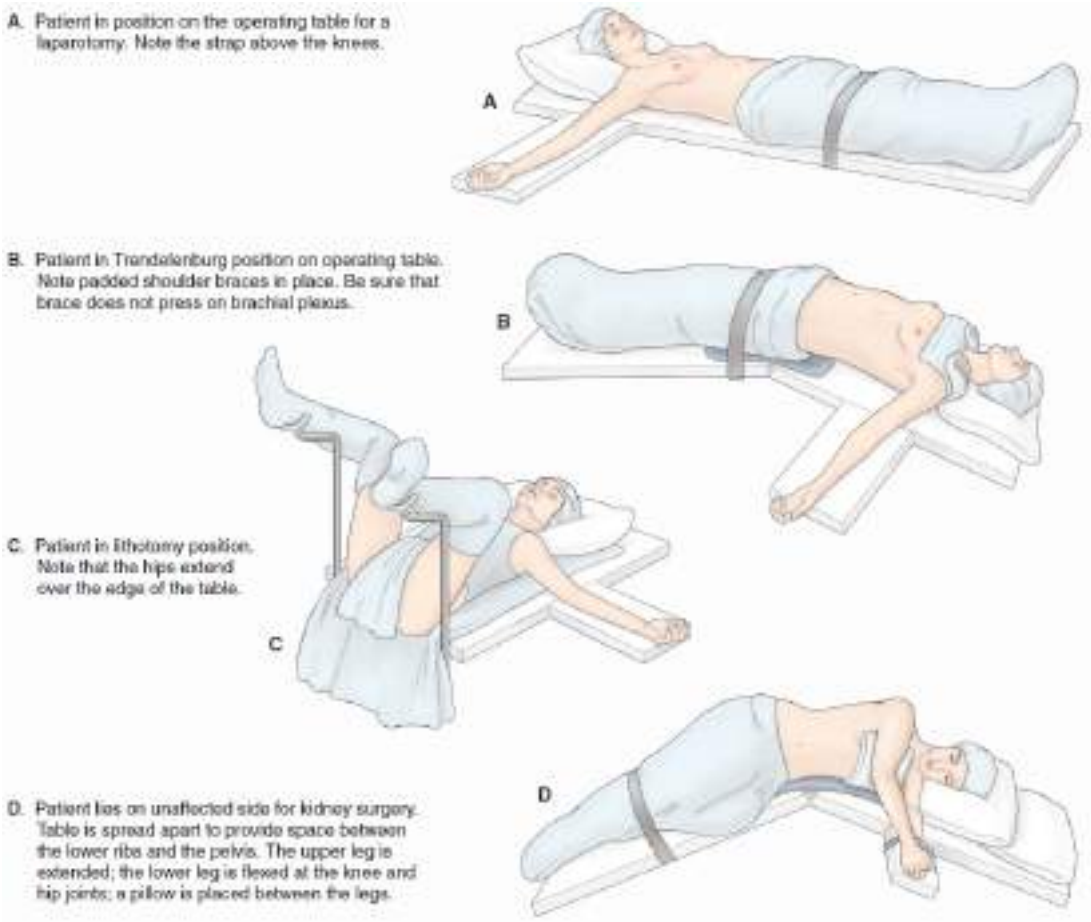

Figure 15-6 • Patient positions on the operating table. Captions call attention to safety and comfort features. All surgical patients wear caps to cover the hair completely.

- The patient should be in as comfortable a position as possible, whether conscious or unconscious.
- The operative field must be adequately exposed.
- An awkward anatomical position, undue pressure on a body part, or the use of stirrups or traction should not obstruct the vascular supply.
- Respiration should not be impeded by pressure of arms on the chest or by a gown that constricts the neck or chest.
- Nerves must be protected from undue pressure. Improper positioning of the arms, hands, legs, or feet can cause serious injury or paralysis. Shoulder braces must be well padded to prevent irreparable nerve injury, especially when the Trendelenburg position is necessary.
- Precautions for patient safety must be observed, particularly with older adults, patients who are thin or obese, and those with a physical deformity.
- The patient may need light restraint before induction in case of excitement.

The usual position for surgery, called the *dorsal recumbent position,* is flat on the back. Both arms are positioned at the side of the table: one with the hand placed palm down and the other carefully positioned on an armboard to facilitate IV infusion of fluids, blood, or medications. This position is used for most abdominal surgeries, except for surgery of the gallbladder or pelvis (see Fig. 15-6A).

The Trendelenburg position usually is used for surgery on the lower abdomen and pelvis to obtain good exposure by displacing the intestines into the upper abdomen. In this position, the head and body are lowered. The patient is supported in position by padded shoulder braces (see Fig. 15-6B), bean bags, and foam padding. Reverse Trendelenburg position provides the space to operate on the upper abdomen by shifting the intestines into the pelvis. A padded footboard and other supportive cushioning preserve a safe environment for the patient.

The lithotomy position is used for nearly all perineal, rectal, and vaginal surgical procedures (see Fig. 15-6C). The patient is positioned on the back with the legs and thighs flexed. The position is maintained by placing the feet in stirrups.

The Sims or lateral position is used for renal surgery. The patient is placed on the nonoperative side with an air pillow 12.5 to 15 cm (5 to 6 inches) thick under the loin, or on a table with a kidney or back lift (see Fig. 15-6D).

Protecting the Patient from Injury

Various activities are used to address the diverse patient safety issues that arise in the OR. The nurse protects the patient from injury by providing a safe environment. Verifying information, checking the medical record for completeness, and maintaining surgical asepsis and an optimal environment are critical nursing responsibilities. Verification that all the required documentation is completed is an important function of the intraoperative nurse. A surgical checklist is used prior to induction of anesthesia, before the skin incision is made, and before the patient leaves the OR (see Fig. 15-1). It is important to review the patient's record for the following:

- Allergies (including latex)
- Correct informed surgical consent, with patient's signature
- Completed records for health history and physical examination
- Results of diagnostic studies

In addition to checking that all necessary patient data are complete, the perioperative nurse obtains the necessary equipment specific to the procedure. The need for nonroutine medications, blood components, instruments, and other equipment and supplies is assessed, and the readiness of the room, completeness of physical setup, and completeness of instrument, suture, and dressing setups are determined. Any aspects of the OR environment that may negatively affect the patient are identified. These include physical features, such as room temperature and humidity; electrical

hazards; potential contaminants (dust, blood, and discharge on floor or surfaces; uncovered hair; nonsterile attire of personnel; jewelry worn by personnel; chipped or artificial fingernails); and unnecessary traffic. The circulating nurse also sets up and maintains suction equipment in working order, initiates appropriate physical comfort measures for the patient, and prepares any potential implantable devices and medications used at the surgical field.

Preventing physical injury includes using safety straps and side rails and not leaving the sedated patient unattended. Transferring the patient from the stretcher to the OR table requires safe transferring practices. Other safety measures include properly positioning a grounding pad under the patient to prevent electrical burns and shock, removing excess antiseptic solution from the patient's skin, and promptly and completely draping exposed areas after the sterile field has been created to decrease the risk of hypothermia.

Nursing measures to prevent injury from excessive blood loss include blood conservation using equipment such as a cell saver (a device for recirculating the patient's own blood cells) and administration of blood products (Rothrock, 2019). Fewer patients undergoing an elective procedure require blood transfusion, but those undergoing high-risk procedures (such as orthopedic or cardiac surgeries) may require an intraoperative transfusion. The circulating nurse anticipates this need, checks that blood has been cross-matched and held in reserve, and is prepared to administer blood.

Serving as Patient Advocate

The patient undergoing general anesthesia or moderate sedation experiences temporary sensory or perceptual alteration or loss, and has an increased need for protection and advocacy. Patient advocacy in the OR entails maintaining the patient's physical and emotional comfort, privacy, rights, and dignity. Patients, whether conscious or unconscious, should not be subjected to excess noise, inappropriate conversation, or, most of all, derogatory comments. Other advocacy activities include minimizing the clinical, dehumanizing aspects of being a surgical patient by making sure that the patient is treated as a person, respecting cultural and spiritual values, providing physical privacy, maintaining confidentiality, and contacting approved family or support personnel about updates throughout the procedure.

Preventing Retained Surgical Items

It is the entire surgical team's responsibility to provide vigilance and communication regarding items entering and leaving the surgical site. As part of their responsibilities, the circulating nurse and scrub personnel must account for items introduced to the sterile field. This includes sponges, needles, instruments, and access devices. Some of these items are radiopaque (visible under x-ray), others are not. All items must be accounted for at the beginning of surgery, prior to wound closure, and again at skin closure. The nurse serves as a patient advocate to alert the team of any missing items.

Technology can assist in surgical item identification; however, it should not be used as the primary source for counting.

Monitoring and Managing Potential Complications

It is the responsibility of the surgeon and the anesthesiologist or CRNA to monitor and manage complications. However, intraoperative nurses also play an important role. Being alert to and reporting changes in vital signs, cardiac arrhythmias, symptoms of nausea and vomiting, anaphylaxis, hypoxia, hypothermia, and MH and assisting with their management are important nursing functions. Each of these complications was discussed earlier. Maintaining asepsis and preventing infection are responsibilities of all members of the surgical team (Rothrock, 2019). Evidence-based interventions to decrease SSIs include appropriate skin preparation and antibiotic administration. These interventions are discussed by the surgical team and documented by the nurse in the intraoperative record.

Evaluation

Expected patient outcomes may include:

1. Exhibits low level of anxiety while awake during the intraoperative phase of care
2. Has no symptoms of latex allergy
3. Remains free of perioperative positioning injury
4. Experiences no unexpected threats to safety
5. Has dignity preserved throughout OR experience
6. Is free of complications (e.g., cardiac arrhythmias, nausea and vomiting, anaphylaxis, hypoxia, hypothermia, or MH or experiences successful management of adverse effects of surgery and anesthesia should they occur)

CRITICAL THINKING EXERCISES

1 ebp A 48-year-old man is scheduled to have robotic-assisted abdominal surgery. What is the best evidence for how his vital signs should be monitored? As the OR nurse, what best practices should you implement to support the patient and OR team during this minimally invasive surgery?

2 ipc A 66-year-old woman with chronic obstructive pulmonary disease (COPD) is scheduled for an elective procedure to remove a lipoma on her chest. She is having problems breathing, is agitated, and cannot lie flat on the surgical bed. How will you, as the circulating nurse, facilitate an interprofessional discussion to improve the patient's breathing and relieve her agitation? Which members of the surgical team are essential to include?

3 pq Identify the priorities, assessments, and nursing interventions you would implement for a 76-year-old female patient who is hard of hearing and is having spinal anesthesia for total knee replacement surgery. How would your priorities, approach, and techniques differ if the patient is having general anesthesia? What other risks should be considered based on this patient's age?

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*Asterisk indicates nursing research.

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Resources

American Association of Nurse Anesthetists (AANA), www.aana.com
American Society of Anesthesiologists (ASA), www.asahq.org
American Society of PeriAnesthesia Nurses (ASPAN), www.aspan.org
Association of PeriOperative Registered Nurses, www.aorn.org
Centers for Disease Control and Prevention, Injury and Violence Prevention and Control, www.cdc.gov/injury
Joint Commission, www.jointcommission.org
Malignant Hyperthermia Association of the United States (MHAUS), www.mhaus.org
World Health Organization (WHO), www.who.int/en/

16 Postoperative Nursing Management

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the responsibilities of the postanesthesia care nurse in the prevention of immediate postoperative complications.
2. Identify common postoperative problems and their management.
3. Explain variables that affect wound healing and surgical site infections.
4. Implement nursing care to enhance recovery in the postoperative phase.
5. Use the nursing process as a framework for care of the hospitalized patient recovering from surgery.

NURSING CONCEPTS

Assessment
Infection
Managing Care

GLOSSARY

dehiscence: partial or complete separation of wound edges

evisceration: protrusion of organs through the surgical incision

first-intention healing: method of healing in which wound edges are surgically approximated and integumentary continuity is restored without granulation

phase I PACU: area designated for care of surgical patients immediately after surgery and for patients whose condition warrants close monitoring

phase II PACU: area designated for care of surgical patients who have been transferred from a phase I PACU because their condition no longer requires the close monitoring provided in a phase I PACU. The patient is prepared for transfer to an inpatient unit or for discharge from the facility

postanesthesia care unit (PACU): area where postoperative patients are monitored as they recover from anesthesia

second-intention healing: method of healing in which wound edges are not surgically approximated and integumentary continuity is restored by the process known as granulation

The postoperative period extends from the time the patient leaves the operating room (OR) until the last follow-up visit with the surgeon. This may be as short as a day or two or as long as several months. During the postoperative period, nursing care focuses on reestablishing the patient's physiologic equilibrium, alleviating pain, preventing complications, and educating the patient about self-care. Careful assessment and immediate intervention assist the patient in returning to optimal function quickly, safely, and as comfortable as possible. Ongoing care in the community through home care, clinic visits, office visits, or telephone follow-up facilitates an uncomplicated recovery.

Care of the Patient in the Postanesthesia Care Unit

The **postanesthesia care unit** (PACU) is located adjacent to the OR suite. Patients still under anesthesia or recovering from anesthesia are placed in this unit for easy access to experienced, highly skilled nurses, anesthesia providers, surgeons, advanced hemodynamic and pulmonary monitoring and support, special equipment, and medications.

Phases of Postanesthesia Care

In some hospitals and ambulatory surgical centers, postanesthesia care is divided into two phases (Rothrock, 2019). In the **phase I PACU**, used during

the immediate recovery phase, intensive nursing care is provided. After this phase, the patient transitions to the next phase of care as either an inpatient to a nursing unit or phase II PACU. In the **phase II PACU**, the patient is prepared for transfer to an inpatient nursing unit, an extended care setting, or discharge. Recliners rather than stretchers or beds are standard in many phase II units, which may also be referred to as step-down, sit-up, or progressive care units. Patients remain in PACU until they have met predetermined discharge criteria, depending on the type of surgery and any preexisting conditions or comorbidities. In facilities without separate phase I and II units, the patient remains in the PACU and may be discharged home directly from this unit.

Admitting the Patient to the Postanesthesia Care Unit

Transferring the postoperative patient from the OR to the PACU is the responsibility of the anesthesiologist or certified registered nurse anesthetist (CRNA) and other licensed members of the OR team. During transport from the OR to the PACU, the anesthesia provider remains at the head of the stretcher (to maintain the airway), and a surgical team member remains at the opposite end. Transporting the patient involves special consideration of the incision site, potential vascular changes, and exposure. The surgical incision is considered every time the postoperative patient is moved; many wounds are closed under considerable tension, and every effort is made to prevent further strain on the incision. The patient is positioned so that they are not lying on and obstructing drains or drainage tubes. Orthostatic hypotension may occur when a patient is moved too quickly from one position to another (e.g., from a lithotomy position to a horizontal position or from a lateral to a supine position), so the patient must be moved slowly and carefully. As soon as the patient is placed on the stretcher or bed, the soiled gown is removed and replaced with a dry gown. The patient is covered with lightweight blanket or a forced air warming blanket.

The nurse who admits the patient to the PACU reviews essential information with the anesthesiologist or CRNA (see Chart 16-1) and the circulating nurse. Oxygen is applied, monitoring equipment is attached, and an immediate physiologic assessment is conducted.

Chart 16-1

Anesthesia Provider-to-Nurse Report and Nurse-to-Nurse Report: Information to Convey

- Patient name, gender, age
- Allergies
- Surgical procedure
- Position during the procedure
- Length of time in the operating room
- Anesthetic agents and reversal agents used
- Estimated blood loss/fluid loss
- Fluid/blood replacement
- Last set of vital signs and any problems during the procedure (e.g., nausea and/or vomiting)
- Any complications encountered (anesthetic or surgical)
- Medical comorbidities (e.g., diabetes, hypertension)
- List of allergies and medications taken at home (including pain medications, antihypertensives, and anticoagulants)
- Considerations for immediate postoperative period (pain management, reversals, ventilator settings)
- Language barrier
- Location of patient's family

Ideally, the anesthesia provider should not leave the patient until the nurse is satisfied with the patient's airway and immediate condition.

Nursing Management in the Postanesthesia Care Unit

The nursing management objectives for the patient in the PACU are to provide care until the patient has recovered from the effects of anesthesia. PACU nurses have unique competencies as they care for patients who have undergone a wide range of surgical procedures. Recovery criteria include a return to baseline cognitive function, the airway is clear, nausea and vomiting is controlled, and vital signs are stabilized. The nurse in the PACU uses critical care skills and training to detect early subtle changes that could lead to complications (i.e., hemorrhage or respiratory distress) without intervention (American Society of PeriAnesthesia Nurses [ASPAN], 2019; Odom-Forren, 2018).

Some patients, particularly those who have had extensive or lengthy surgical procedures, may be transferred from the OR directly to the intensive care unit (ICU) or from the PACU to the ICU while still intubated and receiving mechanical ventilation. In most facilities, the patient is awakened and extubated in the OR (except in cases of trauma or critical illness) and arrives in the PACU breathing without ventilatory support.

Assessing the Patient

The nurse performs frequent, basic assessments of every postoperative patient. These assessments include airway, level of consciousness, cardiac, respiratory, wound, and pain. The patient's comorbidities and type of procedure will dictate additional assessments such as peripheral pulses, hemodynamics, and surgical drain placements (Odom-Forren, 2018). A baseline of any postanesthesia assessment scoring tool, such as the Aldrete score, is performed at this time as well (Aldrete & Wright, 1992). See discussion of this score later in this chapter.

The nurse performs and documents a baseline assessment, checks all drainage tubes, and verifies that monitoring lines are connected and functioning. IV fluids and medications currently infusing are checked, and the nurse verifies that they are infusing at the correct dosage and rate. Vital signs are assessed at time of arrival to PACU and repeated at intervals (i.e., every 5 or 15 minutes) per institutional protocol. The nurse must be aware of any pertinent information from the patient's history that may be significant (e.g., patient is deaf or hard of hearing, has a history of seizures, has diabetes, or is allergic to certain medications or to latex).

Concept Mastery Alert

Following surgery, patients who had ketamine as anesthesia must be placed in a quiet, darkened area of the PACU. See Chapter 15, Table 15-2 for more information about anesthetic agents.

Maintaining a Patent Airway

The primary objective in the immediate postoperative period is to maintain ventilation and thus prevent hypoxemia (reduced oxygen in the blood) and hypercapnia (excess carbon dioxide in the blood). Both can occur if the airway is obstructed and ventilation is reduced (hypoventilation). Besides administering supplemental oxygen as prescribed, the nurse assesses respiratory rate and depth, ease of respirations, oxygen saturation, and breath sounds.

Figure 16-1 • A. A hypopharyngeal obstruction occurs when neck flexion permits the chin to drop toward the chest; obstruction almost always occurs when the head is in the midposition. **B.** Tilting the head back to stretch the anterior neck structure lifts the base of the tongue off the posterior pharyngeal wall. The direction of the *arrows* indicates the pressure of the hands. **C.** Opening the mouth is necessary to correct a valvelike obstruction of the nasal passage during expiration, which occurs in about 30% of unconscious patients. Open the patient's mouth (separate lips and teeth) and move the lower jaw forward so that the lower teeth are in front of the upper teeth. To regain backward tilt of the neck, lift with both hands at the ascending rami of the mandible.

Patients who have experienced prolonged anesthesia usually are unconscious, with all muscles relaxed. This relaxation extends to the muscles of the pharynx. When the patient lies on the back, the lower jaw and the tongue fall backward and the air passages become obstructed (Fig. 16-1A). This is called *hypopharyngeal obstruction.* Signs of occlusion include choking; noisy and irregular respirations; decreased oxygen saturation scores; and, within minutes, a blue, dusky color (cyanosis) of the skin. Because movement of the thorax and the diaphragm does not necessarily indicate that the patient is breathing, the nurse needs to place the palm of the hand at the patient's nose and mouth to feel the exhaled breath.

Quality and Safety Nursing Alert

The treatment of hypopharyngeal obstruction involves tilting the head back and pushing forward on the angle of the lower jaw, as if to push the lower teeth in front of the upper teeth (see Fig. 16-1B,C). This maneuver pulls the tongue forward and opens the air passages.

The anesthesiologist or CRNA may place a temporary, hard rubber or plastic airway in the patient's mouth to maintain a patent airway (see Fig. 16-2). Such a device should not be removed until signs such as gagging indicate

that reflex action is returning. Alternatively, the patient may enter the PACU with an endotracheal tube still in place and may require continued mechanical ventilation. The nurse assists in initiating the use of the ventilator as well as the weaning and extubation processes.

If the teeth are clenched, the mouth may be opened manually but cautiously with a padded tongue depressor. The head of the bed is elevated 15 to 30 degrees unless contraindicated, and the patient is closely monitored to maintain the airway as well as to minimize the risk of aspiration. If vomiting occurs, the patient is turned to the side to prevent aspiration and the vomitus is collected in the emesis basin. Mucus or vomitus obstructing the pharynx or the trachea is suctioned with a pharyngeal suction tip or a nasal catheter introduced into the nasopharynx or oropharynx to a distance of 15 to 20 cm (6 to 8 inch). Caution is necessary in suctioning the throat of a patient who has had a tonsillectomy or other oral or laryngeal surgery because of the risk of bleeding and discomfort.

Maintaining Cardiovascular Stability

To monitor cardiovascular stability, the nurse assesses the patient's level of consciousness; vital signs; cardiac rhythm; skin temperature, color, and moisture; and urine output. The nurse also assesses the patency of all IV lines. The primary cardiovascular complications seen in the PACU include hypotension and shock, hemorrhage, hypertension, and arrhythmias.

In patients who are critically ill, have significant comorbidity, or have undergone riskier procedures, additional monitoring may have been done in the OR and will continue in the PACU. These may include central venous pressure, pulmonary artery pressure, pulmonary artery wedge pressure, and cardiac output.

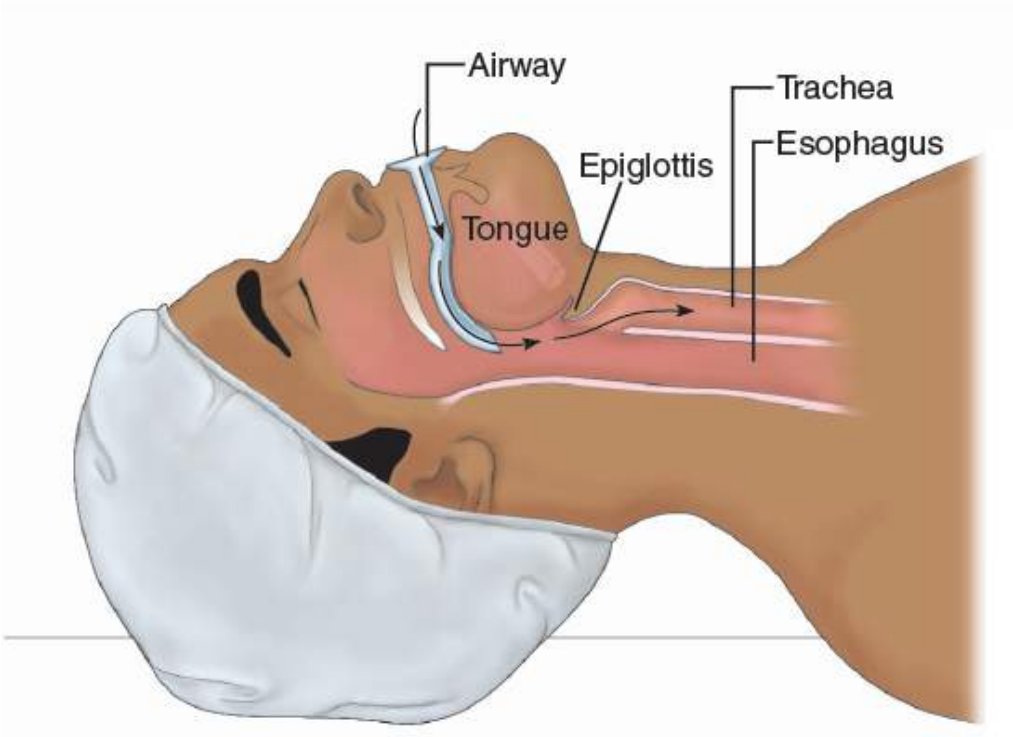


Figure 16-2 • The use of an airway to maintain a patent airway after anesthesia. The airway passes over the base of the tongue and permits air to pass into the pharynx in the region of the epiglottis. Patients often leave the operating room with an airway in place. The airway should remain in place until the patient recovers sufficiently to breathe normally. As the patient regains consciousness, the airway usually causes irritation and should be removed.

Hypotension and Shock

Hypotension can result from blood loss, hypoventilation, position changes, pooling of blood in the extremities, or side effects of medications and anesthetics. The most common cause is loss of circulating volume through blood and plasma loss. If the amount of blood loss exceeds 500 mL (especially if the loss is rapid), replacement may be considered.

Quality and Safety Nursing Alert

A systolic blood pressure of less than 90 mm Hg is usually considered immediately reportable. However, the patient's preoperative or baseline blood pressure is used to make informed postoperative comparisons. A previously stable blood pressure that shows a downward trend of 5 mm Hg at each 15-minute reading should also be reported.

Types of shock are classified as hypovolemic, cardiogenic, neurogenic, anaphylactic, and septic. The most common type of shock in the postoperative setting is hypovolemic and is associated with hemorrhage from the surgical site (Odom-Forren, 2018). The classic signs of hypovolemic shock are pallor; cool, moist skin; rapid breathing; cyanosis of the lips, gums, and tongue; rapid, weak, thready pulse; narrowing pulse pressure; low blood pressure; and concentrated urine (see Chapter 11 for a detailed discussion of shock).

Hypovolemic shock can be avoided largely by the timely administration of IV fluids, blood, blood products, and medications that elevate blood pressure. The primary intervention for hypovolemic shock is volume replacement, with an infusion of lactated Ringer solution, 0.9% sodium chloride solution, colloids, or blood component therapy (see Chapter 11, Table 11-3). Oxygen is given by nasal cannula, facemask, or mechanical ventilation. If fluid administration fails to reverse hypovolemic shock, then various cardiac, vasodilator, and corticosteroid medications may be prescribed to improve cardiac function and reduce peripheral vascular resistance.

The PACU bed can readily be positioned to facilitate the use of measures to counteract shock. The patient is placed flat with the legs elevated, usually with a pillow. Respiratory rate, pulse rate, blood pressure, blood oxygen concentration, urinary output, and level of consciousness are monitored to provide information on the patient's respiratory and cardiovascular status. Vital signs are monitored continuously until the patient's condition has stabilized.

Other factors can contribute to hemodynamic instability, such as body temperature and pain. The PACU nurse implements measures to manage these factors. The nurse keeps the patient warm (while avoiding overheating to prevent cutaneous vessels from dilating and depriving vital organs of blood), avoids exposure, and maintains normothermia (to prevent vasodilation). Pain control measures are implemented, as discussed later in this chapter.

Hemorrhage

Hemorrhage is an uncommon yet serious complication of surgery that can result in hypovolemic shock and death. It can present insidiously or emergently at any time in the immediate postoperative period or up to several days after surgery (see Table 16-1). The patient presents with hypotension; rapid, thready pulse; disorientation; restlessness; oliguria; and cold, pale skin. The early phase of shock will manifest in feelings of apprehension, decreased cardiac output, and vascular resistance. Breathing becomes labored, and "air hunger" will be exhibited; the patient will feel cold (hypothermia) and may experience tinnitus. Laboratory values may show a sharp drop in hemoglobin and hematocrit levels. If shock symptoms are left untreated, the patient will continually grow weaker but can remain conscious until near death (Rothrock, 2019).

TABLE 16-1 Types of Hemorrhage

Classification	Defining Characteristic
Time Frame	
Primary	Hemorrhage occurs at the time of surgery.
Intermediary	Hemorrhage occurs during the first few hours after surgery when the rise of blood pressure to its normal level dislodges insecure clots from nonanastomosed vessels.
Secondary	Hemorrhage may occur sometime after surgery if a suture slips because a blood vessel was not securely anastomosed, became infected, or was eroded by a drainage tube.
Type of Vessel	
Capillary	Hemorrhage is characterized by slow, general ooze.
Venous	Darkly colored blood flows quickly.
Arterial	Blood is bright red and appears in spurts with each heartbeat.
Visibility	
Evident	Hemorrhage is on the surface and can be seen.
Concealed	Hemorrhage is in a body cavity and cannot be seen.

Determining the cause of hemorrhage includes assessing the surgical site and incision for bleeding. If bleeding is evident, a sterile gauze pad and a pressure dressing are applied, and the site of the bleeding is elevated to heart level if possible. The patient is placed in the shock position (flat on back; legs elevated at a 20-degree angle; knees kept straight). Severe bleeding requires immediate action by the nurse. The surgeon is called and preparations are made to return the patient to the OR for ligation of bleeding veins and arteries, hematoma evacuation, or other necessary surgical interventions to stop the bleeding (Odom-Forren, 2018).

If hemorrhage is suspected, the nurse should be aware of any special considerations related to blood loss replacement. The treatment of hemorrhage is infusion of crystalloid and possibly blood product. Patients with blood loss of over 1500 mL should be considered for blood administration (Henry, 2018). Nurses in the PACU should be aware that patients may decline blood transfusions for religious or cultural reasons and may identify this request on their advance directives or living will.

Hypertension and Arrhythmias

Hypertension is common in the immediate postoperative period secondary to sympathetic nervous system stimulation from pain, hypoxia, or bladder distention. Arrhythmias are associated with electrolyte imbalance, altered respiratory function, pain, hypothermia, stress, and anesthetic agents. Both hypertension and arrhythmias are managed by treating the underlying causes.

Relieving Pain and Anxiety

The nurse in the PACU monitors the patient's physiologic status, manages pain, and provides psychological support in an effort to relieve the patient's fears and concerns. The nurse checks the electronic health record (EHR) for special needs and concerns of the patient. Opioid analgesic medications are given mostly by IV in the PACU (Rothrock, 2019). IV opioids provide immediate pain relief and are short acting, thus minimizing the potential for drug interactions or prolonged respiratory depression while anesthetics are still active in the patient's system (Barash, Cullen, Stoelting, et al., 2017). (See Chapter 9 for more information about pain management.) When the patient's condition permits, a close member of the family may visit in the PACU to decrease the family's anxiety and make the patient feel more secure. The nurse should consider providing nonpharmacologic, emotional, and psychological support to the patient. These include massage, acupuncture, heat or cold packs, relaxation and breathing techniques, guided imagery, and soothing music (Odom-Forren, 2018).

Controlling Nausea and Vomiting

Postoperative nausea and vomiting (PONV) occurs in about 30% to 50% of surgical patients (Thomas, Maple, Williams, et al., 2019). The nurse should intervene at the patient's first report of nausea to control the problem rather than wait for it to progress to vomiting.

Quality and Safety Nursing Alert

At the slightest indication of nausea, the patient is turned completely to one side to promote mouth drainage and prevent aspiration of vomitus, which can cause pneumonia, asphyxiation, and death.

PONV is controlled via medication administered intraoperatively and postoperatively. Table 16-2 contains select medications prescribed to control PONV. Studies suggest that nonpharmacologic measures, such as aromatherapy, may be effective for PONV prevention and treatment (Asay, Olson, Donnelly, et al., 2019). Aromatherapy inhalers with ginger, lavender, spearmint, and peppermint are a complementary, homeopathic, and a nonpharmacologic option (de la Vega, Gilliand, Martinez, et al., 2019).

Risk factors for PONV are female gender, age less than 50 years, history of nausea or vomiting after previous anesthesia, and opioid administration (Finch, Parkosewich, Perrone, et al., 2019). Surgical risks are increased with PONV due to an increase in intra-abdominal pressure, elevated central venous pressure, the potential for aspiration, increased heart rate, and systemic blood pressure, which increase the risk of myocardial ischemia and arrhythmias.

Aside from PONV as an unpleasant and uncomfortable experience, it may lead to dehydration, electrolyte imbalances, airway compromise, stress on suture lines or incision dehiscence, esophageal tears, hypotension, and increased length of stay in the recovery room (Asay et al., 2019). Chart 16-2 contains a Nursing Research Profile about PONV.

Gerontologic Considerations

The older patient, like all patients, is transferred from the OR table to the bed or stretcher slowly and gently. The effects of this action on blood pressure and ventilation are monitored. Special attention is given to keeping the patient warm, because older adults are more susceptible to hypothermia. The patient's position is changed frequently to stimulate respirations as well as promote circulation and comfort.

TABLE 16-2 Select Medications Used to Control Postoperative Nausea and Vomiting

Drug Classes	Name	Nursing Implications
GI stimulant	Metoclopramide	Acts by stimulating gastric emptying and increasing GI transit time. Administration recommended at the end of procedure. Available in oral, IM, and IV forms.
Phenothiazine antiemetic	Prochlorperazine	Indicated for control of severe nausea and vomiting. Available in oral, SR, rectal, IM, and IV forms.
Phenothiazine antiemetic antimotion sickness	Promethazine	Recommended every 4–6 h for nausea and vomiting associated with anesthesia and surgery. Available in oral, IM, and IV forms.
Antimotion sickness	Dimenhydrinate	Indicated for prevention of nausea, vomiting, or vertigo of motion sickness. Available in oral, IM, and IV forms.
Antiemetic	Hydroxyzine	Control of nausea and vomiting and as adjunct to analgesia preoperatively and postoperatively to allow decreased opioid dosage. Available in oral and IM forms.
Antiemetic antimotion sickness	Scopolamine	Used to prevent and control of nausea and vomiting associated with motion sickness and recovery from surgery. Available in oral, transdermal SC, and IM forms.
Antiemetic	Ondansetron	Prevention of postoperative nausea and vomiting. Available in oral, IM, and IV forms. With few side effects, frequently the drug of choice.

GI, gastrointestinal; IM, intramuscular; IV, intravenous; SR, sustained release; SC, subcutaneous.

Adapted from Comerford, K. C., & Durkin, M. T. (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer.

Chart 16-2 NURSING RESEARCH PROFILE

An Investigation of PONV in Ambulatory Surgery

Finch, C., Parkosewich, J. A., Perrone, D., et al. (2019). Incidence, timing, and factors associated with postoperative nausea and vomiting in the ambulatory surgery setting. *Journal of PeriAnesthesia Nursing, 34*(6), 1146–1155.

Purpose

Postoperative nausea and vomiting (PONV) is a major concern for patients having surgery under general anesthesia. The purpose of this study was to investigate the incidence, timing, and factors associated with PONV in an ambulatory surgery PACU.

Design

The study used a prospective descriptive correlational, cross-sectional design. A random sample of 139 patients admitted to a 10-bed ambulatory PACU participated.

Findings

The mean age of participants was 50 years and 70% were female. Only 3 participants had nausea upon arrival to the PACU, but this number increased to 10 by 90 minutes in the PACU, and then went back down to 3 at 150 minutes in the PACU. A total of 4 participants vomited after reporting nausea. Participants with nausea had more hydration and longer PACU stays. Younger age and the presence of gastroesophageal reflux disease (GERD) were significantly associated with nausea.

Nursing Implications

Nurses working with postoperative patients should be aware that PONV can and does occur in both ambulatory and inpatient surgery settings. Nurses should take the age of patients into consideration with anticipating PONV. This study provides evidence that a history of GERD may be a risk factor and thus should be included in preoperative assessment.

Immediate postoperative care for the older adult is the same as for any surgical patient; however, additional support is given if cardiovascular, pulmonary, or renal function is impaired. With careful monitoring, it is possible to detect cardiopulmonary deficits before signs and symptoms are apparent. Changes associated with the aging process, the prevalence of chronic diseases, alteration in fluid and nutrition status, and the increased use of medications result in the need for postoperative vigilance. Nurses should keep in mind that older adults may have slower recovery from anesthesia due to the prolonged time it takes to eliminate sedatives and anesthetic agents. Thermoregulation is important to maintain immune function, adequate pain relief, and tissue oxygenation. Special care to maintain normothermia can

minimize the risk of postoperative ischemia and angina in older patients (Odom-Forren, 2018).

Postoperative confusion and delirium may occur in up to half of all older adult patients. Signs and symptoms include cognitive deficits, hallucinations, and fluctuating state of consciousness. It is important for the nurse to verify the preoperative psychological assessment as it can help differentiate between postoperative cognitive dysfunction (POCD) and postoperative delirium. With both conditions, patients exhibit signs of cognitive impairment; however, POCD is of sudden onset in the postsurgical period and is associated with the use of several anesthetic agents (Alalawi & Yasmeen, 2018). Providing adequate hydration, reorienting to the environment, and reassessing the doses of sedative, anesthetic, and analgesic agents may reduce the risk of confusion. Hypoxia can present as confusion and restlessness, as can blood loss and electrolyte imbalances. Exclusion of all other causes of confusion must precede the assumption that confusion is related to age, circumstances, and medications.

Maintaining a safe environment for older adults requires alertness and planning. Arthritis is a common condition among older patients, and it affects mobility, creating difficulty turning from one side to the other or ambulating without discomfort. The nurse provides mobility support and is vigilant for patients with an increased risk for falls. Fall prevention methods include using a fall risk identification method, providing assistance with ambulation, and allowing legs to dangle off of the stretcher prior to standing (DeSilva, Seabra, Thomas, et al., 2019).

Bariatric Considerations

Patients with obesity are seen in the PACU for a wide variety of conditions, including bariatric and nonbariatric procedures (Tjeertes, Hoeks, Beks, et al., 2015). Properly sized blood pressure cuffs, gowns, transfer devices, and wheelchairs may be needed for the recovery and transitioning care of these patients. Patients with obesity have unique postoperative risks including an increased risk of venous thromboembolism (VTE), deep vein thrombosis (DVT), and pulmonary embolus (PE).

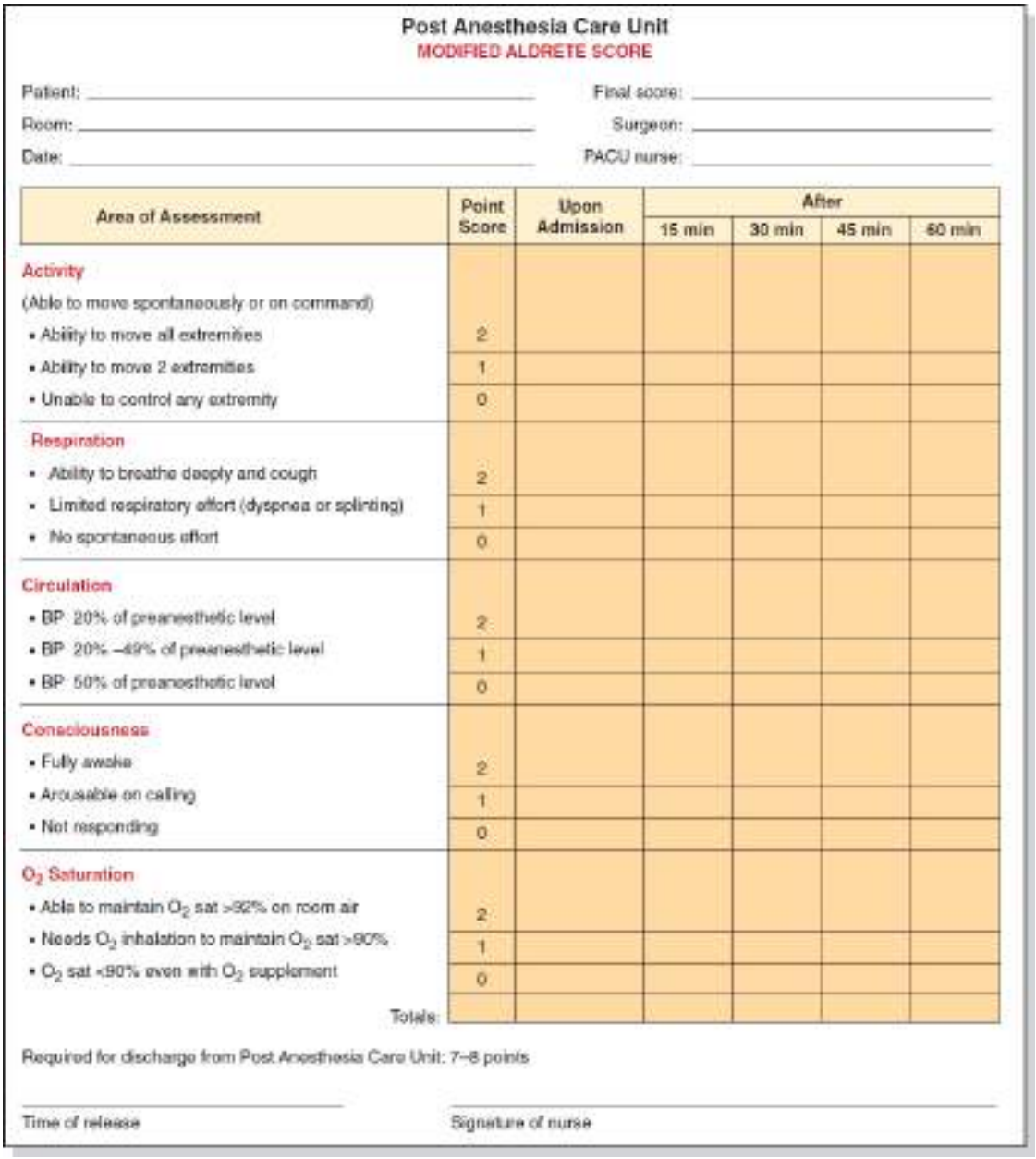
Patients with obesity are at particular risk for obstructive sleep apnea (OSA) in the postoperative period. A direct correlation exists between the incidence of pulmonary complications and the degree of obesity. The mortality rate after upper abdominal operations in patients with severe obesity is 2.5 times that of their normal weight counterparts (Odom-Forren, 2018). As discussed in Chapter 14, careful preoperative assessment for OSA should occur in patients with obesity in order to detect and manage the manifestations that may occur during the surgical stay. A combination of pulse oximetry and capnography should be utilized when patients are on supplemental oxygen therapy as

respiratory depression may be masked when measured only by pulse oximetry (Jungquist, Card, Charchaflieh, et al., 2018). Research suggests that the combination of continuous monitoring tools alerts PACU nurses to respiratory changes allowing for timely interventions (Wortham, Rice, Gupta, et al., 2019). Patients with OSA, many of whom also have obesity, are prone to hypoventilation and airway obstruction (ASPAN, 2019).

Determining Readiness for Postanesthesia Care Unit Discharge

A patient remains in the PACU until fully recovered from the anesthetic agent. Indicators of recovery include stable blood pressure, adequate respiratory function, and adequate oxygen saturation level compared with baseline.

The Aldrete score is used to determine the patient's general condition and readiness for transfer from the PACU (Aldrete & Wright, 1992). Throughout the recovery period, the patient's physical signs are observed and evaluated by means of a scoring system based on a set of objective criteria. This evaluation guide allows an objective assessment of the patient's condition in the PACU (see Fig. 16-3). The patient is assessed at regular intervals, and a total score is calculated and recorded on the assessment record. The Aldrete score is usually between 7 and 10 before discharge from the PACU. The unit policy and the established PACU discharge criteria determine appropriate postanesthesia recovery score parameters. Scores or conditions lower than the preestablished level necessitate evaluation by the anesthesia provider or surgeon and can result in an extension of the PACU stay or possible disposition to a special care or critical care unit (Odom-Forren, 2018).



Post Anesthesia Care Unit
MODIFIED ALDRETE SCORE

Patient: _____ Final score: _____
Room: _____ Surgeon: _____
Date: _____ PACU nurse: _____

Area of Assessment	Point Score	Upon Admission	After 15 min	After 30 min	After 45 min	After 60 min
Activity (Able to move spontaneously or on command)						
• Ability to move all extremities	2					
• Ability to move 2 extremities	1					
• Unable to control any extremity	0					
Respiration						
• Ability to breathe deeply and cough	2					
• Limited respiratory effort (dyspnea or splinting)	1					
• No spontaneous effort	0					
Circulation						
• BP 20% of preanesthetic level	2					
• BP 20%–49% of preanesthetic level	1					
• BP 50% of preanesthetic level	0					
Consciousness						
• Fully awake	2					
• Arousable on calling	1					
• Not responding	0					
O_2 Saturation						
• Able to maintain O_2 sat >92% on room air	2					
• Needs O_2 inhalation to maintain O_2 sat >90%	1					
• O_2 sat <90% even with O_2 supplement	0					
Totals:						

Required for discharge from Post Anesthesia Care Unit: 7–8 points

Time of release _____ Signature of nurse _____

Figure 16-3 • Postanesthesia care unit record; modified Aldrete score. O_2 sat, oxygen saturation; BP, blood pressure. Adapted from Aldrete, A., & Wright, A. (1992). Revised Aldrete score for discharge. *Anesthesiology News, 18*(1), 17.

The patient is discharged from the phase I PACU by the anesthesiologist or CRNA to the critical care unit, the medical-surgical unit, or the phase II PACU.

Preparing the Postoperative Patient for Direct Discharge

Ambulatory surgical centers frequently have a step-down PACU similar to a phase II PACU. Patients seen in this type of unit are usually healthy, and the plan is to discharge them directly to home. Prior to discharge, the patient will require verbal and written instructions and information about follow-up care.

Promoting Home, Community-Based, and Transitional Care

To ensure patient safety and recovery, expert patient education and discharge planning are necessary when a patient undergoes same-day or ambulatory surgery (Association of PeriOperative Registered Nurses [AORN], 2019; ASPAN, 2019). Because anesthetics cloud memory for concurrent events, verbal and written instructions should be given to both the patient and the adult who will be accompanying the patient home. Alternative formats (e.g., large print, Braille) of instructions or the use of a sign language interpreter may be required to ensure patient and family understanding. A translator may be required if the patient and family members do not understand English.

Discharge Preparation

The patient and caregiver (e.g., family member, friend) are informed about expected outcomes and immediate postoperative changes anticipated (AORN, 2019; ASPAN, 2019). Chart 16-3 identifies important educational points; before discharging the patient, the nurse provides written instructions covering each of those points. Prescriptions are given to the patient. Contact information for the hospital and surgeon's office are provided, and the patient and caregiver are encouraged to call with questions and to schedule follow-up appointments. A list of possible complications and how to manage them (e.g., call the surgeon's office, report to the emergency department [ED]), including elevated temperature, bleeding, and wound care instructions, are key focal points during discharge education.

Although recovery time varies depending on the type and extent of surgery and the patient's overall condition, instructions usually advise limited activity for 24 to 48 hours. During this time, the patient should not drive a vehicle, drink alcoholic beverages, or perform tasks that require high levels of energy or skill. Fluids may be consumed as desired and smaller than normal amounts may be eaten at mealtime. Patients are cautioned not to make important decisions at this time because the medications, anesthesia, and surgery may affect their decision-making ability. Follow-up phone calls from the nurse are also used to assess the patient's progress and to answer any questions.

Chart 16-3 **HOME CARE CHECKLIST**

Discharge After Surgery

At the completion of education, the patient and/or caregiver will be able to:

- Name the procedure that was performed and identify any permanent changes in anatomic structure or function as well as changes in ADLs, IADLs, roles, relationships, and spirituality.
- Identify interventions and strategies (e.g., durable medical equipment, adaptive equipment) used in adapting to any permanent change in structure or function.
- Describe ongoing postoperative therapeutic regimen, including diet and activities to perform (e.g., walking and breathing exercises) and to limit or avoid (e.g., lifting weights, driving a car, contact sports).
- State the name, dose, side effects, frequency, and schedule for all medications.
- State how to obtain medical supplies and carry out dressing changes, wound care, and other prescribed regimens.
- Describe signs and symptoms of complications.
- State time and date of follow-up appointments.
- Relate how to reach health care provider with questions or complications.
- State understanding of community resources and referrals (if any).

Identify the need for health promotion (e.g., weight reduction, smoking cessation, stress management), disease prevention, and screening activities. ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Continuing and Transitional Care

Although most patients who undergo ambulatory surgery recover quickly and without complications, some patients require referral for some type of continuing or transitional care. These may be older or frail patients, those who live alone, and patients with other health care problems or disabilities that might interfere with self-care or resumption of usual activities. The home, community, or transitional care nurse assesses the patient's physical status (e.g., respiratory and cardiovascular status, adequacy of pain management, the surgical incision, surgical complications) and the patient's and family's ability to adhere to the recommendations given at the time of discharge. Previous education is reinforced as needed. Nursing interventions may include changing surgical dressings, monitoring the patency of a drainage system, or

administering medications. The patient and family are reminded about the importance of keeping follow-up appointments with the surgeon.

Care of the Hospitalized Postoperative Patient

The majority of surgical patients who require hospital stays are trauma patients, acutely ill patients, patients undergoing major surgery, patients who require emergency surgery, and patients with a concurrent medical disorder. Seriously ill patients and those who have undergone major cardiovascular, pulmonary, or neurologic surgery may be admitted to specialized ICUs for close monitoring and advanced interventions and support. The care required by these patients in the immediate postoperative period is discussed in specific chapters of this book.

Patients admitted to the clinical unit for postoperative care have multiple needs and require frequent assessment and care interventions by nursing staff. Postoperative care for those surgical patients returning to the general medical-surgical unit is discussed later in this chapter.

Receiving the Patient in the Clinical Unit

The patient's room is readied by assembling the necessary equipment and supplies: IV pumps, drainage receptacle holder, suction equipment, oxygen, emesis basin, tissues, disposable pads, blankets, and postoperative documentation forms. When the call comes to the unit about the patient's transfer from the PACU, the need for any additional items is communicated. The PACU nurse reports relevant data about the patient to the receiving nurse (see Chart 16-1).

Usually, the surgeon speaks to the family after surgery and relates the general condition of the patient. The receiving nurse gets a report about the patient's condition, reviews the postoperative orders, admits the patient to the unit, performs an initial assessment, and attends to the patient's immediate needs (see Chart 16-4).

Nursing Management After Surgery

During the first 24 hours after surgery, nursing care of the hospitalized patient on the medical-surgical unit involves continuing to help the patient recover from the effects of anesthesia (Barash et al., 2017), frequently assessing the patient's physiologic status, monitoring for complications, managing pain, and implementing measures designed to achieve the long-range goals of independence with self-care, successful management of the therapeutic regimen, discharge to home, and full recovery. In the initial hours after

admission to the clinical unit, adequate ventilation, hemodynamic stability, incisional pain, surgical site integrity, nausea and vomiting, neurologic status, and spontaneous voiding are primary concerns. The pulse rate, blood pressure, and respiration rate are assessed at intervals determined by the institution.

Patients usually begin to return to their usual state of health several hours after surgery or after awaking the next morning. Although pain may still be intense, many patients feel more alert, less nauseous, and less anxious. They have begun their breathing and leg exercises as appropriate for the type of surgery, and most will have dangled their legs over the edge of the bed, stood, and ambulated a few feet or been assisted out of bed to the chair at least once. Many will have tolerated a light meal and had IV fluids discontinued. The focus of care shifts from intense physiologic management and symptomatic relief of the adverse effects of anesthesia to regaining independence with self-care and preparing for discharge.

Chart 16-4

Immediate Postoperative Nursing Interventions

Nursing Interventions	Rationale
1. Assess breathing and administer supplemental oxygen, if prescribed.	**1.** Assessment provides a baseline and helps identify signs and symptoms of respiratory distress early.
2. Monitor vital signs and note skin warmth, moisture, and color.	**2.** A careful baseline assessment helps identify signs and symptoms of shock early.
3. Assess the surgical site and wound drainage systems. Connect all drainage tubes to gravity or suction as indicated and monitor closed drainage systems.	**3.** Assessment provides a baseline and helps identify signs and symptoms of hemorrhage early.
4. Assess level of consciousness, orientation, and ability to move extremities.	**4.** These parameters provide a baseline and help identify signs and symptoms of neurologic complications.
5. Assess pain level; pain characteristics (location, quality); and timing, type, and route of administration of the last dose of analgesic.	**5.** Assessment provides a baseline of current pain level and assesses effectiveness of pain management strategies.
6. Administer analgesic medications as prescribed and assess their effectiveness in relieving pain.	**6.** Administration of analgesic agents helps decrease pain.
7. Place the call light, emesis basin, ice chips (if allowed), and bedpan or urinal within reach.	**7.** Attending to these needs provides for comfort and safety.
8. Position the patient to enhance comfort, safety, and lung expansion.	**8.** This promotes safety and reduces risk of postoperative complications.
9. Assess IV sites for patency and infusions for correct rate and solution.	**9.** Assessing IV sites and infusions helps detect phlebitis and prevents errors in rate and solution type.
10. Assess urine output in closed drainage system or use bladder scanner to detect distention.	**10.** Assessment provides a baseline and helps identify signs of urinary retention.
11. Reinforce the need to begin deep breathing and leg exercises.	**11.** These activities help prevent complications related to immobility (e.g., atelectasis, VTE).
12. Provide information to the patient and family.	**12.** Patient education helps decrease the patient's and family's anxiety.

VTE, venous thromboembolism.

Adapted from Association of PeriOperative Registered Nurses (AORN). (2019). *Association of PeriOperative Registered Nurses (AORN) standards, recommended practice, and guidelines*. Denver, CO: Author.

NURSING PROCESS

The Hospitalized Patient Recovering from Surgery

Nursing care of the hospitalized patient recovering from surgery takes place in a compressed time frame, with much of the healing and recovery occurring after the patient is discharged to home or to a rehabilitation center.

Assessment

Assessment of the hospitalized postoperative patient includes monitoring vital signs and completing a review of systems upon the patient's arrival to the clinical unit (see Chart 16-4) and at regular intervals thereafter.

Respiratory status is important because pulmonary complications are among the most frequent and serious problems encountered by the surgical patient. The nurse monitors for airway patency and any signs of laryngeal edema. The quality of respirations, including depth, rate, and sound, is assessed regularly. Chest auscultation verifies that breath sounds are normal (or abnormal) bilaterally, and the findings are documented as a baseline for later comparisons. Often, because of the effects of analgesic and anesthetic medications, respirations are slow. Shallow and rapid respirations may be caused by pain, constricting dressings, gastric dilation, abdominal distention, or obesity. Noisy breathing may be due to obstruction by secretions or the tongue. Another possible complication is flash pulmonary edema that occurs when protein and fluid accumulate in the alveoli unrelated to elevated pulmonary artery occlusive pressure. Signs and symptoms include agitation; tachypnea; tachycardia; decreased pulse oximetry readings; frothy, pink sputum; and crackles on auscultation.

The nurse assesses the patient's pain level using a verbal or visual analog scale and assesses the characteristics of the pain. The patient's appearance, pulse, respirations, blood pressure, skin color (adequate or cyanotic), and skin temperature (cold and clammy, warm and moist, or warm and dry) are clues to cardiovascular function. When the patient arrives in the clinical unit, the surgical site is assessed for bleeding, type and integrity of dressings, and drains.

The nurse also assesses the patient's mental status and level of consciousness, speech, and orientation and compares them with the preoperative baseline. Although a change in mental status or postoperative restlessness may be related to anxiety, pain, or medications, it may also be a symptom of oxygen deficit or hemorrhage. These serious causes must be investigated and excluded before other causes are pursued.

General discomfort that results from lying in one position on the operating table, the handling of tissues by the surgical team, the body's

reaction to anesthesia, and anxiety are also common causes of restlessness. These discomforts may be relieved by administering the prescribed analgesic medication, changing the patient's position frequently, and assessing and alleviating the cause of anxiety. If tight, drainage-soaked bandages are causing discomfort, reinforcing or changing the dressing completely as prescribed by the provider may make the patient more comfortable. The bladder is assessed for distention (usually with a bladder scanner) because urinary retention can also cause restlessness and change in mental status (AORN, 2019).

Diagnosis

Nursing Diagnoses

Based on the assessment data, major nursing diagnoses may include the following:

- Impaired airway clearance associated with to depressed respiratory function, pain, and bed rest
- Acute pain associated with surgical incision
- Impaired cardiac output associated with shock or hemorrhage
- Risk for activity intolerance associated with generalized weakness secondary to surgery
- Impaired skin integrity associated with surgical incision and drains
- Impaired thermoregulation associated with surgical environment and anesthetic agents
- Risk for impaired nutritional status associated with decreased intake and increased need for nutrients secondary to surgery
- Risk for constipation associated with effects of medications, surgery, dietary change, and immobility
- Impaired urinary system function associated with anesthetic agents
- Risk for injury associated with surgical procedure/positioning or anesthetic agents
- Anxiety associated with surgical procedure
- Lack of knowledge associated with wound care, dietary restrictions, activity recommendations, medications, follow-up care, or signs and symptoms of complications in preparation for discharge

Collaborative Problems or Potential Complications

Based on the assessment data, potential complications may include the following:

- Pulmonary infection/hypoxia
- Venous thromboembolism (VTE) (e.g., deep vein thrombosis [DVT], pulmonary embolism [PE])
- Hematoma or hemorrhage

- Infection
- Wound dehiscence or evisceration

Planning and Goals

The major goals for the patient include optimal respiratory function, relief of pain, optimal cardiovascular function, increased activity tolerance, unimpaired wound healing, maintenance of body temperature, and maintenance of nutritional balance (Dudek, 2017). Further goals include resumption of usual pattern of bowel and bladder elimination, identification of any perioperative positioning injury, acquisition of sufficient knowledge to manage self-care after discharge, and absence of complications.

Nursing Interventions

Preventing Respiratory Complications

Respiratory depressive effects of opioid medications, decreased lung expansion secondary to opioid pain medication, and decreased mobility combine to put the patient at risk for respiratory complications, particularly atelectasis (alveolar collapse; incomplete expansion of the lung), pneumonia, and hypoxemia (Rothrock, 2019). Atelectasis remains a risk for the patient who is not moving well or ambulating or who is not performing deep-breathing and coughing exercises or using an incentive spirometer. Signs and symptoms include decreased breath sounds over the affected area, crackles, and cough. Pneumonia is characterized by chills and fever, tachycardia, and tachypnea. Cough may or may not be present and may or may not be productive. Pulmonary congestion may occur if secretions are not cleared from the airway. The symptoms are often vague, with perhaps a slight elevation of temperature, pulse, and respiratory rate as well as a cough. Physical examination reveals dullness and crackles at the base of the lungs. If the condition progresses, the outcome may be fatal.

The types of hypoxemia that can affect postoperative patients are subacute and episodic. Subacute hypoxemia is a constant low level of oxygen saturation when breathing appears normal. Episodic hypoxemia develops suddenly, and the patient may be at risk for cerebral dysfunction, myocardial ischemia, and cardiac arrest. Risk for hypoxemia is increased in patients who have undergone major surgery (particularly abdominal), have obesity, or have preexisting pulmonary problems. Unidentified hypoxemia in the postanesthesia patient is not common since the advent of noninvasive oxygen saturation monitoring with pulse oximetry (Odom-Forren, 2018). Factors that may affect the accuracy of pulse oximetry readings include cold extremities, tremors, atrial fibrillation, acrylic nails, and nail polish.

Preventive measures and timely recognition of signs and symptoms help avert pulmonary complications. Crackles indicate static pulmonary secretions that need to be mobilized by coughing and deep-breathing

exercises. When a mucus plug obstructs one of the bronchi entirely, the pulmonary tissue beyond the plug collapses, resulting in atelectasis.

To clear secretions and prevent pneumonia, the nurse encourages the patient to turn frequently, take deep breaths, cough, and use the incentive spirometer at least every 2 hours. These pulmonary exercises should begin as soon as the patient arrives on the clinical unit and continue until the patient is discharged. Even if they are not fully awake from anesthesia, the patient can be asked to take several deep breaths. This helps expel residual anesthetic agents, mobilize secretions, and prevent atelectasis. Careful splinting of abdominal or thoracic incision sites helps the patient overcome the fear that the exertion of coughing might open the incision (see Chapter 14, Chart 14-5). Analgesic agents are given to permit more effective coughing, and oxygen is given as prescribed to prevent or relieve hypoxia. To encourage lung expansion, the patient is encouraged to yawn or take sustained maximal inspirations to create a negative intrathoracic pressure of −40 mm Hg and expand lung volume to total capacity. Chest physical therapy may be prescribed if indicated (see Chapter 19).

Coughing is contraindicated in patients who have head injuries or have undergone intracranial surgery (because of the risk for increasing intracranial pressure), as well as in patients who have undergone eye surgery (because of the risk for increasing intraocular pressure) or plastic surgery (because of the risk for increasing tension on delicate tissues).

Early ambulation increases metabolism and pulmonary aeration and, in general, improves all body functions. Assessment for readiness to ambulate as soon as the patient arrives in the PACU provides consistency and increased patient safety (Persico, Miller, Way, et al., 2019). Ambulation occurs as soon as the patient returns to a safe physical state and level of consciousness.

Relieving Pain

Most patients experience some pain after a surgical procedure. Complete absence of pain in the area of the surgical incision may not occur for a few weeks, depending on the site and nature of the surgery, but the intensity of postoperative pain gradually subsides on subsequent days. A comprehensive pain assessment provides the foundation of good pain control and includes obtaining information regarding the location, intensity, and quality (e.g., sharp, shooting) (Odom-Forren, 2018). Many patients are unable to accurately report their level of pain in the postoperative setting due to sedatives and other medications given during surgery. Nurses must be able to accurately assess other indicators such as behavior, vital signs, level of consciousness, and preoperative baseline pain report (see Chapter 9).

The degree and severity of postoperative pain and the patient's tolerance for pain depend on the incision site, the nature of the surgical procedure,

the extent of surgical trauma, the type of anesthesia, and the route of administration.

Intense pain stimulates the stress response, which adversely affects the cardiac and immune systems. When pain impulses are transmitted, both muscle tension and local vasoconstriction increase, further stimulating pain receptors. This increases myocardial demand and oxygen consumption. The hypothalamic stress response also results in an increase in blood viscosity and platelet aggregation, increasing the risk of thrombosis and PE.

In some states, providers may prescribe different medications or dosages to cover various levels of pain. After the medication is delivered, the nurse should periodically assess the patient's level of pain using a validated pain scale.

Opioid Analgesic Medications. Opioid analgesic agents are commonly prescribed for pain and immediate postoperative restlessness. A realistic goal for postoperative pain management is toleration rather than the elimination of pain. A preventive approach, rather than an "as needed" (PRN) approach, is more effective in relieving pain. With a preventive approach, the medication is given at prescribed intervals rather than when the pain becomes severe or unbearable. In the postoperative setting, intravenous (IV) route is the first-line route of administration for analgesia delivery (Odom-Forren, 2018).

Prior to opioid delivery, the nurse should assess the patient's level of sedation. Sedation assessment tools, such as the POSS (Pasero Opioid-Induced Sedation Scale), are used by the nurse to assess sedation level at frequent intervals to safely care for patients in the PACU. The POSS is a tool developed to identify advancing sedation before it is compounded by continued opioid administration and results in clinically significant respiratory depression or apnea. The POSS indicates the nurse may administer opioids to a patient at sedation level S (*sleep, easy to arouse*) if it has been determined that the patient's respiratory status (rate, depth, regularity, and airway patency) is optimal. Patients assigned a sedation level of 1 or 2 may receive opioid administration; however, beginning at sedation level 3, the recommendation is that the nurse should provide nonopioid therapies to treat pain because the patient is becoming too sedated. Other sedation scales commonly used in the PACU are the RASS (Richmond Agitation–Sedation Scale), Aldrete Scale (see Fig. 16-3), and Glasgow Coma Scale (Hall & Stanley, 2019).

Patient-Controlled Analgesia. The goal is pain prevention rather than sporadic pain control. Patients recover more quickly when adequate pain relief measures are used, and patient-controlled analgesia (PCA) permits patients to administer their own pain medication when needed. Most patients are candidates for PCA. The two requirements for PCA are an understanding of the need to self-dose and the physical ability to self-dose.

The amount of medication delivered by the IV or epidural route and the time span during which the opioid medication is released are controlled by the PCA device. PCA promotes patient participation in care; eliminates delayed administration of analgesic medications; maintains a therapeutic drug level; and enables the patient to move, turn, cough, and take deep breaths with less pain, thus reducing postoperative pulmonary complications (Rothrock, 2019).

Multimodal Analgesia. The use of more than one method of analgesia, referred to as multimodal analgesia, is a growing trend to manage postoperative pain. Some of these methods are started in the preoperative area; however, the effects are seen in the postoperative area. The most common analgesics used for postoperative pain are a mixture of opioid and nonopioid analgesics (i.e., acetaminophen and NSAIDs) and local anesthetics. A multimodal approach may combine agents in any of the analgesic groups to provide effective pain relief and minimize adverse effects (Odom-Forren, 2018). A balanced, multimodal approach to pain management within the larger framework of an Enhanced Recovery After Surgery (ERAS) pathway has become standard at many institutions for perioperative care, to control postsurgical pain, reduce opioid-related adverse events, hasten postsurgical recovery, and shorten length of hospital stay (Montgomery & McNamara, 2016). ERAS is an evidence-based, multimodal care model resulting in substantial improvements in clinical outcomes and cost savings (Ljungqvist, Scott, & Fearon, 2017).

Epidural Infusions and Intrapleural Anesthesia. Epidural analgesia involves a continuous infusion of local anesthetics through a catheter and is the most widely used neuraxial technique for acute postoperative pain (Wolfe, 2018). A local opioid or a combination anesthetic (opioid plus local anesthetic agent) is used in the epidural infusion. Epidural infusions are used with caution in chest procedures because the analgesic may ascend along the spinal cord and affect respiration. Intrapleural anesthesia involves the administration of a local anesthetic by a catheter between the parietal and visceral pleura. It provides sensory anesthesia without affecting motor function to the intercostal muscles. This anesthesia allows more effective coughing and deep breathing in conditions such as cholecystectomy, renal surgery, and rib fractures, in which pain in the thoracic region would interfere with these exercises.

Postoperative nurses may also care for patients who received a preoperative local anesthetic block. The intended effects of pain relief may last for hours or up to days, depending on the method used. Nurses should include the location of the block, when it was administered, current pain level, and insertion site assessment when providing report to the inpatient nursing unit. Patient discharge instructions include information about when

to expect the return of sensation, mobility precautions with decreased sensation, and care of the dressing at the insertion site.

Other Pain Relief Measures. For pain that is difficult to control, a subcutaneous pain management system may be used. In this system, a nylon catheter is inserted at the site of the affected area. The catheter is attached to a pump that delivers a continuous amount of local anesthetic at a specific amount determined and prescribed by the primary provider (see Fig. 16-4).

Nonpharmacologic pain management approaches may be used as components of multimodal pain management plans of care. Effective methods include music therapy, guided imagery, Reiki, and therapeutic massage (Poulson, Coto, & Cooney, 2019). Changing the patient's position, using distraction, applying cool washcloths to the face, and providing back massage may be useful in relieving general discomfort temporarily, promoting relaxation, and rendering medication more effective when it is given.

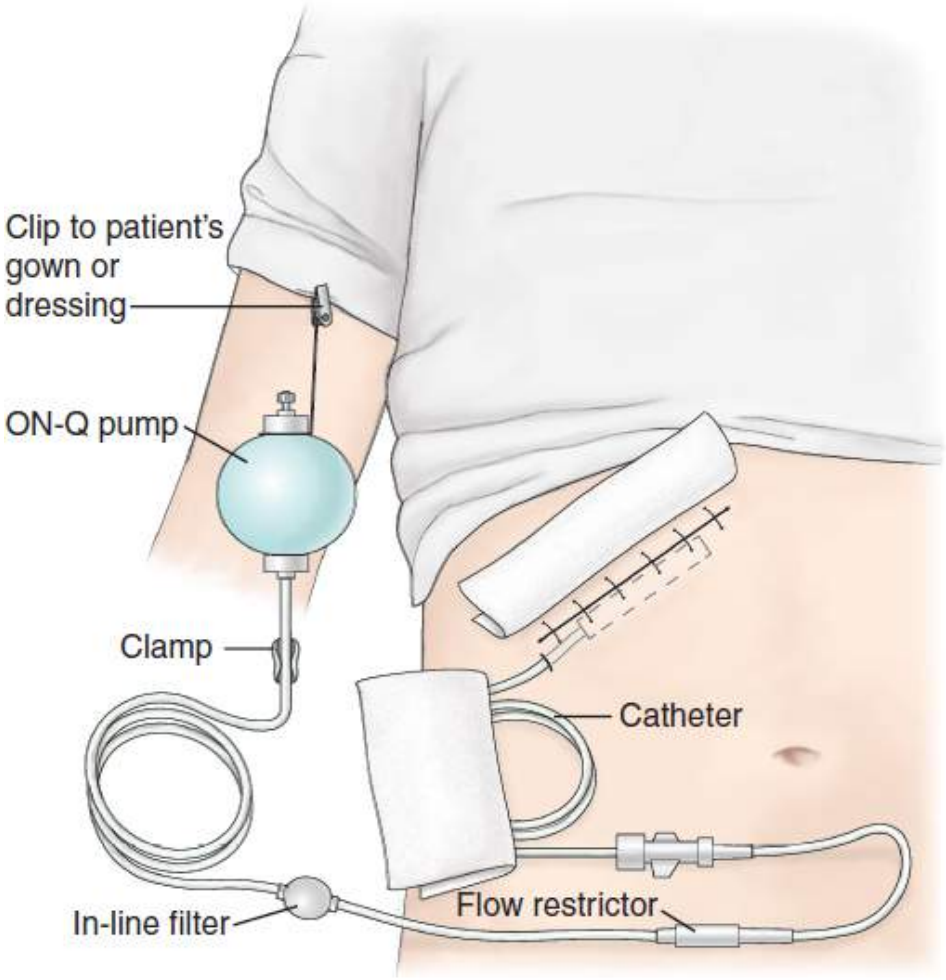


Figure 16-4 • Subcutaneous pain management system consists of a pump, filter, and catheter that delivers a specific amount of prescribed local anesthetic at the rate determined by the physician. Redrawn with permission from Kimberly-Clark Corporation, Neenah, WI.

PROMOTING CARDIAC OUTPUT

If signs and symptoms of shock or hemorrhage occur, treatment and nursing care are implemented as described in the discussion of care in the PACU and in Chapter 11.

Although most patients do not hemorrhage or go into shock, changes in circulating volume, the stress of surgery, and the effects of medications and preoperative preparations all affect cardiovascular function. Volume status assessment in the PACU can be difficult because vasoconstriction from surgical stress and hypothermia can compensate for hypovolemia (Odom-Forren, 2018). Close monitoring is indicated to detect and correct conditions such as fluid volume deficit, altered tissue perfusion, and decreased cardiac output, all of which can increase the patient's discomfort, place him or her at risk of complications, and prolong the hospital stay. Consequently, fluid replacement must be carefully managed, and intake and

output records must be accurate. IV fluid replacement may be prescribed for up to 24 hours after surgery or until the patient is stable and tolerating oral fluids.

Nursing management includes assessing the patency of the IV lines and ensuring that the correct fluids are given at the prescribed rate. Intake and output, including emesis and output from wound drainage systems, are recorded separately and totaled to determine fluid balance. If the patient has an indwelling urinary catheter, hourly outputs are monitored and should not be less than 0.5 mL/kg/h or 25 mL/h; oliguria is reported immediately (Odom-Forren, 2018). Electrolyte levels and hemoglobin and hematocrit levels are monitored. Decreased hemoglobin and hematocrit levels can indicate blood loss or dilution of circulating volume by IV fluids. If dilution is contributing to the decreased levels, the hemoglobin and hematocrit will rise as the stress response abates and fluids are mobilized and excreted.

Venous stasis from dehydration, immobility, and pressure on leg veins during surgery put the patient at risk for VTE. Leg exercises and frequent position changes are initiated early in the postoperative period to stimulate circulation. Patients should avoid positions that compromise venous return, such as raising the bed's knee gatch, placing a pillow under the knees, sitting for long periods, and dangling the legs with pressure at the back of the knees. Venous return is promoted by antiembolism stockings and early ambulation.

Encouraging Activity

Early ambulation has a significant effect on recovery and the prevention of complications (e.g., atelectasis, hypostatic pneumonia, gastrointestinal [GI] discomfort, circulatory problems) (Rothrock, 2019). Postoperative activity orders are checked before the patient is assisted to get out of bed, in many instances, on the evening following surgery. Sitting up at the edge of the bed for a few minutes may be all that the patient who has undergone a major surgical procedure can tolerate at first.

Ambulation reduces postoperative abdominal distention by increasing GI tract and abdominal wall tone and stimulating peristalsis. Early ambulation prevents stasis of blood, and thromboembolic events occur less frequently. Pain is often decreased when early ambulation is possible, and the hospital stay is shorter and less costly.

Despite the advantages of early ambulation, patients may be reluctant to get out of bed on the evening of surgery. Reminding them of the importance of early mobility in preventing complications may help patients overcome their fears. When a patient gets out of bed for the first time, orthostatic hypotension, also called *postural hypotension,* is a concern. Orthostatic hypotension is an abnormal drop in blood pressure that occurs as the patient changes from a supine to a standing position. It is common after surgery because of changes in circulating blood volume and bed rest. Signs and

symptoms include a decrease of 20 mm Hg in systolic blood pressure or 10 mm Hg in diastolic blood pressure, weakness, dizziness, and fainting (Weber & Kelley, 2018). Patients may report a sense of dizziness or fainting, along with a marked drop in blood pressure. Older adults are at increased risk for orthostatic hypotension secondary to age-related changes in vascular tone. To detect orthostatic hypotension, the nurse assesses the patient's blood pressure first in the supine position, after the patient sits up, again after the patient stands, and 2 to 3 minutes later. Gradual position change gives the circulatory system time to adjust. If the patient becomes dizzy, they are returned to the supine position, and ambulation is delayed for several hours.

To assist the postoperative patient in getting out of bed for the first time after surgery, the nurse:

- Helps the patient move gradually from the lying position to the sitting position by raising the head of the bed and encourages the patient to splint the incision when applicable.
- Positions the patient completely upright (sitting) and turned so that both legs are hanging over the edge of the bed.
- Helps the patient stand beside the bed.

After becoming accustomed to the upright position, the patient may start to walk. The nurse should be at the patient's side to give physical support and encouragement. Care must be taken not to tire the patient; the extent of the first few periods of ambulation varies with the type of surgical procedure and the patient's physical condition and age.

Whether or not the patient can ambulate early in the postoperative period, bed exercises are encouraged to improve circulation. Bed exercises consist of the following:

- Arm exercises (full range of motion, with specific attention to abduction and external rotation of the shoulder)
- Hand and finger exercises
- Foot exercises to prevent VTE, footdrop, and toe deformities and to aid in maintaining good circulation
- Leg flexion and leg-lifting exercises to prepare the patient for ambulation
- Abdominal and gluteal contraction exercises

Hampered by pain, dressings, IV lines, or drains, many patients cannot engage in activity without assistance. Helping the patient increase the activity level on the first postoperative day is important to prevent complications related to prolonged inactivity. One way to increase the patient's activity is to have the patient perform as much routine hygiene care as possible. Setting up the patient to bathe with a bedside wash basin or, if possible, assisting the patient to the bathroom to sit in a chair at the

sink not only gets the patient moving but helps restore a sense of self-control and prepares the patient for discharge.

For a safe discharge to home, patients need to be able to ambulate a functional distance (e.g., length of the house or apartment), get in and out of bed unassisted, and be independent with toileting. Patients can be asked to perform as much as they can and then to call for assistance. The patient and the nurse can collaborate on a schedule for progressive activity that includes ambulating in the room and hallway and sitting out of bed in a chair. Assessing the patient's vital signs before, during, and after a scheduled activity helps the nurse and patient determine the rate of progression. By providing physical support, the nurse maintains the patient's safety; by communicating a positive attitude about the patient's ability to perform the activity, the nurse promotes the patient's confidence. The nurse encourages the patient to continue to perform bed exercises, wear pneumatic compression or prescribed antiembolism stockings when in bed, and rest as needed. If the patient has had orthopedic surgery of the lower extremities or will require a mobility aid (i.e., walker, crutches) at home, a physical therapist may be involved the first time the patient gets out of bed to educate him or her to ambulate safely or to use the mobility aid correctly.

Caring for Wounds

Wound Healing. Wounds heal by different mechanisms, depending on the condition of the wound.

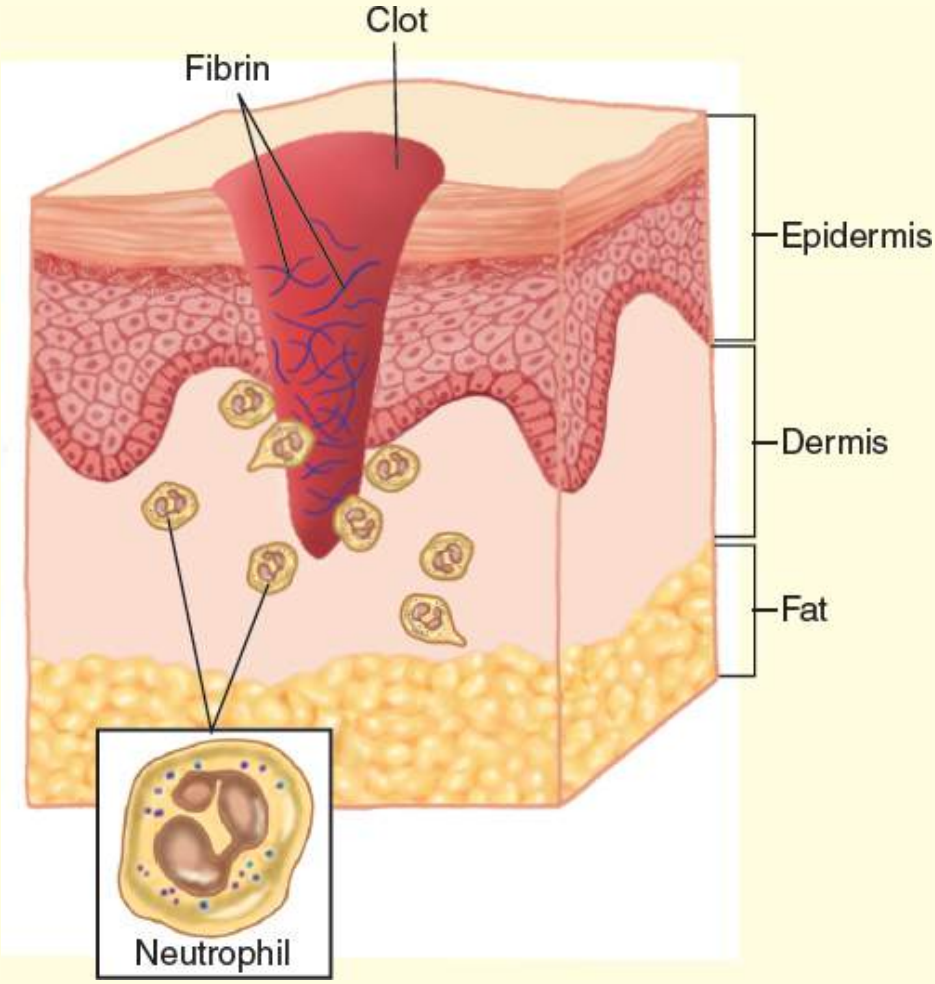
The healing of skin wounds follows three general phases, the inflammatory phase, the proliferative phase, and then wound contraction and remodeling phase. Each of these phases is mediated through cytokines and growth factors (Norris, 2019). See **Chart 16-5** for explanations and illustrations of these three phases.

Surgical wound healing occurs in two ways, by **first-intention or second-intention wound healing** (Norris, 2019). A sutured surgical incision is an example of first-intention healing. A larger wound, such as a burn heals by secondary intention.

Chart 16-5

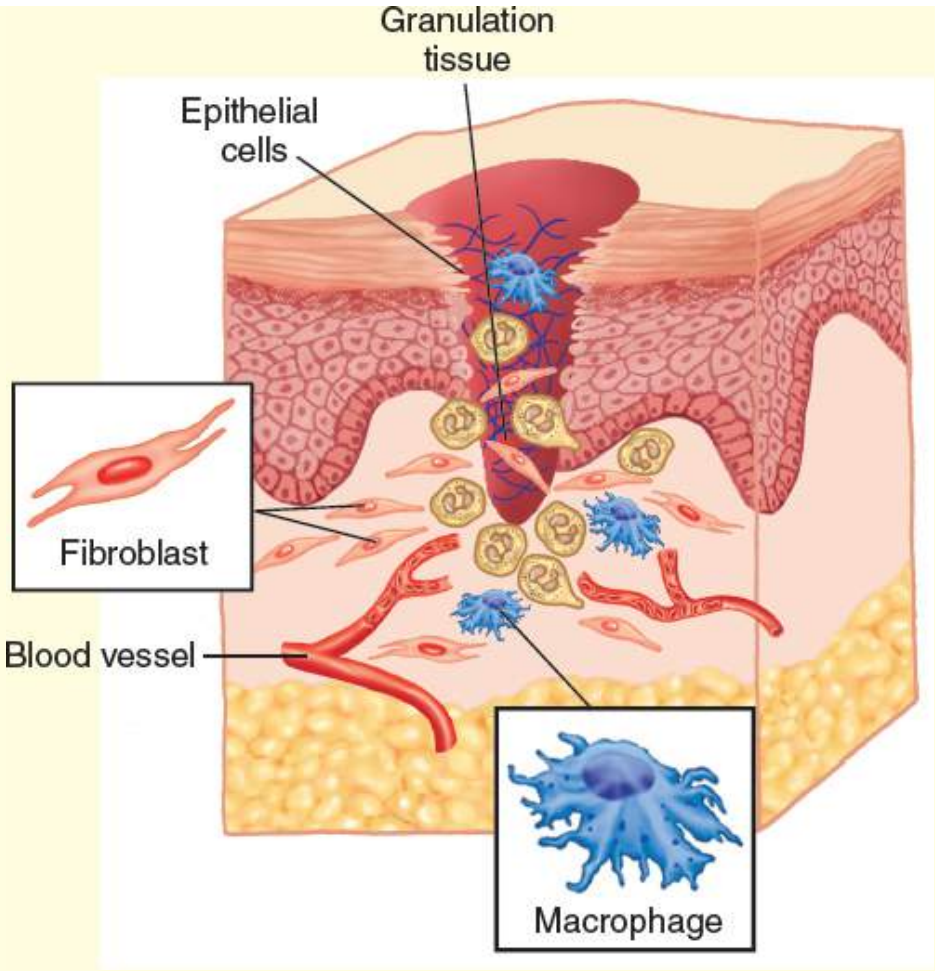
Three Phases of Wound Healing

Inflammatory Phase



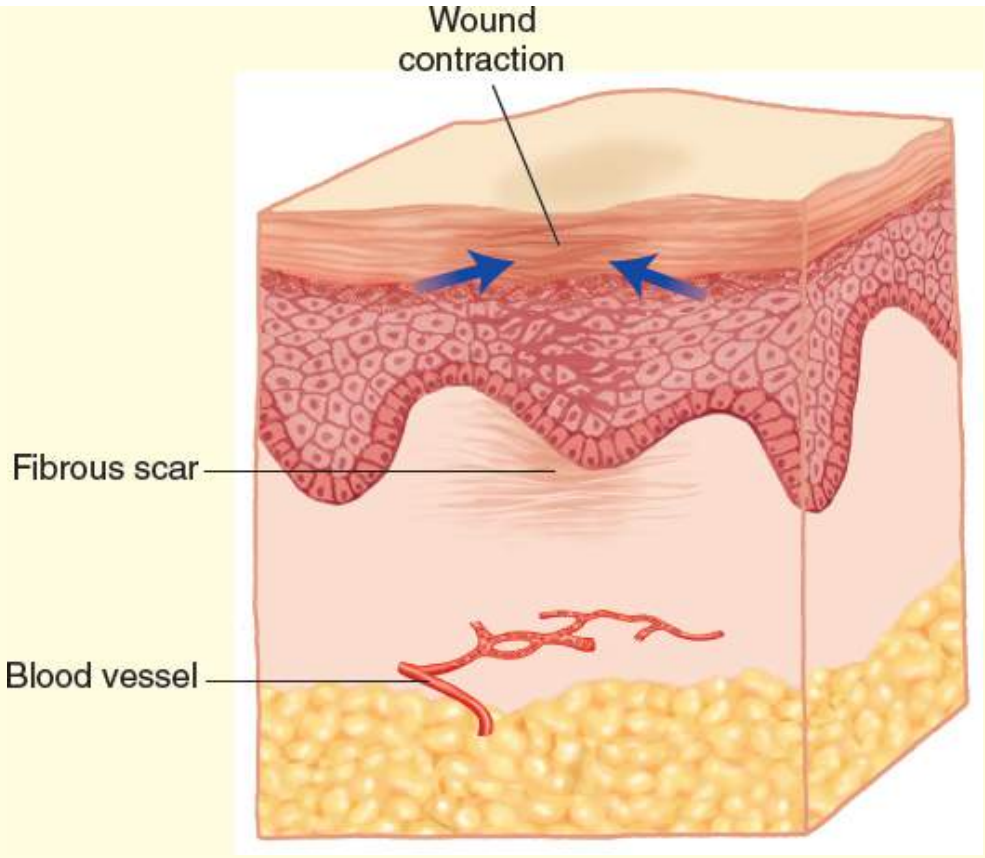
The inflammatory phase begins at the time of injury with the formation of a blood clot and the migration of phagocytic white blood cells into the wound site. The first cells to arrive, the neutrophils, ingest and remove bacteria and cellular debris. After 24 hours, the neutrophils are joined by macrophages, which continue to ingest cellular debris and play an essential role in the production of growth factors for the proliferative phase.

Proliferative Phase



The primary processes during this phase focus on the building of new tissue to fill the wound space. The key cell during this phase is the *fibroblast*, a connective tissue cell that synthesizes and secretes the collagen, proteoglycans, and glycoproteins needed for wound healing. Fibroblasts also produce a family of growth factors that induce angiogenesis (growth of new blood vessels) and endothelial cell proliferation and migration. The final component of the proliferative phase is epithelialization, during which epithelial cells at the wound edges proliferate to form a new surface layer that is similar to that which was destroyed by the injury.

Wound Contraction and Remodeling Phase



This phase begins approximately 3 weeks after injury with the development of the fibrous scar and can continue for 6 months or longer, depending on the extent of the wound. During this phase, there is a decrease in vascularity and continued remodeling of scar tissue by simultaneous synthesis of collagen by fibroblasts and lysis by collagenase enzymes. As a result of these two processes, the architecture of the scar is capable of increasing its tensile strength, and the scar shrinks so it is less visible.

Reprinted with permission from Norris, T. L. (2018). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Wolters Kluwer.

With shorter hospital stays, much of the healing takes place at home, and both the hospital and the transitional or home health nurse needs to be well versed in the principles of wound healing.

Ongoing assessment of the surgical site involves inspection for approximation of wound edges, integrity of sutures or staples, redness, discoloration, warmth, swelling, unusual tenderness, or drainage. The area around the wound should also be inspected for a reaction to tape or trauma from tight bandages. Risk factors for altered wound healing include poor nutrition, smoking, diabetes, and poor hygiene (Nasser, Kosty, Shah, et al., 2018; Norris, 2019). Specific nursing assessments and interventions that

address these factors and help promote wound healing are presented in Table 16-3.

TABLE 16-3 Factors Affecting Wound Healing

Factors	Rationale	Nursing Interventions
Age of patient	The older the patient, the less resilient the tissues.	Handle all tissues gently.
Bathing protocol	Use of chlorhexidine gluconate shower and preoperative wipes as a means for antimicrobial skin antisepsis.	Educate patient regarding use and importance. Confirm use with patient in preoperative area.
Hemorrhage	Accumulation of blood creates dead spaces as well as dead cells that must be removed. The area becomes a growth medium for organisms.	Monitor vital signs. Observe incision site for evidence of bleeding and infection.
Hypovolemia	Insufficient blood volume leads to vasoconstriction and reduced oxygen and nutrients available for wound healing.	Monitor for volume deficit (circulatory impairment). Correct by fluid replacement as prescribed.
Temperature Management	Hypothermia causes poor tissue oxygenation and thus poor perfusion needed for wound healing.	Assess the patient's temperature pre-, intra-, and postoperatively. Implement warm blanket or forced air warming measures.
Local Factors		
Edema	Reduces blood supply by exerting increased interstitial pressure on vessels.	Elevate part; apply cool compresses.
Inadequate dressing technique:		
Too small	Permits bacterial invasion and contamination.	Follow guidelines for proper dressing technique.
Too tight	Reduces blood supply carrying nutrients and oxygen.	
Nutritional deficits	Protein–calorie depletion may occur.	Correct deficits; this may require parenteral nutritional therapy.
	Insulin secretion may be inhibited, causing blood glucose to rise.	Monitor blood glucose levels.
		Administer vitamin supplements as prescribed.
Foreign bodies	Foreign bodies retard healing.	Keep wounds free of dressing threads, ensure sterility of implanted items.
Oxygen deficit	Insufficient oxygen may be due to	Encourage deep

(tissue oxygenation insufficient)	inadequate lung and cardiovascular function as well as localized vasoconstriction.	breathing, turning, and controlled coughing.
Drainage accumulation	Accumulated secretions hamper healing process.	Monitor closed drainage systems for proper functioning. Institute measures to remove accumulated secretions.
Medications		
Corticosteroids	May mask presence of infection by impairing normal inflammatory response.	Be aware of action and effect of medications patient is receiving.
Anticoagulants	May cause hemorrhage.	
Broad-spectrum and specific antibiotics	Effective if given immediately before surgery for specific pathology or bacterial contamination. Ineffective if given after wound is closed due to intravascular coagulation at the periphery of the surgical site.	
Patient overactivity	Prevents approximation of wound edges. Resting favors healing.	Use measures to keep wound edges approximated: taping, bandaging, splints. Encourage rest.
Systemic Disorders		
Hemorrhagic shock Acidosis Hypoxia Kidney injury Hepatic disease Sepsis	These depress cell functions that directly affect wound healing.	Be familiar with the nature of the specific disorder. Administer prescribed treatment. Cultures may be indicated to determine appropriate antibiotic.
Immunosuppressed state	Patient is more vulnerable to bacterial and viral invasion; defense mechanisms are impaired.	Provide maximum protection to prevent infection. Restrict visitors with colds; institute mandatory hand hygiene by all staff.
Wound Stressors		
Vomiting Valsalva maneuver Heavy coughing Straining	Produce tension on wounds, particularly of the torso.	Encourage frequent turning and ambulation, and administer antiemetic

	medications as prescribed. Assist patient in splinting incision.

Adapted from Padgette, P., & Wood, B. (2018). Conducting a surgical site infection prevention tracer. *AORN Journal*, *107*(5), 580–590.

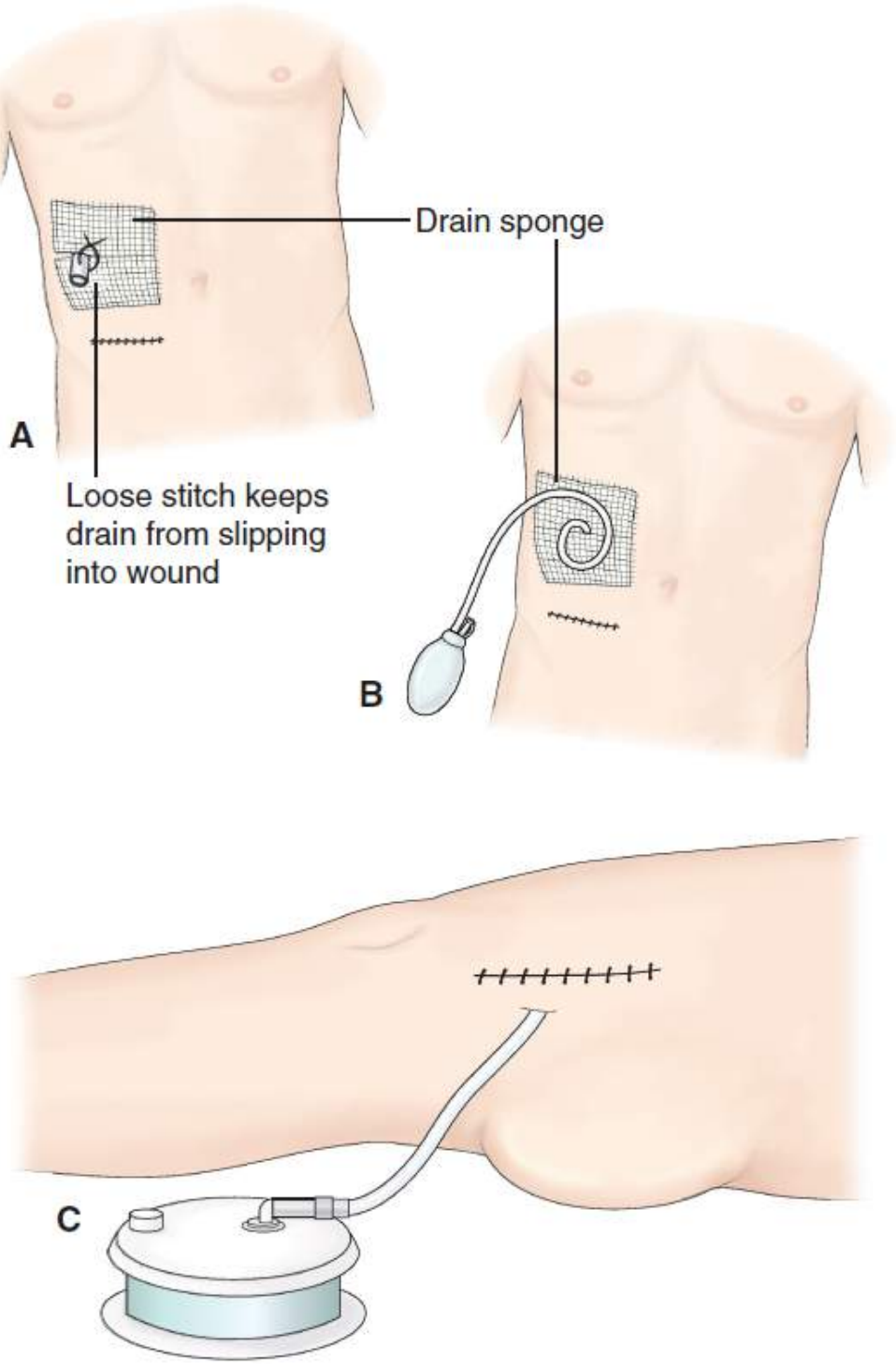


Figure 16-5 • Types of surgical drains: **A.** Penrose. **B.** Jackson–Pratt. **C.** Hemovac.

Caring for Surgical Drains. Nursing interventions to promote wound healing also include management of surgical drains. Drains are tubes that exit the peri-incisional area, either into a portable wound suction device (closed) or into the dressings (open). The principle involved is to allow the escape of fluids that could otherwise serve as a culture medium for bacteria. In portable wound suction, the use of gentle, constant suction enhances drainage of these fluids and collapses the skin flaps against the underlying tissue, thus removing "dead space." Types of wound drains include the Penrose, Jackson-Pratt, and Hemovac drains (see Fig. 16-5). Output (drainage) from wound systems is recorded.

Wound vacuum-assisted closure (VAC) devices are used on open wounds allowed to heal on their own. The wound VAC is a foam dressing that uses negative pressure suction at the wound surface. The vacuum removes debris while promoting granulation tissue growth and blood flow. Wound VACs are placed intraoperatively and the foam dressing is changed periodically as the wound shrinks in size (see Fig. 16-6). The amount, pressure, and color of drainage should be assessed and recorded. Patients should be assessed for pain as nerve endings may grow into the sponge as tissue regrows.

The amount of bloody drainage on the surgical dressing is assessed frequently. Spots of drainage on the dressings are outlined with a pen, and the date and time of the outline are recorded on the dressing so that increased drainage can be easily seen. A certain amount of bloody drainage in a wound drainage system or on the dressing is expected, but excessive amounts should be reported to the surgeon. Increasing amounts of fresh blood on the dressing should be reported immediately. Some wounds are irrigated heavily before closure in the OR, and open drains exiting the wound may be embedded in the dressings. These wounds may drain large amounts of blood-tinged fluid that saturate the dressing. The dressing can be reinforced with sterile gauze bandages; the time at which they were reinforced should be documented. If drainage continues, the surgeon should be notified so that the dressing can be changed. Multiple similar drains are numbered or otherwise labeled (e.g., left lower quadrant, left upper quadrant) so that output measurements can be reliably and consistently recorded.

Figure 16-6 • Example of an abdominal wound with a vacuum-assisted closure (VAC). **A.** Abdominal gunshot wound showing VAC following initial laparotomy that allows for swelling. **B.** Abdominal gunshot wound showing VAC following partial closure 3 days later. Photos courtesy of Blaine Thomas.

Changing the Dressing

The surgical dressing is placed in the operating suite by a member of the surgical team. Dressing changes (if needed) in the immediate postoperative period are performed by the nurse. A dressing is applied to a wound for one or more of the following reasons: (1) to provide a proper environment for wound healing; (2) to absorb drainage; (3) to splint or immobilize the wound; (4) to protect the wound and new epithelial tissue from mechanical injury; (5) to protect the wound from bacterial contamination and from soiling by feces, vomitus, and urine; (6) to promote hemostasis, as in a pressure dressing; and (7) to provide mental and physical comfort for the patient.

The patient is told that the dressing is to be changed and that changing the dressing is a simple procedure associated with little discomfort. The dressing change is performed at a suitable time (e.g., not at mealtimes or when visitors are present). Privacy is provided, and the patient is not unduly exposed. Assurance is given that the incision will shrink as it heals and that the redness will fade.

The nurse performs hand hygiene before and after the dressing change and wears disposable gloves (sterile or clean as needed) for the dressing change itself. Most dressing changes following surgery are sterile. In accordance with standard precautions, dressings are never touched by ungloved hands because of the danger of transmitting pathogenic organisms. The tape or adhesive portion of the dressing is removed by pulling it parallel with the skin surface and in the direction of hair growth rather than at right angles. Alcohol wipes or nonirritating solvents aid in removing adhesive painlessly and quickly. The soiled dressing is removed and deposited in a container designated for disposal of biomedical waste.

Gloves are changed, and a new dressing is applied. If the patient is sensitive to adhesive tape, the dressing may be held in place with hypoallergenic tape. Many tapes are porous to prevent skin maceration. Some wounds become edematous after having been dressed, causing considerable tension on the tape. If the tape is not flexible, the stretching bandage will also cause a shear injury to the skin. This can result in denuded areas or large blisters and should be avoided. An elastic adhesive bandage (Elastoplast, 3M Microfoam) may be used to hold dressings in place over mobile areas, such as the neck or the extremities, or where pressure is required.

While changing the dressing, the nurse has an opportunity to educate the patient on how to care for the incision and change the dressings at home. The nurse observes for indicators of the patient's readiness to learn, such as looking at the incision, expressing interest, or assisting in the dressing change. Information on self-care activities and possible signs of infection is summarized in **Chart 16-6.**

Maintaining Normal Body Temperature

The patient is still at risk for malignant hyperthermia and hypothermia in the postoperative period. Efforts are made to identify malignant hyperthermia and to treat it early and promptly (Rothrock, 2019).

Patients who have received anesthesia are susceptible to chills and drafts. Interventions to avoid hypothermia, temperatures below 36°C (98.6°F), begin in the preoperative area (see Chapter 14) and continue throughout the intraoperative period (see Chapter 15). Low body temperature is reported to the primary provider. The room is maintained at a comfortable temperature, and blankets are provided to prevent chilling. Treatment includes oxygen administration, adequate hydration, and proper nutrition including glycemic control. The patient is also monitored for cardiac arrhythmias. The risk of hypothermia is greater in older adults and in patients who were in the cool OR environment for a prolonged period.

Managing Gastrointestinal Function and Resuming Nutrition

Discomfort of the GI tract (nausea, vomiting, and hiccups) and resumption of oral intake are issues for the patient and affect their outcome following surgery. (See the earlier discussion of PONV in the PACU.)

If the risk of vomiting is high due to the nature of surgery, a nasogastric tube is inserted preoperatively and remains in place throughout the surgery and the immediate postoperative period. A nasogastric tube also may be inserted before surgery if postoperative distention is anticipated. In addition, a nasogastric tube may be inserted if a patient who has food in the stomach requires emergency surgery.

Hiccups, produced by intermittent spasms of the diaphragm secondary to irritation of the phrenic nerve, can occur after surgery. The irritation may be direct, such as from stimulation of the nerve by a distended stomach, subdiaphragmatic abscess, or abdominal distention; indirect, such as from toxemia or uremia that stimulates the nerve; or reflexive, such as from irritation from a drainage tube or obstruction of the intestines. These occurrences usually are mild, transitory attacks that cease spontaneously. If hiccups persist, they may produce considerable distress and serious effects, such as vomiting, exhaustion, and wound dehiscence. Chlorpromazine (a phenothiazine) is the only drug approved to treat intractable hiccups (Aroke & Hicks, 2019).

Chart 16-6 **PATIENT EDUCATION**

Wound Care Instructions

Until Sutures Are Removed

1. Keep the wound dry and clean.
   - If there is no dressing, ask your nurse or physician if you can bathe or shower.
   - If a dressing or splint is in place, do not remove it unless it is wet or soiled.
   - If wet or soiled, change dressing yourself if you have been taught to do so; otherwise, call your nurse or physician for guidance.
   - If you have been taught, instruction might be as follows:
   - Cleanse area *gently* with sterile normal saline once or twice daily.
   - Cover with a sterile Telfa pad™ or gauze square large enough to cover wound.
   - Apply hypoallergenic tape (Dermicel™ or paper). Adhesive is not recommended because it is difficult to remove without possible injury to the incisional site.
2. Immediately report any of these signs of infection:
   - Redness, marked swelling exceeding 0.5 inch (2.5 cm) from incision site; tenderness; or increased warmth around wound
   - Red streaks in skin near wound
   - Pus or discharge, foul odor
   - Chills or temperature higher than 37.7°C (100°F)
3. If soreness or pain causes discomfort, apply a dry cool pack (containing ice or cold water) or take prescribed acetaminophen tablets every 4 to 6 hours. Avoid using aspirin without direction or instruction because bleeding can occur with its use.
4. Swelling after surgery is common. To help reduce swelling, elevate the affected part to the level of the heart.
   - Hand or arm:
   - Sleep—elevate arm on pillow at side
   - Sitting—place arm on pillow on adjacent table
   - Standing—rest affected hand on opposite shoulder; support elbow with unaffected hand
   - Leg or foot:
   - Sitting—place a pillow on a facing chair; provide support underneath the knee
   - Lying—place a pillow under affected leg

After Sutures Are Removed

Although the wound appears to be healed when sutures are removed, it is still tender and will continue to heal and strengthen for several weeks.

- Follow recommendations of physician or nurse regarding extent of activity.
- Keep suture line clean; do not rub vigorously; pat dry. Wound edges may look red and may be slightly raised. This is normal.
- If the site continues to be red, thick, and painful to pressure after 8 weeks, consult the health care provider. (This may be due to excessive collagen formation and should be checked.)

Adapted from American Society of PeriAnesthesia Nurses (ASPAN). (2019). *Perianesthesia nursing standards, practice recommendations and interpretive statements*. Cherry Hill, NJ: Author.

Association of PeriOperative Registered Nurses (AORN). (2019). *Association of PeriOperative Registered Nurses (AORN) standards, recommended practice, and guidelines*. Denver, CO: Author.

Quality and Safety Nursing Alert

Any condition that is persistent or considered intractable, such as hiccups, should be reported to the primary provider so that appropriate measures can be implemented.

Once PONV has subsided and the patient is fully awake and alert, the sooner they can tolerate a usual diet, the more quickly normal GI function will resume. Taking food by mouth stimulates digestive juices and promotes gastric function and intestinal peristalsis. The return to normal dietary intake should proceed at a pace set by the patient. The nature of the surgery and the type of anesthesia directly affect the rate at which normal gastric activity resumes. Enhanced recovery programs encourage early nutrition as a way to maintain fluid balance, prevent postoperative ileus, and decrease overall length of stay (Persico et al., 2019).

Clear liquids are typically the first substances desired and tolerated by the patient after surgery. Water, juice, and tea may be given in increasing amounts. Cool fluids are tolerated more easily than those that are ice cold or hot. Soft foods (gelatin, custard, milk, and creamed soups) are added gradually after clear fluids have been tolerated. As soon as the patient tolerates soft foods well, solid food may be given.

Assessment and management of GI function are important after surgery because the GI tract is subject to uncomfortable or potentially life-threatening complications. Any postoperative patient may suffer from distention. Postoperative distention of the abdomen results from the accumulation of gas in the intestinal tract. Manipulation of the abdominal

organs during surgery may produce a loss of normal peristalsis for 24 to 48 hours, depending on the type and extent of surgery. Even though nothing is given by mouth, swallowed air and GI tract secretions enter the stomach and intestines; if not propelled by peristalsis, they collect in the intestines, producing distention and causing the patient to complain of fullness or pain in the abdomen. Most often, the gas collects in the colon. Abdominal distention is further increased by immobility, anesthetic agents, and the use of opioid medications.

After major abdominal surgery, distention may be avoided by having the patient turn frequently, exercise, and ambulate as early as possible. This also alleviates distention produced by swallowing air, which is common in anxious patients. A nasogastric tube inserted before surgery may remain in place until full peristaltic activity (indicated by the passage of flatus) has resumed. The nurse detects bowel sounds by listening to the abdomen with a stethoscope. Bowel sounds are documented so that diet progression can occur.

Paralytic ileus and intestinal obstruction are potential postoperative complications that occur more frequently in patients undergoing intestinal or abdominal surgery (see Chapter 41).

Promoting Bowel Function

Constipation can occur after surgery as a minor or a serious complication. Decreased mobility, decreased oral intake, and opioid analgesic medications can contribute to difficulty having a bowel movement. In addition, irritation and trauma to the bowel during surgery may inhibit intestinal movement for several days. The combined effect of early ambulation, improved dietary intake, and a stool softener (if prescribed) promotes bowel elimination. Multimodal analgesia regimens in surgical patients minimize opioid-related adverse effects such as nausea, vomiting, and reduced gastric motility (Wolfe, 2018). The nurse should assess the abdomen for distention and the presence and frequency of bowel sounds. If the patient does not have a bowel movement by the second or third postoperative day, the primary provider should be notified and a laxative or other test or intervention may be needed.

Managing Voiding

The type of procedure, length of case, and patient position may have warranted a catheter being placed in the patient's urinary tract in the OR. In the postoperative period, any urine that was collected using a catheter (indwelling or straight) during the operative procedure should be noted. This information will assist the nurse to anticipate the patient's voiding needs.

Urinary retention after surgery can occur for various reasons. Anesthetics, anticholinergic agents, and opioids interfere with the

perception of bladder fullness and the urge to void and inhibit the ability to initiate voiding and completely empty the bladder. Abdominal, pelvic, and hip surgery may increase the likelihood of retention secondary to pain. In addition, some patients find it difficult to use the bedpan or urinal in the recumbent position.

Bladder distention and the urge to void should be assessed at the time of the patient's arrival at the unit and frequently thereafter. The patient is expected to void within 8 hours after surgery (this includes time spent in the PACU). If the patient has an urge to void and cannot, or if the bladder is distended and no urge is felt or the patient cannot void, catheterization is not delayed solely on the basis of the 8-hour time frame. All methods to encourage the patient to void should be tried (e.g., letting water run, applying heat to the perineum). The bedpan should be warm; a cold bedpan causes discomfort and automatic tightening of muscles (including the urethral sphincter). If the patient cannot void on a bedpan, it may be possible to use a commode or a toilet (if there is one in the PACU). Male patients are often permitted to sit up or stand beside the bed to use the urinal; however, safeguards should be taken to prevent the patient from falling or fainting due to loss of coordination from medications or orthostatic hypotension. If the patient has not voided within the specified time frame, a portable bladder ultrasound is performed to check for urinary retention (see Chapter 47, Fig. 47-8). The patient is catheterized, and the catheter is removed after the bladder has emptied. Straight intermittent catheterization is preferred over indwelling catheterization because the risk of infection is increased with an indwelling catheter.

Even if the patient voids, the bladder may not empty. The nurse notes the amount of urine voided and palpates the suprapubic area for distention or tenderness. Postvoid residual urine may be assessed by using either straight catheterization or a portable bladder ultrasound scanner and is considered diagnostic of urinary retention. Bladder scanning is an effective way to detect urinary retention in patients who have had general and regional anesthesia. Research suggests that frequent bladder scanning decreases incontinence as retention is detected early and treated before an incontinent episode (Wishart, 2019).

Maintaining a Safe Environment

During the immediate postoperative period, the patient recovering from anesthesia should have two side rails up, and the bed should be in the low position. The nurse assesses the patient's level of consciousness and orientation and determines whether the patient can resume wearing assistive devices as needed (e.g., eyeglasses, hearing aid). Impaired vision, inability to hear postoperative instructions, or inability to communicate verbally places the patient at risk for injury. All objects the patient may need should be within reach, especially the call light. Any immediate

postoperative prescribed therapies concerning special positioning, equipment, or interventions should be implemented as soon as possible. The patient is instructed to ask for assistance with any activity. Although restraints are occasionally necessary for a patient who is disoriented, they should be avoided if at all possible (see Chapter 1 for further discussion on use of restraints). Agency policy on the use of restraints must be consulted and followed.

Any surgical procedure has the potential for injury due to disrupted neurovascular integrity resulting from prolonged awkward positioning in the OR, manipulation of tissues, inadvertent severing of nerves or blood vessels, or tight bandages. Any orthopedic or neurologic surgery or surgery involving the extremities carries a risk of peripheral nerve damage. Vascular surgeries, such as replacement of sections of diseased peripheral arteries or insertion of an arteriovenous graft, put the patient at risk for thrombus formation at the surgical site and subsequent ischemia of tissues distal to the thrombus. Assessment includes having the patient move the hand or foot distal to the surgical site through a full range of motion, assessing all surfaces for intact sensation, and assessing peripheral pulses (Rothrock, 2019).

Providing Emotional Support to the Patient and Family

Although patients and families are undoubtedly relieved that surgery is over, stress and anxiety levels may remain high in the immediate postoperative period. Many factors contribute to this stress and anxiety, including pain, being in an unfamiliar environment, inability to control one's circumstances or care for oneself, fear of the long-term effects of surgery, fear of complications, fatigue, spiritual distress, altered role responsibilities, ineffective coping, and altered body image, and all are potential reactions to the surgical experience. The nurse helps the patient and family work through their stress and anxieties by providing reassurance and information and by spending time listening to and addressing their concerns. The nurse describes hospital routines and what to expect in the time until discharge and explains the purpose of nursing assessments and interventions. Informing patients when they will be able to drink fluids or eat, when they will be getting out of bed, and when tubes and drains will be removed helps them gain a sense of control and participation in recovery and engages them in the plan of care. Acknowledging family members' concerns and accepting and encouraging their participation in the patient's care assist them in feeling that they are helping their loved one. The nurse can modify the environment to enhance rest and relaxation by providing privacy, reducing noise, adjusting lighting, providing enough seating for family members, and encouraging a supportive atmosphere.

TABLE 16-4 Select Postoperative Complications

Body System/Type	Complications
Respiratory	Atelectasis, pneumonia, pulmonary embolism, aspiration
Cardiovascular	Shock, thrombophlebitis, DVT, pulmonary embolism
Neurologic	Delirium, stroke
Skin/Wound	Breakdown, infection, dehiscence, evisceration, delayed healing, hemorrhage, hematoma
Gastrointestinal	Constipation, paralytic ileus, bowel obstruction
Urinary	Acute urine retention, urinary tract infection
Functional	Weakness, fatigue, functional decline

DVT, deep vein thrombosis.

Managing Potential Complications

The postoperative patient is at risk for complications as outlined next and summarized in Table 16-4.

Venous Thromboembolism. Serious potential VTE complications of surgery include DVT and PE (Rothrock, 2019).

Prevention of DVT and PE development includes pharmacologic prophylaxis (e.g., subcutaneous heparin) (Odom-Forren, 2018). External pneumatic compression and antiembolism stockings can be used alone or in combination with low-dose heparin. The stress response that is initiated by surgery inhibits the thrombolytic (fibrinolytic) system, resulting in blood hypercoagulability. Dehydration, low cardiac output, blood pooling in the extremities, and bed rest add to the risk of thrombosis formation. Although all postoperative patients are at some risk, factors such as a history of thrombosis, malignancy, trauma, obesity, indwelling venous catheters, and hormone use (e.g., estrogen) increase the risk. The first symptom of DVT may be a pain or cramp in the calf, although many patients are asymptomatic. Other signs and symptoms include tachypnea, chest pain, hemoptysis, shortness of breath, and a sense of impending doom (Odom-Forren, 2018).

The benefits of early ambulation and leg exercises in preventing DVT cannot be overemphasized, and these activities are recommended for all patients, regardless of their risk. It is important to avoid the use of blanket rolls, pillow rolls, or any form of elevation that can constrict vessels under the knees. Even prolonged "dangling" (having the patient sit on the edge of the bed with legs hanging over the side) can be dangerous and is not recommended in susceptible patients because pressure under the knees can impede circulation. Adequate hydration is also encouraged; the patient can be offered juices and water throughout the day to avoid dehydration. (Refer to Chapter 26 for discussion of DVT and PE.)

Hematoma. At times, concealed bleeding occurs beneath the skin at the surgical site. This hemorrhage usually stops spontaneously but results in clot (hematoma) formation within the wound. If the clot is small, it will be absorbed and need not be treated. If the clot is large, the wound usually bulges somewhat, and healing will be delayed unless the clot is removed. Evacuation of the clot requires surgery where several sutures are removed by the surgeon, the clot is evacuated, and the wound is packed lightly with gauze. Healing occurs usually by granulation, or a secondary closure may be performed.

Infection (Wound Sepsis). The creation of a surgical wound disrupts the integrity of the skin, bypassing the body's primary defense and protection against infection. Exposure of deep body tissues to pathogens in the environment places the patient at risk for infection of the surgical site, and a potentially life-threatening complication such as infection can increase the length of hospital stay, costs of care, and risk of further complications.

Joint Commission–approved hospitals measure surgical site infections (SSIs) for the first 30 or 90 days following surgical procedures based on national standards. Reduction of SSIs remains an important National Patient Safety Goal (see Chapter 14, Chart 14-7) (Joint Commission, 2019).

Multiple factors, including the type of wound, place the patient at potential risk for infection. Surgical wounds are classified according to the degree of contamination. Table 16-5 defines the classification of surgical wounds and SSI rates per category. Patient-related factors include age, nutritional status, diabetes, smoking, obesity, remote infections, endogenous mucosal microorganisms, altered immune response, length of preoperative stay, and severity of illness (Rothrock, 2019). Factors related to the surgical procedure are proper ventilation in the surgical space, aseptic technique of personnel, sterile instrument use, and overall room cleanliness (Armellino, 2017). The focus of infection prevention has transitioned from controlling infections to preventing their occurrence. Prevention efforts include skin antisepsis, preoperative bathing, hair removal, antimicrobial prophylaxis, and patient temperature management (Padgette & Wood, 2018). (Preoperative and intraoperative risks and interventions are discussed in Chapters 14 and 15.) Postoperative care of the wound centers on assessing the wound, preventing contamination and infection before wound edges have sealed, and enhancing healing.

Signs and symptoms of wound infection include increased pulse rate and temperature; an elevated white blood cell count; wound swelling, warmth, tenderness, or discharge; and increased incisional pain. Local signs may be absent if the infection is deep. *Staphylococcus aureus* accounts for many postoperative wound infections. Other infections may result from *Escherichia coli, Proteus vulgaris, Aerobacter aerogenes, Pseudomonas aeruginosa,* and other organisms. Although they are rare, beta-hemolytic

streptococcal or clostridial infections can be rapid and deadly and need strict infection control practices to prevent the spread of infection to others. Intensive medical and nursing care is essential if the patient is to survive (Ackley & Ladwig, 2017).

When a wound infection is diagnosed in a surgical incision, the surgeon may remove one or more sutures or staples and, using aseptic precautions, separate the wound edges with a pair of blunt scissors or a hemostat. Once the incision is opened, a drain may be inserted. If the infection is deep, an incision and drainage procedure may be necessary. Antimicrobial therapy and a wound care regimen are also initiated.

Wound Dehiscence and Evisceration. Wound **dehiscence** (disruption of surgical incision or wound) and **evisceration** (protrusion of wound contents) are serious surgical complications (see Fig. 16-7). Dehiscence and evisceration are especially serious when they involve abdominal incisions or wounds. These complications result from sutures giving way, from infection, or, more frequently, from marked distention or strenuous cough. They may also occur because of increasing age, anemia, poor nutritional status, obesity, malignancy, diabetes, the use of steroids, and other factors in patients undergoing abdominal surgery.

TABLE 16-5 Wound Classification and Associated Surgical Site Infection Risk

Surgical Category	Determinants of Category	Expected Risk of Postsurgical Infection (%)
Clean	Nontraumatic site Uninfected site No inflammation No break in aseptic technique No entry into respiratory, alimentary, genitourinary, or oropharyngeal tracts	1–3
Clean contaminated	Entry into respiratory, alimentary, genitourinary, or oropharyngeal tracts without unusual contamination Appendectomy Minor break in aseptic technique Mechanical drainage	3–7
Contaminated	Open, newly experienced traumatic wounds Gross spillage from gastrointestinal tract Major break in aseptic technique Entry into genitourinary or biliary tract when urine or bile is infected	7–16
Dirty	Traumatic wound with delayed repair, devitalized tissue, foreign bodies, or fecal contamination Acute inflammation and purulent drainage encountered during procedure	16–29

Adapted from Edmiston, C. E., Jr., & Spencer, M. (2014). Patient care interventions to help reduce the risk of surgical site infections. *AORN Journal*, *100*(6), 590–602.

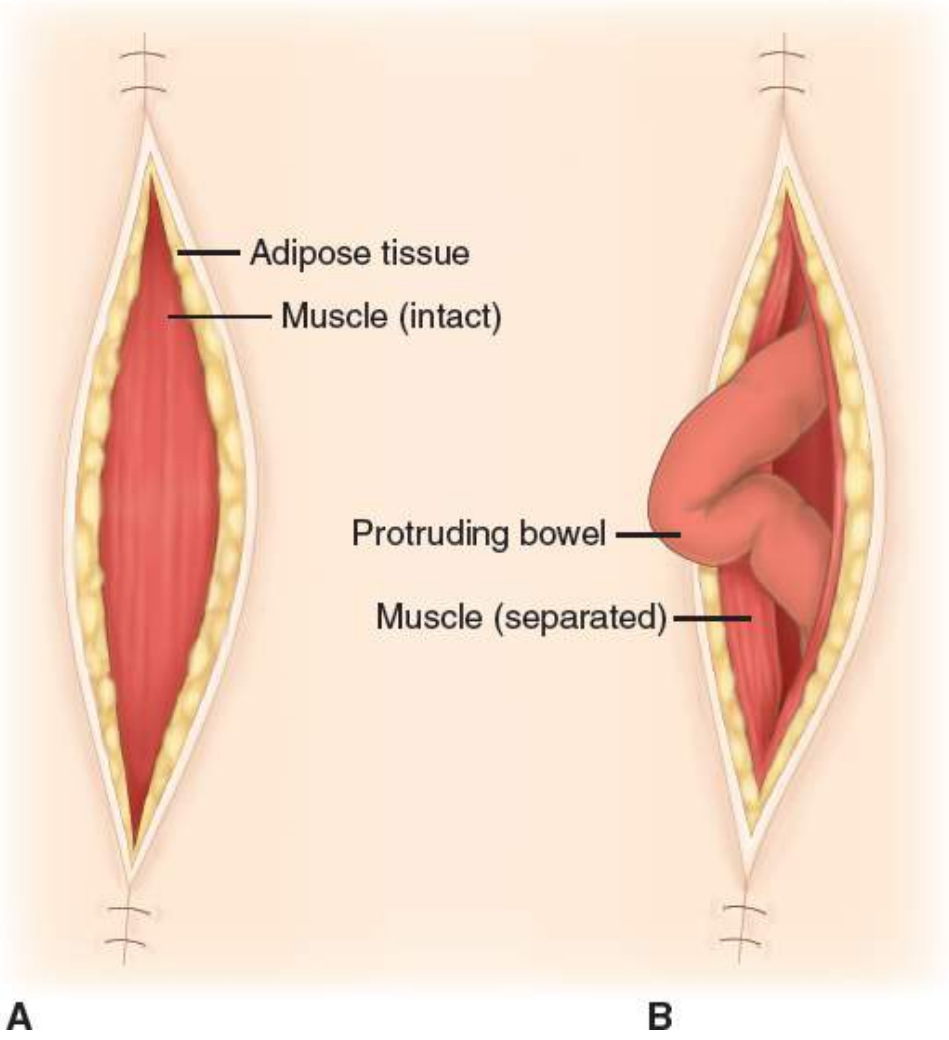


Figure 16-7 • **A.** Wound dehiscence. **B.** Wound evisceration.

When the wound edges separate slowly, the intestines may protrude gradually or not at all, and the earliest sign may be a gush of bloody (serosanguineous) peritoneal fluid from the wound. When a wound ruptures suddenly, coils of intestine may push out of the abdomen. The patient may report that "something gave way." The evisceration causes pain and may be associated with vomiting.

Quality and Safety Nursing Alert

If disruption of a wound occurs, the patient is placed in the low Fowler position and instructed to lie as still as possible. These actions minimize protrusion of body tissues. The protruding coils of intestine are covered with sterile dressings moistened with sterile saline solution, and the surgeon is notified at once.

An abdominal binder can provide support and guard against dehiscence and may be used along with the primary dressing, especially in patients with weak or pendulous abdominal walls or when rupture of a wound has occurred.

Gerontologic Considerations. Older patients recover more slowly, have longer hospital stays, and are at greater risk for development of postoperative complications. Cardiovascular, respiratory, renal, hepatic, thermoregulatory, sensory, and cognition problems unique to the older adult can cause complications throughout the recovery phase (Odom-Forren, 2018). Expert nursing care can help the older adult avoid these complications or minimize their effects (Rothrock, 2019).

Potential causes of postoperative delirium are multifactorial (see Chart 16-7). Skilled and frequent assessment of mental status and of all physiologic factors helps the nurse plan care because delirium may be the initial or only indicator of infection, fluid and electrolyte imbalance, or deterioration of respiratory or hemodynamic status in the older adult patient. Factors that determine whether a patient is at risk for delirium include age, history of alcohol abuse, preoperative cognitive function, physical function, serum chemistries, and type of surgery.

Chart 16-7

Potential Causes of Postoperative Delirium

- Acid–base disturbances
- Acute myocardial infarction
- Age >80 years
- Alcohol withdrawal
- Blood loss
- Cerebral hypoxia
- Decreased cardiac output
- Dehydration
- Emergent surgery
- Fecal impaction
- Fluid and electrolyte imbalance
- Heart failure
- High stress or anxiety levels
- History of dementia like symptoms
- Hypercarbia
- Hypothermia or hyperthermia
- Hypoxia
- Infection (urinary tract, wound, respiratory)
- Medications (anticholinergics, benzodiazepines, central nervous system depressants)
- Polypharmacy
- Presence of multiple diseases
- Sensory impairments
- Unfamiliar surroundings and sensory deprivation
- Unrelieved pain
- Urinary retention

Recognizing postoperative delirium and identifying and treating its underlying cause are the goals of care. Postoperative delirium is sometimes mistaken for preexisting dementia or is attributed to age. In addition to monitoring and managing identifiable causes, the nurse implements supportive interventions. Keeping the patient in a well-lit room and in close proximity to staff can reduce sensory deprivation. At the same time, distracting and unfamiliar noises should be minimized. Because pain can contribute to postoperative delirium, adequate pain control without oversedation is essential (Rothrock, 2019).

The patient is reoriented as often as necessary, and staff should introduce themselves each time they come in contact with the patient. Engaging the patient in conversation and care activities and placing a clock and calendar nearby may improve cognitive function. Physical activity should not be

neglected while the patient is confused because physical deterioration can worsen delirium and place the patient at increased risk for other complications. Restraints should be avoided because they can worsen confusion. A staff member is asked to stay with the patient instead. Medications may be given during episodes of acute confusion but should be discontinued as soon as possible to avoid side effects.

Other problems confronting the older postoperative patient, such as pneumonia, altered bowel function, DVT, weakness, and functional decline, often can be prevented by early and progressive ambulation. Prolonged sitting positions are avoided as they promote venous stasis in the lower extremities. A physical therapy referral may be indicated to promote safe, regular exercise for the older adult.

Urinary incontinence can be prevented by providing easy access to the call bell and the commode and by prompting voiding. Early ambulation and familiarity with the room help the patient become self-sufficient sooner.

Optimal nutrition can help promote wound healing and anesthesia recovery. The nurse and patient can consult with the dietitian to plan appealing, high-protein meals that provide sufficient fiber, calories, and vitamins. Nutritional supplements, such as Ensure™ or Sustacal™, may be recommended. Multivitamins, iron, and vitamin C supplements may be prescribed to aid in tissue healing, formation of new red blood cells, and overall nutritional status.

In addition to monitoring and managing physiologic recovery of the older adult, the nurse identifies and addresses psychosocial needs. The older adult may require much encouragement and support to resume activities, and the pace may be slow. Sensory deficits may require frequent repetition of instructions, and decreased physiologic reserve may necessitate frequent rest periods. The older adult may require extensive discharge planning to coordinate both professional and family care providers, and the nurse, social worker, or case management resource may institute the plan for continuing and transitional care.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care. Patient education is critical during postoperative care and includes what can be expected at every stage of the surgical process, including after discharge. It is important for nurses to assess patients preoperatively, especially outpatients, to determine their ability to manage at home and begin educating them about managing any postoperative wound care, drains, or other daily care needs (Lahr & Elliot, 2018). Although needs are specific to individual patients and the procedures they have undergone, general patient education needs prior to discharge have been identified (see Chart 16-3).

Continuing and Transitional Care. Community-based and transitional care services are frequently necessary after surgery. Older patients, patients who live alone, patients without family support, and patients with preexisting chronic illness or disabilities are often in greatest need. Planning for discharge involves arranging for necessary services early in the acute care hospitalization for wound care, drain management, catheter care, infusion therapy, and physical or occupational therapy. The home, community-based, or transitional care nurse coordinates these activities and services.

During home visits, the nurse assesses the patient for postoperative complications by assessment of the surgical incision, respiratory and cardiovascular status, adequacy of pain management, fluid and nutritional status, and the patient's progress in returning to preoperative status. The nurse evaluates the patient's ability to administer prescribed medications, manage dressing changes, drainage systems and other devices. The nurse may change dressings or catheters if needed. The nurse identifies any additional services that are needed and assists the patient and family to arrange for them. Previous education is reinforced, and the patient is reminded to keep follow-up appointments. The patient and family are educated about signs and symptoms to be reported to the surgeon. In addition, the nurse provides information about how to obtain needed supplies and suggests resources or support groups.

Evaluation

Expected patient outcomes may include the following:

1. Maintains optimal respiratory function
    a. Performs deep-breathing exercises
    b. Displays clear breath sounds
    c. Uses incentive spirometer as prescribed
    d. Splints incisional site when coughing to reduce pain
2. Indicates that pain is decreased in intensity
3. Increases activity as prescribed
    a. Alternates periods of rest and activity
    b. Progressively increases ambulation
    c. Resumes normal activities within the prescribed time frame
    d. Performs activities related to self-care
4. Wound heals without complication
5. Maintains body temperature within normal limits
6. Resumes oral intake
    a. Reports absence of nausea and vomiting
    b. Eats at least 75% of usual diet

c. Is free of abdominal distress and gas pains
d. Exhibits normal bowel sounds

7. Reports resumption of usual bowel elimination pattern
8. Resumes usual voiding pattern
9. Is free of injury
10. Exhibits decreased anxiety
11. Acquires knowledge and skills necessary to manage regimen after discharge
12. Experiences no complications

CRITICAL THINKING EXERCISES

1 ipc A 38-year-old woman is admitted to the PACU following open abdominal surgery for excision of a benign tumor and lysis of adhesions. The patient has been a smoker for many years and begins coughing as soon as she is transferred from the OR stretcher to the bed in PACU. How will you, as the nurse receiving this patient, facilitate an interprofessional discussion to improve her care and increase her chance of a good surgical outcome? What information is essential to obtain from the OR team during handoff report?

2 pq A 60-year-old man with obesity and a history of diabetes is admitted to the PACU following a right shoulder repair. He received multimodal analgesia, including a peripheral nerve block, and is scheduled to be discharged home. Identify the essential information you would need reported from the OR team. What are your immediate priorities in delivering care to this patient? He is transferred to Phase II PACU. What are your priorities for discharge instructions and education for this patient?

3 ebp An 80-year-old man has had a right total knee replacement. The anesthesia given was a spinal anesthetic. What signs and symptoms might he exhibit as he awakens from the surgery? As the PACU nurse, what complications should you observe for as he recovers? Describe an evidence-based nursing care plan for the patient during his hospital stay.

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

American Academy of Ambulatory Care Nursing (AAACN), www.aaacn.org
American Society of Anesthesiologists (ASA), www.asahq.org
American Society of PeriAnesthesia Nurses (ASPAN), www.aspan.org
Association of PeriOperative Registered Nurses (AORN), www.aorn.org
Malignant Hyperthermia Association of the United States (MHAUS), www.mhaus.org

UNIT 4 Gas Exchange and Respiratory Function

Case Study

PROVIDING EVIDENCE-BASED CARE FOR A PATIENT WITH COVID-19

The medical unit where you work has just been designated to exclusively admit patients with coronavirus 2019 (COVID-19). A 35-year-old male admitted to the unit has a history of asthma and

hypertension that are both normally well controlled with medication. His temperature is 39°C (101.4°F), he has a cough and tests positive for COVID-19. The nurse manager asks you to develop an evidence-based plan of care that can be individualized for this patient and used as a template for other patients admitted to your unit with COVID-19.

QSEN Competency Focus: Evidence-Based Practice (EBP)

The complexities inherent in today's health care system challenge nurses to demonstrate integration of specific interdisciplinary core competencies. These competencies are aimed at ensuring the delivery of safe, quality patient care (Institute of Medicine, 2003). The Quality and Safety Education for Nurses project (Cronenwett, Sherwood, Barnsteiner, et al., 2007; QSEN, 2020) provides a framework for the knowledge, skills, and attitudes (KSAs) required for nurses to demonstrate competency in these key areas, which include ***patient-centered care***, ***interdisciplinary teamwork and collaboration***, ***evidence-based practice***, ***quality improvement***, ***safety***, and ***informatics.***

Evidence-Based Practice Definition: Integrate best current evidence with clinical expertise and patient/family preferences and values for delivery of optimal health care.

SELECT PRE-LICENSURE KSAs	APPLICATION AND REFLECTION
Knowledge	
Differentiate clinical opinion from research and evidence summaries	Identify the pathophysiologic basis for why patients with asthma and hypertension are at higher risk for COVID-19. What is the strength of the evidence for an evidence-based plan of care for this patient?
Skills	
Locate evidence reports related to clinical practice topics and guidelines	What strategies would you use to search for and then identify appropriate evidence for developing an evidence-based plan of care for this patient? What resources might you mobilize for this patient so he can become educated on the best practices to prevent the spread of COVID-19 while he is in the hospital and upon discharge?
Attitudes	
Value the concept of EBP as integral to determining best clinical practice	Reflect on your attitudes toward using EBP for patients with COVID-19. Do you tend to think that infection is inevitable in patients with risk factors?

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17 Assessment of Respiratory Function

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the structures and functions of the upper and lower respiratory tracts and concepts of ventilation, diffusion, perfusion, and ventilation–perfusion imbalances.
2. Explain and demonstrate proper techniques utilized to perform a comprehensive respiratory assessment.
3. Discriminate between normal and abnormal assessment findings of the respiratory system identified by inspection, palpation, percussion, and auscultation.
4. Recognize and evaluate the major symptoms of respiratory dysfunction by applying concepts from the patient's health history and physical assessment findings.
5. Identify the diagnostic tests used to evaluate respiratory function and related nursing implications.

NURSING CONCEPTS

Assessment
Oxygenation
Perfusion

GLOSSARY

apnea: temporary cessation of breathing

bronchophony: abnormal increase in clarity of transmitted voice sounds heard when auscultating the lungs

bronchoscopy: direct examination of the larynx, trachea, and bronchi using an endoscope

cilia: short, fine hairs that provide a constant whipping motion that serves to propel mucus and foreign substances away from the lung toward the larynx

compliance: measure of the force required to expand or inflate the lungs

crackles: nonmusical, discontinuous popping sounds during inspiration caused by delayed reopening of the airways heard on chest auscultation

dyspnea: subjective experience that describes an uncomfortable or painful breathing sensation when either at rest or while walking or climbing stairs; also commonly referred to as shortness of breath

egophony: abnormal change in tone of voice that is heard when auscultating the lungs

fremitus: vibrations of speech felt as tremors of the chest wall during palpation

hemoptysis: expectoration of blood from the respiratory tract

hypoxemia: decrease in arterial oxygen tension in the blood

hypoxia: decrease in oxygen supply to the tissues and cells

obstructive sleep apnea: temporary absence of breathing during sleep secondary to transient upper airway obstruction

orthopnea: shortness of breath when lying flat; relieved by sitting or standing

oxygen saturation: percentage of hemoglobin that is bound to oxygen

physiologic dead space: portion of the tracheobronchial tree that does not participate in gas exchange

pulmonary diffusion: exchange of gas molecules (oxygen and carbon dioxide) from areas of high concentration to areas of low concentration

pulmonary perfusion: blood flow through the pulmonary vasculature

respiration: gas exchange between atmospheric air and the blood and between the blood and cells of the body

rhonchi: deep, low-pitched snoring sound associated with partial airway obstruction, heard on chest auscultation

stridor: continuous, high-pitched, musical sound heard on inspiration, best heard over the neck; may be heard without use of a stethoscope, secondary to upper airway obstruction

tachypnea: abnormally rapid respirations

tidal volume: volume of air inspired and expired with each breath during normal breathing

ventilation: movement of air in and out of the airways

wheezes: continuous musical sounds associated with airway narrowing or partial obstruction

whispered pectoriloquy: whispered sounds heard loudly and clearly upon thoracic auscultation

Disorders of the respiratory system are common and are encountered by nurses in every setting, from the community to the intensive care unit. Expert assessment skills must be developed and used to provide the best care for patients with acute and chronic respiratory problems. Alterations in respiratory status have been identified as important predictors of clinical deterioration in hospitalized patients (Institute for Healthcare Improvement [IHI], 2019). To differentiate between normal and abnormal assessment findings and recognize subtle changes that may negatively impact patient outcomes, nurses require an understanding of respiratory function and the significance of abnormal diagnostic test results.

Anatomic and Physiologic Overview

The respiratory system is composed of the upper and lower respiratory tracts. Together, the two tracts are responsible for **ventilation** (movement of air in and out of the airways). The upper respiratory tract, known as the upper airway, warms and filters inspired air so that the lower respiratory tract (the lungs) can accomplish gas exchange or diffusion. Gas exchange involves delivering oxygen to the tissues through the bloodstream and expelling waste gases, such as carbon dioxide, during expiration. The respiratory system depends on the cardiovascular system for perfusion, or blood flow through the pulmonary system (Norris, 2019).

Anatomy of the Respiratory System

Upper Respiratory Tract

Upper airway structures consist of the nose; paranasal sinuses; pharynx, tonsils, and adenoids; larynx; and trachea.

Nose

The nose serves as a passageway for air to pass to and from the lungs. It filters impurities and humidifies and warms the air as it is inhaled. The nose is

composed of an external and an internal portion. The external portion protrudes from the face and is supported by the nasal bones and cartilage. The anterior nares (nostrils) are the external openings of the nasal cavities.

The internal portion of the nose is a hollow cavity separated into the right and left nasal cavities by a narrow vertical divider, the septum. Each nasal cavity is divided into three passageways by the projection of the turbinates from the lateral walls. The turbinate bones are also called *conchae* (the name suggested by their shell-like appearance). Because of their curves, these bones increase the mucous membrane surface of the nasal passages and slightly obstruct the air flowing through them (Fig. 17-1).

Air entering the nostrils is deflected upward to the roof of the nose, and it follows a circuitous route before it reaches the nasopharynx. It comes into contact with a large surface of moist, warm, highly vascular, ciliated mucous membrane (called *nasal mucosa*) that traps practically all of the dust and organisms in the inhaled air. The air is moistened, warmed to body temperature, and brought into contact with sensitive nerves. Some of these nerves detect odors; others provoke sneezing to expel irritating dust. Mucus, secreted continuously by goblet cells, covers the surface of the nasal mucosa and is moved back to the nasopharynx by the action of the **cilia** (short, fine hairs).

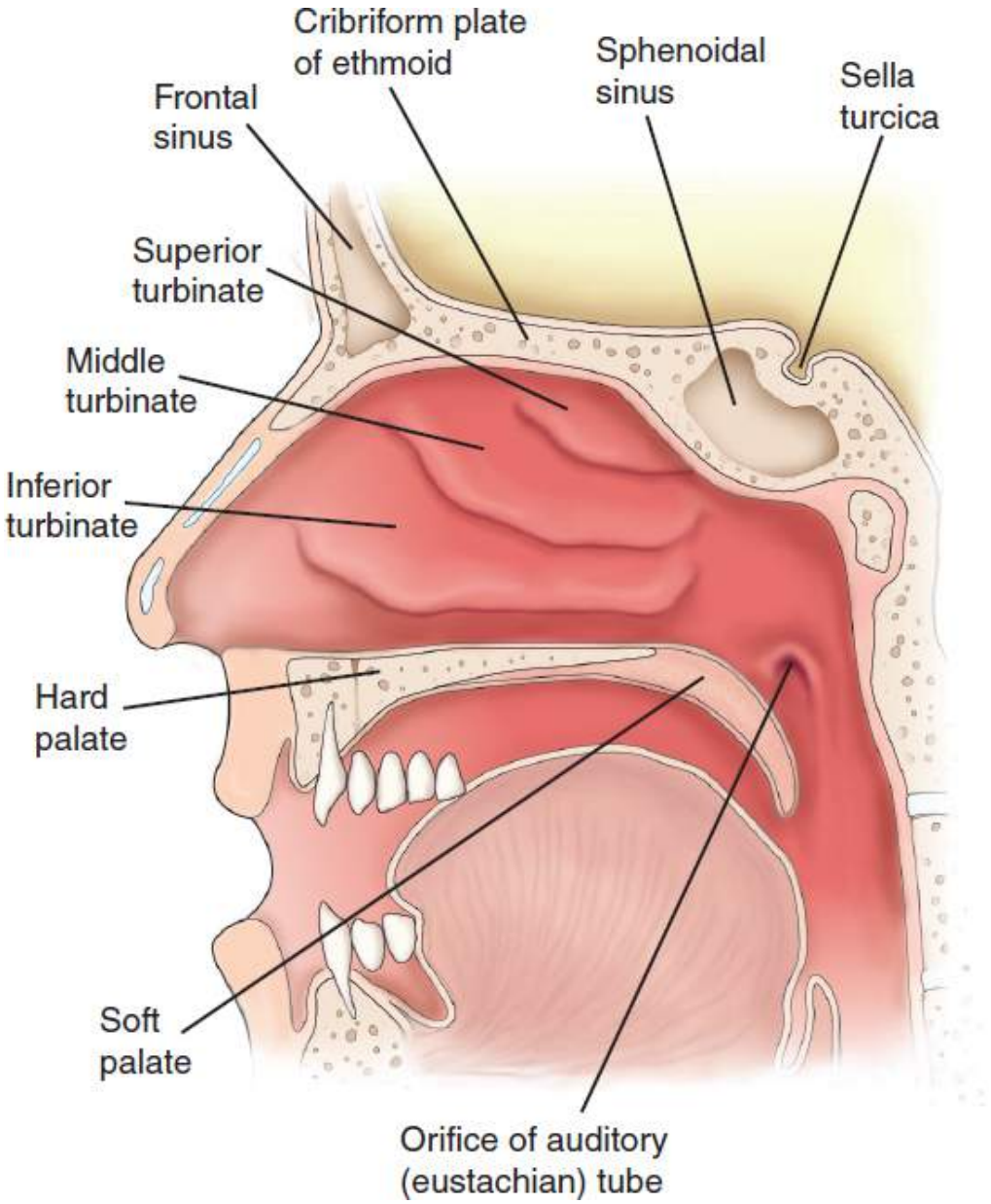


Figure 17-1 • Cross-section of nasal cavity.

Paranasal Sinuses

The paranasal sinuses include four pairs of bony cavities that are lined with nasal mucosa and ciliated pseudostratified columnar epithelium. These airspaces are connected by a series of ducts that drain into the nasal cavity. The sinuses are named by their location: frontal, ethmoid, sphenoid, and maxillary (Fig. 17-2). A prominent function of the sinuses is to serve as a resonating chamber in speech. The sinuses are a common site of infection.

Pharynx, Tonsils, and Adenoids

The pharynx, or throat, is a tubelike structure that connects the nasal and oral cavities to the larynx. It is divided into three regions: nasal, oral, and laryngeal.

The nasopharynx is located posterior to the nose and above the soft palate. The oropharynx houses the faucial, or palatine, tonsils. The laryngopharynx extends from the hyoid bone to the cricoid cartilage. The epiglottis forms the entrance to the larynx.

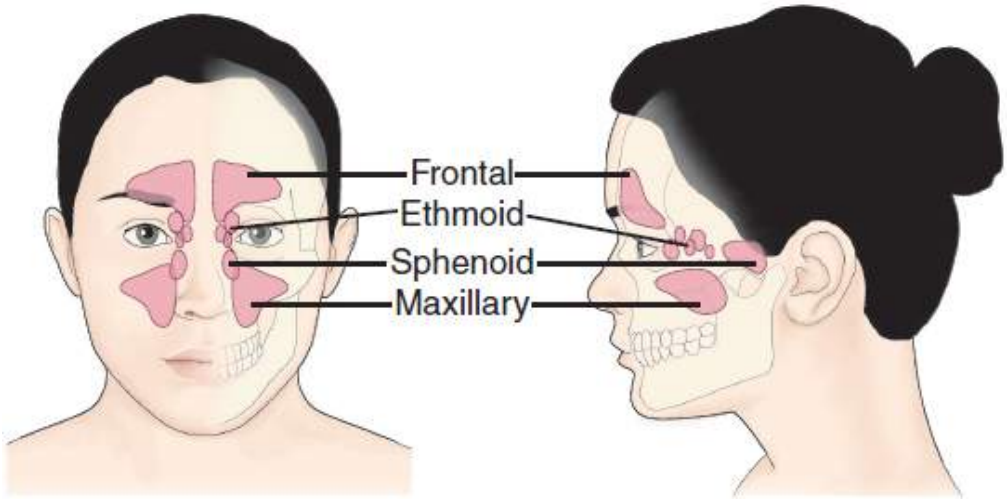


Figure 17-2 • The paranasal sinuses.

The adenoids, or pharyngeal tonsils, are located in the roof of the nasopharynx. The tonsils, the adenoids, and other lymphoid tissue encircle the throat. These structures are important links in the chain of lymph nodes guarding the body from invasion by organisms entering the nose and the throat. The pharynx functions as a passageway for the respiratory and digestive tracts.

Larynx

The larynx, or voice box, is a cartilaginous epithelium-lined organ that connects the pharynx and the trachea and consists of the following:

- *Epiglottis:* a valve flap of cartilage that covers the opening to the larynx during swallowing
- *Glottis:* the opening between the vocal cords in the larynx
- *Thyroid cartilage:* the largest of the cartilage structures; part of it forms the Adam's apple
- *Cricoid cartilage:* the only complete cartilaginous ring in the larynx (located below the thyroid cartilage)
- *Arytenoid cartilages:* used in vocal cord movement with the thyroid cartilage
- *Vocal cords:* ligaments controlled by muscular movements that produce sounds; located in the lumen of the larynx

Although the major function of the larynx is vocalization, it also protects the lower airway from foreign substances and facilitates coughing; it is, therefore, sometimes referred to as the "watchdog of the lungs" (Norris, 2019).

Trachea

The trachea, or windpipe, is composed of smooth muscle with C-shaped rings of cartilage at regular intervals. The cartilaginous rings are incomplete on the posterior surface and give firmness to the wall of the trachea, preventing it from collapsing. The trachea serves as the passage between the larynx and the right and left main stem bronchi, which enter the lungs through an opening called the *hilus*.

Lower Respiratory Tract

The lower respiratory tract consists of the lungs, which contain the bronchial and alveolar structures needed for gas exchange.

Lungs

The lungs are paired elastic structures enclosed in the thoracic cage, which is an airtight chamber with distensible walls (Fig. 17-3). Each lung is divided into lobes. The right lung has upper, middle, and lower lobes, whereas the left lung consists of upper and lower lobes (Fig. 17-4). Each lobe is further subdivided into two to five segments separated by fissures, which are extensions of the pleura.

Pleura

The lungs and wall of the thoracic cavity are lined with a serous membrane called the *pleura.* The visceral pleura covers the lungs; the parietal pleura lines the thoracic cavity, lateral wall of the mediastinum, diaphragm, and inner aspects of the ribs. The visceral and parietal pleura and the small amount of pleural fluid between these two membranes serve to lubricate the thorax and the lungs and permit smooth motion of the lungs within the thoracic cavity during inspiration and expiration.

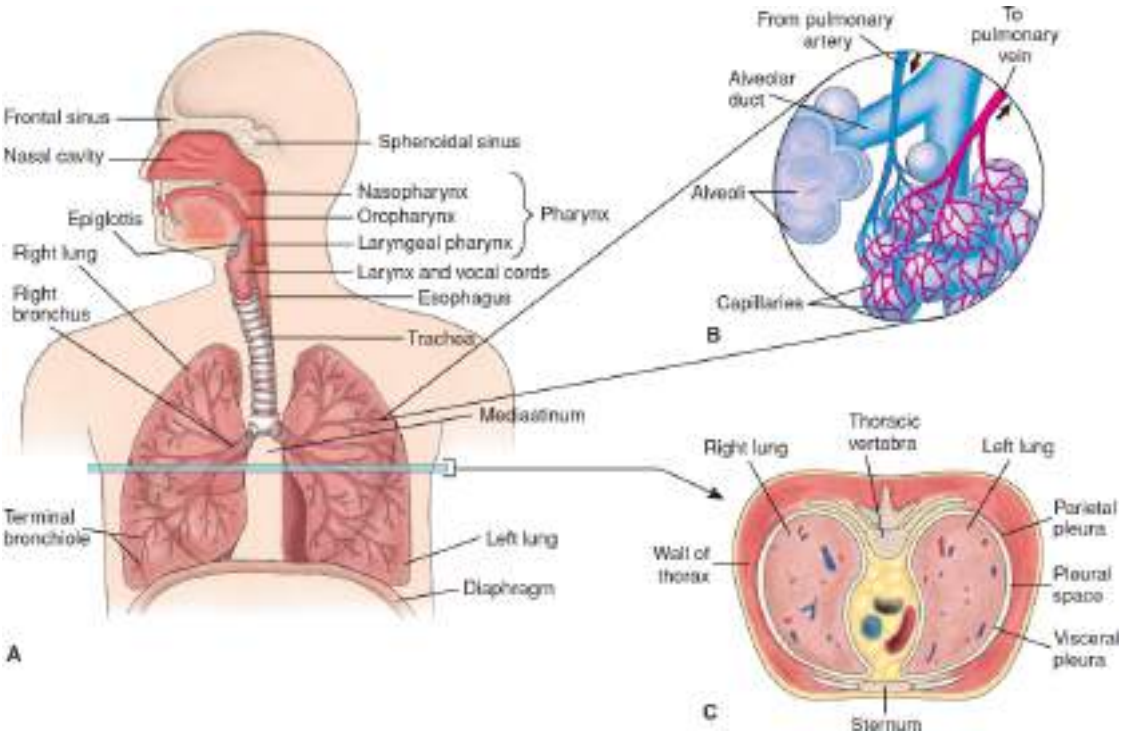


Figure 17-3 • The respiratory system. **A.** Upper respiratory structures and the structures of the thorax. **B.** Alveoli. **C.** A horizontal cross-section of the lungs.

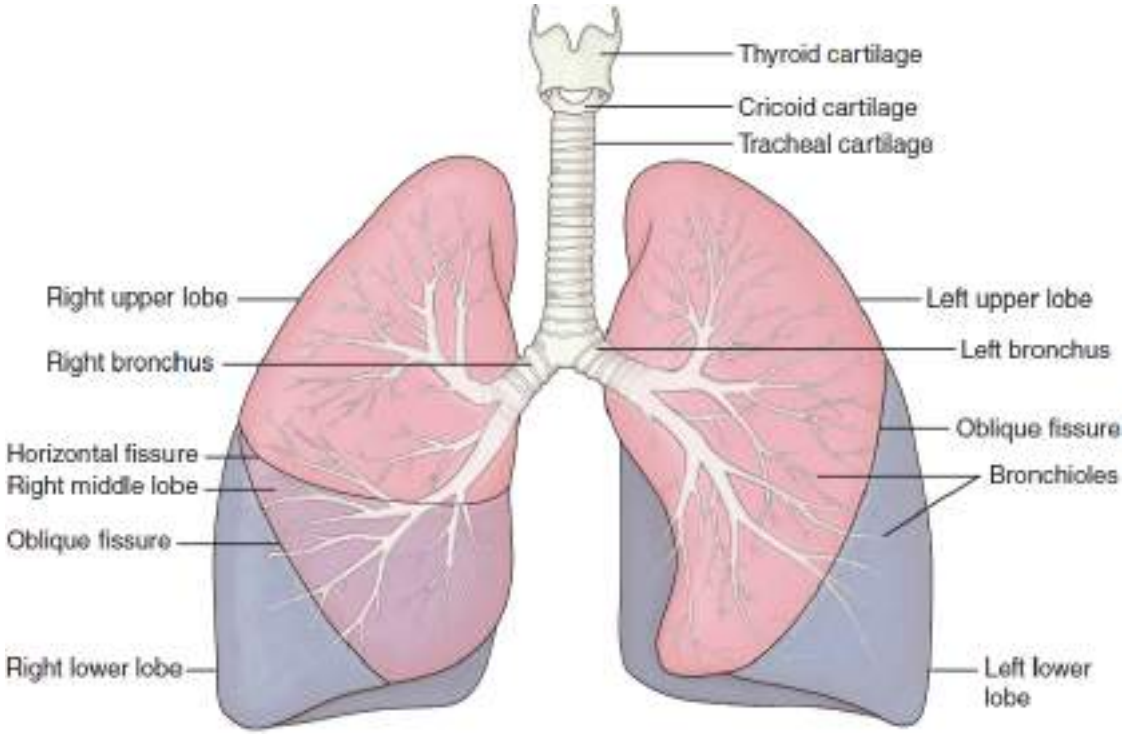


Figure 17-4 • Anterior view of the lungs. The lungs consist of five lobes. The right lung has three lobes (upper, middle, lower); the left has two (upper and lower). The lobes are further subdivided by fissures. The bronchial tree, another lung structure, inflates with air to fill the lobes.

Mediastinum

The mediastinum is in the middle of the thorax, between the pleural sacs that contain the two lungs. It extends from the sternum to the vertebral column and contains all of the thoracic tissue outside the lungs (heart, thymus, the aorta and vena cava, and esophagus).

Bronchi and Bronchioles

There are several divisions of the bronchi within each lobe of the lung. First are the lobar bronchi (three in the right lung and two in the left lung). Lobar bronchi divide into segmental bronchi (10 on the right and 8 on the left); these structures facilitate effective postural drainage in the patient. Segmental bronchi then divide into subsegmental bronchi. These bronchi are surrounded by connective tissue that contains arteries, lymphatics, and nerves.

The subsegmental bronchi then branch into bronchioles, which have no cartilage in their walls. Their patency depends entirely on the elastic recoil of the surrounding smooth muscle and on the alveolar pressure. The bronchioles contain submucosal glands, which produce mucus that covers the inside lining of the airways. The bronchi and bronchioles are also lined with cells that have surfaces covered with cilia. These cilia create a constant whipping motion that propels mucus and foreign substances away from the lungs toward the larynx.

The bronchioles branch into terminal bronchioles, which do not have mucous glands or cilia. Terminal bronchioles become respiratory bronchioles, which are considered to be the transitional passageways between the conducting airways and the gas exchange airways. Up to this point, the conducting airways contain about 150 mL of air in the tracheobronchial tree that does not participate in gas exchange, known as **physiologic dead space.** The respiratory bronchioles then lead into alveolar ducts and sacs and then alveoli (see Fig. 17-3). Oxygen and carbon dioxide exchange takes place in the alveoli.

Alveoli

The lung is made up of about 300 million alveoli, constituting a total surface area between 50 and 100 m^2 (Norris, 2019). There are three types of alveolar cells. Type I and type II cells make up the alveolar epithelium. Type I cells account for 95% of the alveolar surface area and serve as a barrier between the air and the alveolar surface; type II cells account for only 5% of this area but are responsible for producing type I cells and surfactant. Surfactant reduces surface tension, thereby improving overall lung function. Alveolar macrophages, the third type of alveolar cells, are phagocytic cells that ingest foreign matter and, as a result, provide an important defense mechanism.

Function of the Respiratory System

The cells of the body derive the energy they need from the oxidation of carbohydrates, fats, and proteins. This process requires oxygen. Vital tissues, like the brain and the heart, cannot survive long without a continuous supply of oxygen. As a result of oxidation, carbon dioxide is produced and must be removed from the cells to prevent the buildup of acid waste products. The respiratory system performs this function by facilitating life-sustaining processes such as oxygen transport, respiration, ventilation, and gas exchange.

Oxygen Transport

Oxygen is supplied to, and carbon dioxide is removed from, cells by way of the circulating blood through the thin walls of the capillaries. Oxygen diffuses from the capillary through the capillary wall to the interstitial fluid. At this point, it diffuses through the membrane of tissue cells, where it is used by mitochondria for cellular respiration. The movement of carbon dioxide occurs by diffusion in the opposite direction—from cell to blood.

Respiration

After these tissue capillary exchanges, blood enters the systemic venous circulation and travels to the pulmonary circulation. The oxygen concentration

in blood within the capillaries of the lungs is lower than that in the lungs' alveoli. Because of this concentration gradient, oxygen diffuses from the alveoli to the blood. Carbon dioxide, which has a higher concentration in the blood than in the alveoli, diffuses from the blood into the alveoli. Movement of air in and out of the airways continually replenishes the oxygen and removes the carbon dioxide from the airways and the lungs. This whole process of gas exchange between the atmospheric air and the blood and between the blood and cells of the body is called **respiration.**

Ventilation

Ventilation requires movement of the walls of the thoracic cage and of its floor, the diaphragm. The effect of these movements is alternately to increase and decrease the capacity of the chest. When the capacity of the chest is increased, air enters through the trachea (inspiration) and moves into the bronchi, bronchioles, and alveoli, and inflates the lungs. When the chest wall and the diaphragm return to their previous positions (expiration), the lungs recoil and force the air out through the bronchi and the trachea. Inspiration occurs during the first third of the respiratory cycle; expiration occurs during the latter two thirds. The inspiratory phase of respiration normally requires energy; the expiratory phase is normally passive, requiring very little energy. Physical factors that govern airflow in and out of the lungs are collectively referred to as the mechanics of ventilation and include air pressure variances, resistance to airflow, and lung compliance.

Air Pressure Variances

Air flows from a region of higher pressure to a region of lower pressure. During inspiration, movements of the diaphragm and intercostal muscles enlarge the thoracic cavity and thereby lower the pressure inside the thorax to a level below that of atmospheric pressure. As a result, air is drawn through the trachea and the bronchi into the alveoli. During expiration, the diaphragm relaxes and the lungs recoil, resulting in a decrease in the size of the thoracic cavity. The alveolar pressure then exceeds atmospheric pressure, and air flows from the lungs into the atmosphere.

Airway Resistance

Resistance is determined by the radius, or size of the airway through which the air is flowing, as well as by lung volumes and airflow velocity. Any process that changes the bronchial diameter or width affects airway resistance and alters the rate of airflow for a given pressure gradient during respiration (Chart 17-1). With increased resistance, greater-than-normal respiratory effort is required to achieve normal levels of ventilation.

Compliance

Compliance is the elasticity and expandability of the lungs and thoracic structures. Compliance allows the lung volume to increase when the difference in pressure between the atmosphere and the thoracic cavity (pressure gradient) causes air to flow in. Factors that determine lung compliance are the surface tension of the alveoli, the connective tissue and water content of the lungs, and the compliance of the thoracic cavity.

Chart 17-1

Causes of Increased Airway Resistance

Common phenomena that may alter bronchial diameter, which affects airway resistance, include the following:

- Contraction of bronchial smooth muscle—as in asthma
- Thickening of bronchial mucosa—as in chronic bronchitis
- Obstruction of the airway—by mucus, a tumor, or a foreign body
- Loss of lung elasticity—as in emphysema, which is characterized by connective tissue encircling the airways, thereby keeping them open during both inspiration and expiration

Compliance is determined by examining the volume–pressure relationship in the lungs and the thorax. Compliance is normal (1 L/cm H_2O) if the lungs and the thorax easily stretch and distend when pressure is applied. Increased compliance occurs if the lungs have lost their elastic recoil and become overdistended (e.g., in emphysema). Decreased compliance occurs if the lungs and the thorax are "stiff." Conditions associated with decreased compliance include severe obesity, pneumothorax, hemothorax, pleural effusion, pulmonary edema, atelectasis, pulmonary fibrosis, and acute respiratory distress syndrome (ARDS). Lungs with decreased compliance require greater-than-normal energy expenditure by the patient to achieve normal levels of ventilation.

Lung Volumes and Capacities

Lung function, which reflects the mechanics of ventilation, is viewed in terms of lung volumes and lung capacities. Lung volumes are categorized as tidal volume, inspiratory reserve volume, expiratory reserve volume, and residual volume. Lung capacity is evaluated in terms of vital capacity, inspiratory capacity, functional residual capacity, and total lung capacity. These terms are explained in Table 17-1.

Pulmonary Diffusion and Perfusion

Pulmonary diffusion is the process by which oxygen and carbon dioxide are exchanged from areas of high concentration to areas of low concentration at the air–blood interface. The alveolar–capillary membrane is ideal for diffusion because of its thinness and large surface area. In the normal healthy adult, oxygen and carbon dioxide travel across the alveolar–capillary membrane without difficulty as a result of differences in gas concentrations in the alveoli and capillaries.

Pulmonary perfusion is the actual blood flow through the pulmonary vasculature. The blood is pumped into the lungs by the right ventricle through the pulmonary artery. The pulmonary artery divides into the right and left branches to supply both lungs. Normally, about 2% of the blood pumped by the right ventricle does not perfuse the alveolar capillaries. This shunted blood drains into the left side of the heart without participating in alveolar gas exchange. Bronchial arteries extending from the thoracic aorta also support perfusion but do not participate in gas exchange, further diluting oxygenated blood exiting through the pulmonary vein (Norris, 2019).

TABLE 17-1 Lung Volumes and Lung Capacities

Term	Symbol	Description	Normal Value*	Significance
Lung Volumes				
Tidal volume	VT or TV	The volume of air inhaled and exhaled with each breath	500 mL or 5–10 mL/kg	The tidal volume may not vary, even with severe disease.
Inspiratory reserve volume	IRV	The maximum volume of air that can be inhaled after a normal inhalation	3000 mL	
Expiratory reserve volume	ERV	The maximum volume of air that can be exhaled forcibly after a normal exhalation	1100 mL	Expiratory reserve volume is decreased with restrictive conditions, such as obesity, ascites, pregnancy.
Residual volume	RV	The volume of air remaining in the lungs after a maximum exhalation	1200 mL	Residual volume may be increased with obstructive disease.
Lung Capacities				
Vital capacity	VC	The maximum volume of air exhaled from the point of maximum inspiration: VC = TV + IRV + ERV	4600 mL	A decrease in vital capacity may be found in neuromuscular disease, generalized fatigue, atelectasis, pulmonary edema, COPD, and obesity.
Inspiratory capacity	IC	The maximum volume of air inhaled after normal expiration: IC = TV + IRV	3500 mL	A decrease in inspiratory capacity may indicate restrictive disease. It may also be decreased in obesity.
Functional residual capacity	FRC	The volume of air remaining in the lungs after a normal expiration: FRC = ERV + RV	2300 mL	Functional residual capacity may be increased with COPD and decreased in ARDS and obesity.
Total lung capacity	TLC	The volume of air in the lungs after a maximum inspiration: TLC = TV + IRV + ERV + RV	5800 mL	Total lung capacity may be decreased with restrictive disease such as atelectasis and pneumonia and increased in COPD.

*Values for healthy men; women are 20–25% less.
ARDS, acute respiratory distress syndrome; COPD, chronic obstructive pulmonary disease.
Adapted from West, J. B., & Luks, A. M. (2016). West's respiratory physiology: The essentials (10th ed.). Philadelphia, PA: Wolters Kluwer Health Lippincott Williams & Wilkins.

The pulmonary circulation is considered a low-pressure system because the systolic blood pressure in the pulmonary artery is 20 to 30 mm Hg and the diastolic pressure is 5 to 15 mm Hg. Because of these low pressures, the pulmonary vasculature normally can vary its capacity to accommodate the blood flow it receives. However, when a person is in an upright position, the pulmonary artery pressure is not great enough to supply blood to the apex of the lung against the force of gravity. Thus, when a person is upright, the lung may be considered to be divided into three sections: an upper part with poor blood supply, a lower part with maximal blood supply, and a section between

the two with an intermediate supply of blood. When a person who is lying down turns to one side, more blood passes to the dependent lung.

Perfusion is also influenced by alveolar pressure. The pulmonary capillaries are sandwiched between adjacent alveoli. If the alveolar pressure is sufficiently high, the capillaries are squeezed. Depending on the pressure, some capillaries completely collapse, whereas others narrow.

Pulmonary artery pressure, gravity, and alveolar pressure determine the patterns of perfusion. In lung disease, these factors vary, and the perfusion of the lung may become abnormal.

Ventilation and Perfusion Balance and Imbalance

Adequate gas exchange depends on an adequate ventilation–perfusion (V./Q.) ratio. In different areas of the lung, the V./Q. ratio varies. Airway blockages, local changes in compliance, and gravity may alter ventilation. Alterations in perfusion may occur with a change in the pulmonary artery pressure, alveolar pressure, or gravity.

V./Q. imbalance occurs as a result of inadequate ventilation, inadequate perfusion, or both. There are four possible V./Q. states in the lung:normal V./Q. ratio, low V./Q. ratio (shunt), high V./Q. ratio (dead space), and absence of ventilation and perfusion (silent unit) (Chart 17-2). V./Q. imbalance causes shunting of blood, resulting in **hypoxia** (low level of cellular oxygen). Shunting appears to be the main cause of hypoxia after thoracic or abdominal surgery and most types of respiratory failure. Severe hypoxia results when the amount of shunting exceeds 20%. Supplemental oxygen may eliminate hypoxia, depending on the type of V./Q. imbalance.

Gas Exchange

Partial Pressure of Gases

The air we breathe is a gaseous mixture consisting mainly of nitrogen (78%), oxygen (21%), argon (1%), and trace amounts of other gases including carbon dioxide, methane, and helium, among other gases. The atmospheric pressure at sea level is about 760 mm Hg. Partial pressure is the pressure exerted by each type of gas in a mixture of gases. The partial pressure of a gas is proportional to the concentration of that gas in the mixture. The total pressure exerted by the gaseous mixture, whether in the atmosphere or in the lungs, is equal to the sum of the partial pressures. The partial pressure of nitrogen is approximately 596 mm Hg, oxygen is 152 mm Hg, and argon is 7.6 mm Hg. Chart 17-3 identifies and defines terms and abbreviations related to partial pressure of gases. However, the partial pressure of gases will be affected when the air is inhaled and humidified by the pulmonary tract. It is possible to calculate the partial pressure of gases, specifically oxygen, within the alveoli.

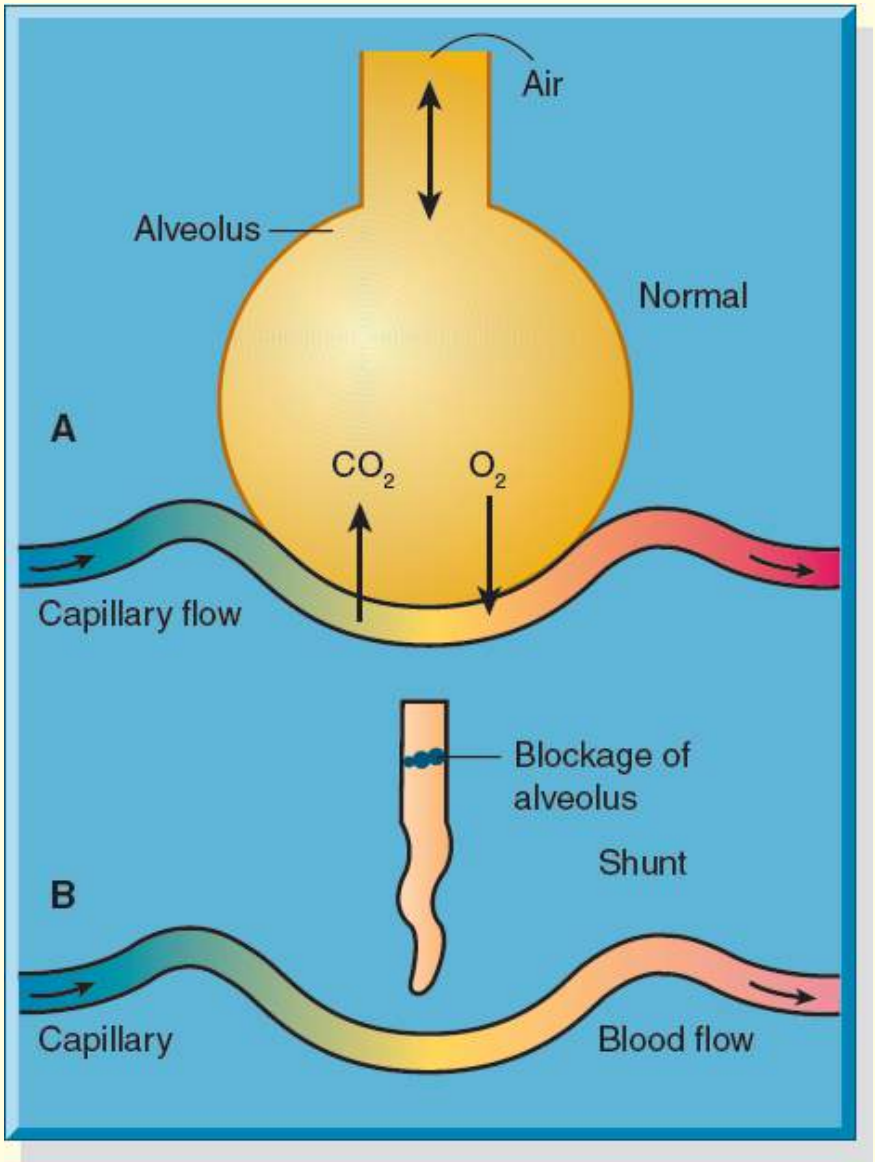
Chart 17-2

Normal Ratio (A)

In the healthy lung, a given amount of blood passes an alveolus and is matched with an equal amount of gas **(A).** The ratio is 1:1 (ventilation matches perfusion).

Low Ventilation–Perfusion Ratio: Shunts (B)

Low ventilation–perfusion states may be called *shunt-producing disorders.* When perfusion exceeds ventilation, a shunt exists **(B).** Blood bypasses the alveoli without gas exchange occurring. This is seen with obstruction of the distal airways, such as with pneumonia, atelectasis, tumor, or a mucus plug.

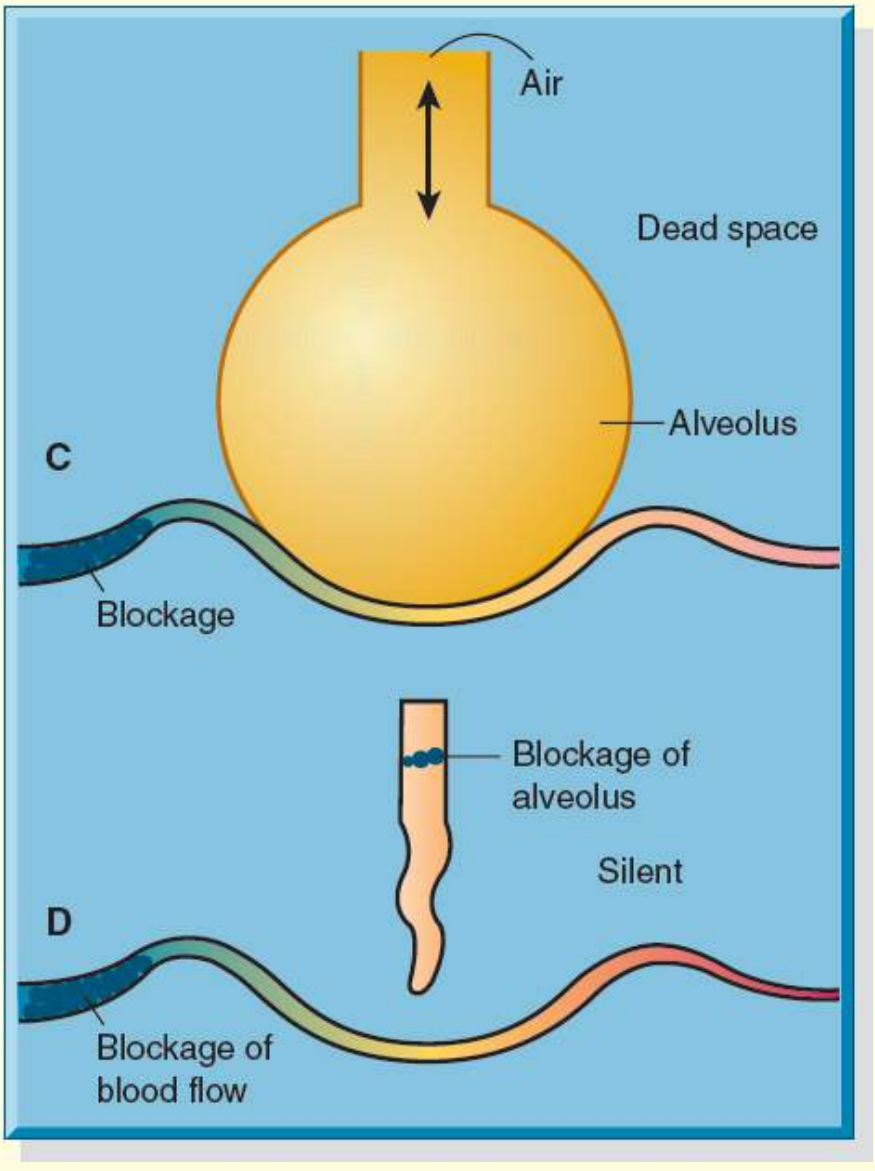


High Ventilation–Perfusion Ratio: Dead Space (C)

When ventilation exceeds perfusion, dead space results **(C).** The alveoli do not have an adequate blood supply for gas exchange to occur. This is characteristic of a variety of disorders, including pulmonary emboli, pulmonary infarction, and cardiogenic shock.

Silent Unit (D)

In the absence of both ventilation and perfusion or with limited ventilation and perfusion, a condition known as a silent unit occurs **(D).** This is seen with pneumothorax and severe acute respiratory distress syndrome.



Once the air enters the trachea, it becomes fully saturated with water vapor, which displaces some of the other gases. Water vapor exerts a pressure of 45 mm Hg when it fully saturates a mixture of gases at the body temperature of 37°C (98.6°F). Nitrogen and oxygen are responsible for almost all of the

remaining 715 mm Hg pressure. Once this mixture enters the alveoli, it is further diluted by carbon dioxide. In the alveoli, the water vapor continues to exert a pressure of 45 mm Hg. Under typical baseline conditions (i.e., without supplemental oxygen and at sea level), the partial pressure of alveolar oxygen (PAO_2) is approximately 100 mm Hg. This pressure ensures diffusion of oxygen across the alveolar–capillary membranes, and then eventually into the arterial blood and to red blood cells for transport to meet systemic oxygenation needs (Sharma, Hashmi, & Rawat, 2019).

Chart 17-3

Partial Pressure Abbreviations

P = Pressure
PO_2 = Partial pressure of oxygen
PCO_2 = Partial pressure of carbon dioxide
PAO_2 = Partial pressure of alveolar oxygen
$PACO_2$ = Partial pressure of alveolar carbon dioxide
PaO_2 = Partial pressure of arterial oxygen
$PaCO_2$ = Partial pressure of arterial carbon dioxide
$Pv\text{-}O_2$ = Partial pressure of venous oxygen
$Pv\text{-}CO_2$ = Partial pressure of venous carbon dioxide
P_{50} = Partial pressure of oxygen when the hemoglobin is 50% saturated

When a gas is exposed to a liquid, the gas dissolves in the liquid until equilibrium is reached. The dissolved gas also exerts a partial pressure. At equilibrium, the partial pressure of the gas in the liquid is the same as the partial pressure of the gas in the gaseous mixture. Oxygenation of venous blood in the lung illustrates this point. In the lung, venous blood and alveolar oxygen are separated by a very thin alveolar membrane. Oxygen diffuses across this membrane to dissolve in the blood until the partial pressure of oxygen in the blood is the same as that in the alveoli. However, because carbon dioxide is a by-product of oxidation in the cells, venous blood contains carbon dioxide at a higher partial pressure than that in the alveolar gas. In the lung, carbon dioxide diffuses out of venous blood into the alveolar gas. At equilibrium, the partial pressure of carbon dioxide in the blood and in alveolar gas is the same. The changes in partial pressure are shown in Figure 17-5.

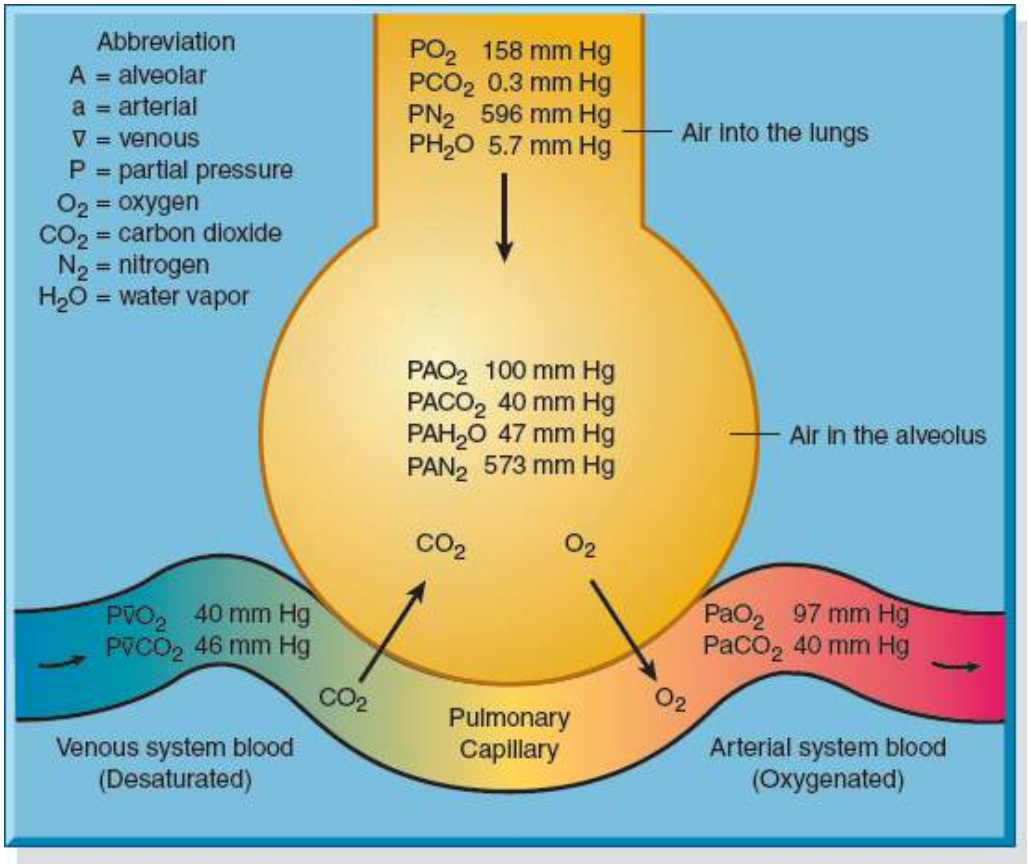


Figure 17-5 • Changes occur in the partial pressure of gases during respiration. These values vary as a result of the exchange of oxygen and carbon dioxide and the changes that occur in their partial pressures as venous blood flows through the lungs.

Effects of Pressure on Oxygen Transport

Oxygen and carbon dioxide are transported simultaneously, either dissolved in blood or combined with hemoglobin in red blood cells. Each 100 mL of normal arterial blood carries 0.3 mL of oxygen physically dissolved in the plasma and 20 mL of oxygen in combination with hemoglobin. Large amounts of oxygen can be transported in the blood because oxygen combines easily with hemoglobin to form oxyhemoglobin:

$$O_2 + Hgb \leftrightarrow HgbO_2$$

The volume of oxygen physically dissolved in the plasma is measured by the partial pressure of oxygen in the arteries (PaO_2). The higher the PaO_2, the greater the amount of oxygen dissolved. For example, at a PaO_2 of 10 mm Hg, 0.03 mL of oxygen is dissolved in 100 mL of plasma. At PaO_2 of 20 mm Hg, twice this amount is dissolved in plasma, and at PaO_2 of 100 mm Hg, 10 times this amount is dissolved. Therefore, the amount of dissolved oxygen is directly

proportional to the partial pressure, regardless of how high the oxygen pressure becomes.

The amount of oxygen that combines with hemoglobin depends on both the amount of hemoglobin in the blood and on PaO_2, although only up to a PaO_2 of about 150 mm Hg. This is measured as **oxygen saturation** (SaO_2), the percentage of the O_2 that could be carried if all the hemoglobin held the maximum possible amount of O_2. When the PaO_2 is 150 mm Hg, hemoglobin is 100% saturated and does not combine with any additional oxygen. When hemoglobin is 100% saturated, 1 g of hemoglobin combines with 1.34 mL of oxygen. Therefore, in a person with 14 g/dL of hemoglobin, each 100 mL of blood contains about 19 mL of oxygen associated with hemoglobin. If the PaO_2 is less than 150 mm Hg, the percentage of hemoglobin saturated with oxygen decreases. For example, at a PaO_2 of 100 mm Hg (normal value), saturation is 97%; at a PaO_2 of 40 mm Hg, saturation is 70%.

Oxyhemoglobin Dissociation Curve

The oxyhemoglobin dissociation curve (Chart 17-4) shows the relationship between the partial pressure of oxygen (PaO_2) and the percentage of saturation of oxygen (SaO_2). The percentage of saturation can be affected by carbon dioxide, hydrogen ion concentration, temperature, and 2,3-diphosphoglycerate. An increase in these factors shifts the curve to the right, thus less oxygen is picked up in the lungs, but more oxygen is released to the tissues, if PaO_2 is unchanged. A decrease in these factors causes the curve to shift to the left, making the bond between oxygen and hemoglobin stronger. If the PaO_2 is still unchanged, more oxygen is picked up in the lungs, but less oxygen is given up to the tissues. The unusual shape of the oxyhemoglobin dissociation curve is a distinct advantage to the patient for two reasons:

1. If the PaO_2 decreases from 100 to 80 mm Hg as a result of lung disease or heart disease, the hemoglobin of the arterial blood remains almost maximally saturated (94%), and the tissues do not suffer from hypoxia.

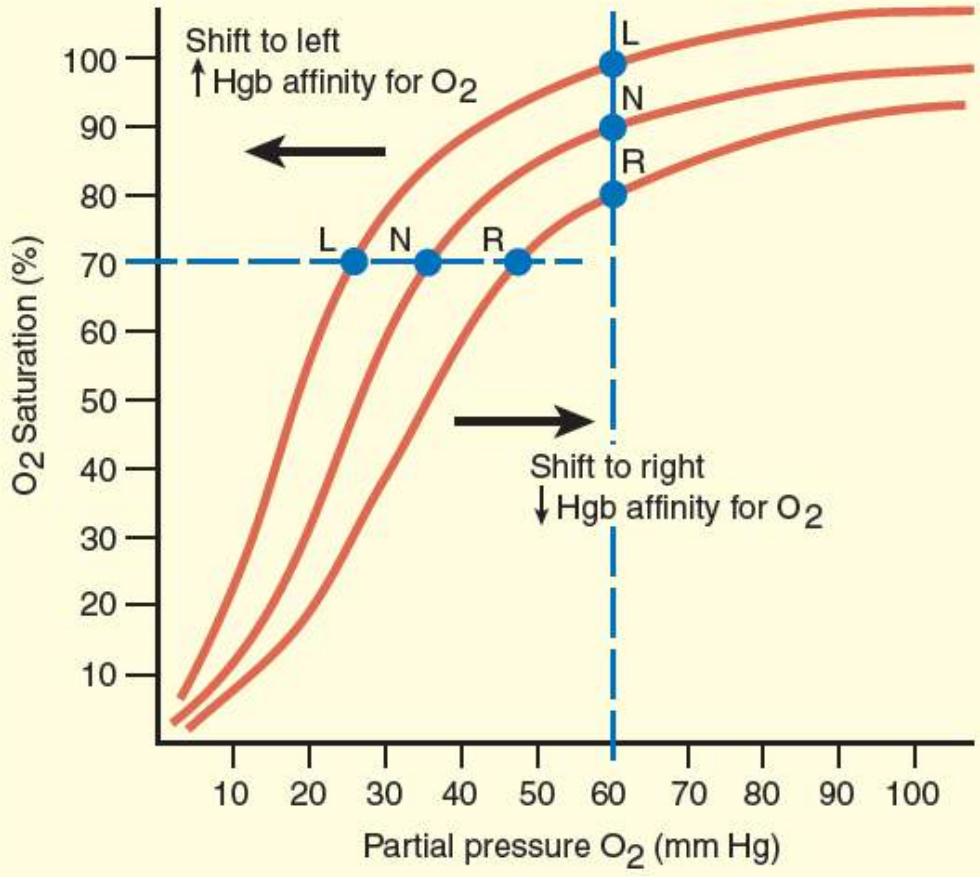
Chart 17-4

Oxyhemoglobin Dissociation Curve

The oxyhemoglobin dissociation curve is marked to show three oxygen levels:

1. Normal levels—PaO_2 >70 mm Hg
2. Relatively safe levels—PaO_2 45–70 mm Hg
3. Dangerous levels—PaO_2 <40 mm Hg

The normal (middle) curve (N) shows that 75% saturation occurs at a PaO_2 of 40 mm Hg. If the curve shifts to the right (R), the same saturation (75%) occurs at the higher PaO_2 of 57 mm Hg. If the curve shifts to the left (L), 75% saturation occurs at a PaO_2 of 25 mm Hg.



2. When the arterial blood passes into tissue capillaries and is exposed to the tissue tension of oxygen (about 40 mm Hg), hemoglobin gives up large quantities of oxygen for use by the tissues.

With a normal value for PaO_2 (80 to 100 mm Hg) and SaO_2 (95% to 98%), there is a 15% margin of excess oxygen available to the tissues. With a normal hemoglobin level of 15 mg/dL and a PaO_2 level of 40 mm Hg (SaO_2 75%), there is adequate oxygen available for the tissues but no reserve for physiologic stresses that increase tissue oxygen demand. If a serious incident

occurs (e.g., bronchospasm, aspiration, hypotension, or cardiac arrhythmias) that reduces the intake of oxygen from the lungs, tissue hypoxia results.

An important consideration in the transport of oxygen is cardiac output, which determines the amount of oxygen delivered to the body and affects lung and tissue perfusion. If the cardiac output is normal (5 L/min), the amount of oxygen delivered to the body per minute is normal. Under normal conditions, only 250 mL of oxygen is used per minute, which is approximately 25% of available oxygen. The rest of the oxygen returns to the right side of the heart, and the PaO_2 of venous blood drops from 80 to 100 mm Hg to about 40 mm Hg. If cardiac output falls, however, the amount of oxygen delivered to the tissues also falls and may be inadequate to meet the body's needs.

Carbon Dioxide Transport

At the same time that oxygen diffuses from the blood into the tissues, carbon dioxide diffuses from tissue cells to blood and is transported to the lungs for excretion. The amount of carbon dioxide in transit is one of the major determinants of the acid–base balance of the body. Normally, only 6% of the venous carbon dioxide is removed in the lungs and enough remains in the arterial blood to exert a pressure of 40 mm Hg. Most of the carbon dioxide (90%) is carried by red blood cells; the small portion (5%) that remains dissolved in the plasma (partial pressure of carbon dioxide [PCO_2]) is the critical factor that determines carbon dioxide movement in or out of the blood.

Although the many processes involved in respiratory gas transport seem to occur in intermittent stages, the changes are rapid, simultaneous, and continuous.

Neurologic Control of Ventilation

Resting respiration is the result of cyclic excitation of the respiratory muscles by the phrenic nerve. The rhythm of breathing is controlled by respiratory centers in the brain. The inspiratory and expiratory centers in the medulla oblongata and pons control the rate and depth of ventilation to meet the body's metabolic demands.

The apneustic center in the lower pons stimulates the inspiratory medullary center to promote deep, prolonged inspirations. The pneumotaxic center in the upper pons is thought to control the pattern of respirations.

Several groups of receptor sites assist in the brain's control of respiratory function. The central chemoreceptors, located in the medulla, respond to chemical changes in the cerebrospinal fluid, which result from chemical changes in the blood. These receptors respond to an increase or decrease in the pH and convey a message to the lungs to change the depth and then the rate of ventilation to correct the imbalance. The peripheral chemoreceptors are located

in the aortic arch and the carotid arteries and respond first to changes in PaO_2, then to partial pressure of carbon dioxide ($PaCO_2$) and pH.

Mechanoreceptors in the lung include stretch, irritant, and juxtacapillary receptors, and respond to changes in resistance by altering breathing patterns to support optimal lung function. For example, the Hering–Breuer reflex is activated by stretch receptors in the alveoli. When the lungs are distended, inspiration is inhibited; as a result, the lungs do not become overdistended.

Proprioceptors in the muscles and chest wall respond to body movements, causing an increase in ventilation. Thus, range-of-motion exercises in a patient who is immobile stimulate breathing. Finally, baroreceptors, also located in the aortic and carotid bodies, respond to an increase or decrease in arterial blood pressure and cause reflex hypoventilation or hyperventilation.

Gerontologic Considerations

A gradual decline in respiratory function begins in early to middle adulthood and affects the structure and function of the respiratory system. The vital capacity of the lungs and the strength of the respiratory muscles peak between 20 and 25 years of age and decrease thereafter. With aging (40 years and older), changes occur in the alveoli that reduce the surface area available for the exchange of oxygen and carbon dioxide. At approximately 50 years of age, the alveoli begin to lose elasticity. A decrease in vital capacity occurs with the loss of chest wall mobility, which restricts the tidal flow of air. The amount of respiratory dead space increases with age. These changes result in a decreased diffusion capacity for oxygen with increasing age, producing lower oxygen levels in the arterial circulation. Older adults have a decreased ability to rapidly move air in and out of the lungs.

Gerontologic changes in the respiratory system are summarized in Table 17-2. Despite these changes, in the absence of chronic pulmonary disease, older adults are able to carry out activities of daily living, but they may have decreased tolerance for, and require additional rest after, prolonged or vigorous activity.

Assessment

Health History

The health history initially focuses on the patient's presenting problem and associated symptoms. In conducting the history, the nurse should explore the onset, location, duration, character, aggravating and alleviating factors, radiation (if relevant), and timing of the presenting problem and associated

signs and symptoms. The nurse should also explore how these factors impact the patient's activities of daily living, usual work and family activities, and quality of life.

Common Symptoms

The major signs and symptoms of respiratory disease are dyspnea, cough, sputum production, chest pain, wheezing, and hemoptysis. During the health history, the nurse should also consider nonpulmonary diseases when evaluating symptoms, as these symptoms may occur with a variety of other illnesses.

TABLE 17-2 Age-Related Changes in the Respiratory System

	Structural Changes	Functional Changes	History and Physical Findings
Defense Mechanisms (Respiratory and Nonrespiratory)	↓ Number of cilia and ↓ mucus ↓ Cough and gag reflex Loss of surface area of the capillary membrane Lack of a uniform or consistent ventilation and/or blood flow	↓ Protection against foreign particles ↓ Protection against aspiration ↓ Antibody response to antigens ↓ Response to hypoxia and hypercapnia (chemoreceptors)	↓ Cough reflex and mucus ↑ Infection rate History of respiratory infections, chronic obstructive pulmonary disease (COPD), pneumonia. Risk factors: smoking, environmental exposure, exposure to tuberculosis (TB)
Lung	↓ Size of airway ↑ Diameter of alveolar ducts ↑ Collagen of alveolar walls ↑ Thickness of alveolar membranes ↓ Elasticity of alveolar sacs	↑ Airway resistance ↑ Pulmonary compliance ↓ Expiratory flow rate ↓ Oxygen diffusion capacity ↑ Dead space Premature closure of airways ↑ Air trapping ↓ Expiratory flow rates Ventilation–perfusion mismatch ↓ Exercise capacity ↑ Anteroposterior (AP) diameter	Unchanged total lung capacity (TLC) ↑ Residual volume (RV) ↓ Inspiratory reserve volume (IRV) ↓ Expiratory reserve volume (ERV) ↓ Forced vital capacity (FVC) and vital capacity (VC) ↑ Functional residual capacity (FRC) ↓ PaO_2 ↑ CO_2
Chest Wall and Muscles	Calcification of intercostal cartilages Arthritis of costovertebral joints ↓ Continuity of diaphragm Osteoporotic changes ↓ Muscle mass Muscle atrophy	↑ Rigidity and stiffness of thoracic cage ↓ Respiratory muscle strength ↑ Work of breathing ↓ Capacity for exercise ↓ Peripheral chemosensitivity ↑ Risk for inspiratory muscle fatigue	Kyphosis, barrel chest Skeletal changes ↑ AP diameter Shortness of breath ↑ Abdominal and diaphragmatic breathing ↓ Maximum expiratory flow rates

↓, decreased; ↑, increased.
Adapted from Ramly, E., Kaafarani, H. M. A., & Velmahos, G. C. (2015). The effect of aging on pulmonary function: Implications for monitoring and support of the surgical and trauma patient. *Surgical Clinics of North America*, *95*(1), 53–69.

Dyspnea

The official American Thoracic Society Statement (2012) defines **dyspnea** as a subjective feeling of discomfort while breathing; its causes may include multiple physiologic, psychological, environmental, or social factors (Parshall, Schwartzstein, Adams, et al., 2012). In general, acute diseases of the lungs produce a more severe grade of dyspnea than do chronic diseases. Sudden dyspnea in a healthy person may indicate pneumothorax (air in the pleural cavity), acute respiratory obstruction, allergic reaction, or myocardial infarction. In patients who are immobilized, sudden dyspnea may denote pulmonary embolism (PE). Dyspnea and **tachypnea** (abnormally rapid respirations) accompanied by progressive **hypoxemia** (low blood oxygen level) in a person who has recently experienced lung trauma, shock, cardiopulmonary bypass, or multiple blood transfusions may signal ARDS. **Orthopnea** (shortness of breath when lying flat, relieved by sitting or standing) may be found in patients with heart disease and occasionally in patients with chronic obstructive pulmonary disease (COPD); dyspnea with an expiratory wheeze occurs with COPD. Dyspnea associated with noisy breathing may result from a narrowing of the airway or localized obstruction of a major bronchus by a tumor or foreign body. The high-pitched sound heard (usually on inspiration) when someone is breathing through a partially blocked upper airway is called **stridor.** To help determine the cause of dyspnea, the nurse should ask the following questions:

- Is the shortness of breath related to other symptoms? Is a cough present?
- Was the onset of shortness of breath sudden or gradual?
- At what time of day or night does the shortness of breath occur?
- Is the shortness of breath worse when lying flat?
- How much exertion triggers shortness of breath? Does it occur with exercise? Climbing stairs? At rest?
- How severe is the shortness of breath? On a scale of 0 to 10, if 0 is not at all breathless and 10 is very breathless, how hard is it to breathe?

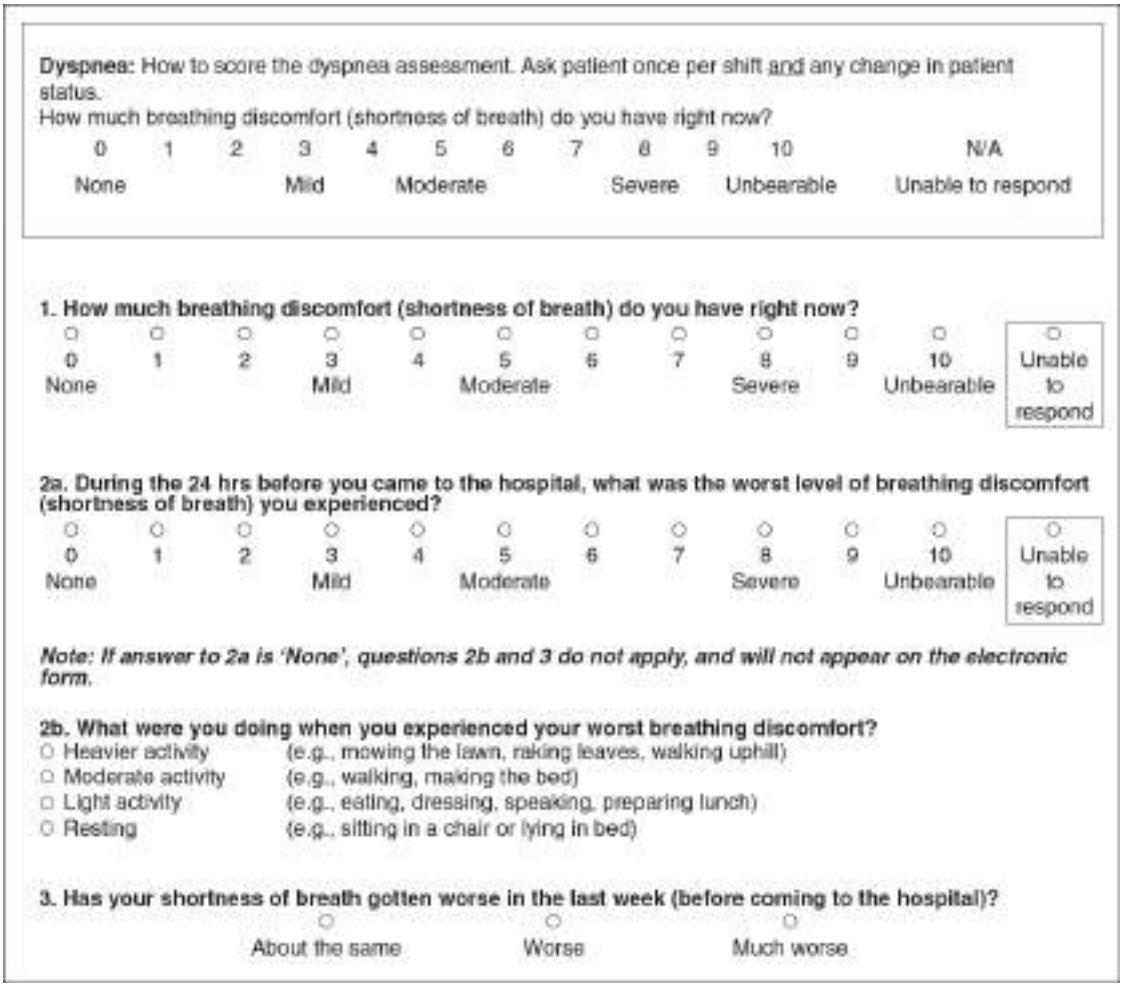
Because patients use a variety of terms to describe breathlessness, the nurse must explore what these terms mean to each patient. The use of a standardized tool to assess dyspnea, as part of the routine nursing assessment, can be beneficial (Fig. 17-6). It is especially important to assess the patient's rating of the intensity or distress of breathlessness, what breathing feels like, and its impact on the patient's general health, function, and quality of life (Baker,

DeSanto-Madeya, & Banzett, 2017). See the Nursing Research Profile in Chart 17-5.

Cough

Cough is a reflex that protects the lungs from the accumulation of secretions or the inhalation of foreign bodies. Its presence or absence can be a diagnostic clue because some disorders cause coughing and others suppress it. The cough reflex may be impaired by weakness or paralysis of the respiratory muscles, prolonged inactivity, the presence of a nasogastric tube, or depressed function of the brain's medullary centers (e.g., anesthesia, brain disorders).

Cough results from irritation or inflammation of the mucous membranes anywhere in the respiratory tract and is associated with multiple pulmonary disorders. Mucus, pus, blood, or an airborne irritant, such as smoke or a gas, may stimulate the cough reflex. Common causes of cough include asthma, gastrointestinal reflux disease, infection, and side effects of medications, such as angiotensin-converting enzyme (ACE) inhibitors (Norris, 2019).



Dyspnea: How to score the dyspnea assessment. Ask patient once per shift and any change in patient status.
How much breathing discomfort (shortness of breath) do you have right now?

0	1	2	3	4	5	6	7	8	9	10	N/A
None			Mild		Moderate			Severe		Unbearable	Unable to respond

1. How much breathing discomfort (shortness of breath) do you have right now?

0	1	2	3	4	5	6	7	8	9	10	Unable to respond
None			Mild		Moderate			Severe		Unbearable	

2a. During the 24 hrs before you came to the hospital, what was the worst level of breathing discomfort (shortness of breath) you experienced?

0	1	2	3	4	5	6	7	8	9	10	Unable to respond
None			Mild		Moderate			Severe		Unbearable	

Note: If answer to 2a is 'None', questions 2b and 3 do not apply, and will not appear on the electronic form.

2b. What were you doing when you experienced your worst breathing discomfort?

- Heavier activity (e.g., mowing the lawn, raking leaves, walking uphill)
- Moderate activity (e.g., walking, making the bed)
- Light activity (e.g., eating, dressing, speaking, preparing lunch)
- Resting (e.g., sitting in a chair or lying in bed)

3. Has your shortness of breath gotten worse in the last week (before coming to the hospital)?

About the same | Worse | Much worse

Figure 17-6 • Dyspnea scale and patient's report of current and recent dyspnea. Reprinted from Baker, K. M., DeSanto-Madeya, S., & Banzett, R. B. (2017). Routine dyspnea assessment and documentation: Nurses experience yields wide acceptance. *BMC Nursing, 16*(3), 1–11. This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (www.creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium.

To help determine the cause of the cough, the nurse inquires about the onset and time of coughing. Coughing at night may indicate the onset of left-sided heart failure or bronchial asthma. A cough in the morning with sputum production may indicate bronchitis. A cough that worsens when the patient is supine suggests postnasal drip (rhinosinusitis). Coughing after food intake may indicate aspiration of material into the tracheobronchial tree or reflux. A cough of recent onset is usually from an acute infection.

The nurse assesses the character of the cough and associated symptoms. A dry, irritative cough is characteristic of an upper respiratory tract infection of viral origin, or it may be a side effect of ACE inhibitor therapy. An irritative, high-pitched cough can be caused by laryngotracheitis. A brassy cough is the

result of a tracheal lesion, and a severe or changing cough may indicate bronchogenic carcinoma. Pleuritic chest pain that accompanies coughing may indicate pleural or chest wall (musculoskeletal) involvement. Violent coughing causes bronchial spasm, obstruction, and further irritation of the bronchi and may result in syncope (fainting).

Concept Mastery Alert

A nurse interviewing a patient who says he has a dry, irritating cough that is not "bringing anything up" should ask whether he is taking ACE inhibitors.

A persistent cough may affect a patient's quality of life and may produce embarrassment, exhaustion, inability to sleep, and pain. Therefore, the nurse should explore how a chronic cough impacts all aspects of the patient's life.

Chart 17-5 **NURSING RESEARCH PROFILE**

Dyspnea Assessment

Baker, K. M., DeSanto-Madeya, S., & Banzett, R. B. (2017). Routine dyspnea assessment and documentation: Nurses' experience yields wide acceptance. *BMC Nursing, 16*(3), 1–11.

Purpose

The study aims to explore nurses' approaches to dyspnea assessment, their perception of patient response, and their perception of the utility and burden of dyspnea measurement.

Design

This was a qualitative, descriptive study utilizing a three-part assessment of practice: a series of focus group interviews, a time-motion observation, and a randomized, anonymous online survey. A convenience sample of 63 nurses from six medical-surgical units participated in 12 half-hour focus group sessions. The focus group included questions about the process nurses used for assessment of dyspnea, views on the importance of dyspnea assessment and awareness, patients' abilities to rate and use a dyspnea scale, impact of routine assessment on workflow, and suggestions for improvement. Focus group sessions were conducted during regular work shifts and were recorded. Forty registered nurses representing 14 medical-surgical inpatient units were randomly selected for participation in the time-motion study. For this observation, a clinical nurse specialist recorded the time nurses spent assessing and documenting pain and dyspnea during routine morning nursing assessment of patients. The online survey addressed issues raised during the focus group sessions. Seventy registered nurses, from 14 inpatient medical-surgical units, were randomly selected to complete the anonymous, online survey.

Findings

Nursing assessment of dyspnea and pain took less than 1 min. Overwhelmingly, most of the nurses surveyed (94%) reported understanding the importance of assessing dyspnea. They described assessment of dyspnea as "easy" or "very easy" to complete and that the utilization of an assessment tool enhanced awareness of dyspnea, improved workflow, and standardized documentation.

Nursing Implications

Findings from this study support the use of a standardized tool to assess dyspnea as part of routine nursing assessment of patients.

Sputum Production

Sputum production is the reaction of the lungs to any constantly recurring irritant and often results from persistent coughing. It may also be associated

with a nasal discharge. The nature of the sputum is often indicative of its cause. A profuse amount of purulent sputum (thick and yellow, green, or rust colored) or a change in color of the sputum is a common sign of a bacterial infection. Thin, mucoid sputum frequently results from viral bronchitis. A gradual increase of sputum over time may occur with chronic bronchitis or bronchiectasis. Pink-tinged mucoid sputum suggests a lung tumor. Profuse, frothy, pink material, often welling up into the throat, may indicate pulmonary edema. Foul-smelling sputum and bad breath point to the presence of a lung abscess, bronchiectasis, or an infection caused by fusospirochetal or other anaerobic organisms.

Chest Pain

Chest pain or discomfort may be associated with pulmonary, cardiac, gastrointestinal, or musculoskeletal disease or anxiety. Chest pain associated with pulmonary conditions may be sharp, stabbing, and intermittent, or it may be dull, aching, and persistent. The pain usually is felt on the side where the pathologic process is located, although it may be referred elsewhere—for example, to the neck, back, or abdomen.

Chest pain may occur with pneumonia, pulmonary infarction, or pleurisy, or as a late symptom of bronchogenic carcinoma. In carcinoma, the pain may be dull and persistent because the cancer has invaded the chest wall, mediastinum, or spine.

Lung disease does not always cause thoracic pain because the lungs and the visceral pleura lack sensory nerves and are insensitive to pain stimuli. However, the parietal pleura have a rich supply of sensory nerves that are stimulated by inflammation and stretching of the membrane. Pleuritic pain from irritation of the parietal pleura is sharp and seems to "catch" on inspiration; patients often describe it as being "like the stabbing of a knife." Patients are more comfortable when they lay on the affected side because this position splints the chest wall, limits expansion and contraction of the lung, and reduces the friction between the injured or diseased pleurae on that side. Pain associated with cough may be reduced manually by splinting the rib cage.

The nurse assesses the onset, quality, intensity, and radiation of pain and identifies and explores precipitating factors and their relationship to the patient's position. In addition, the nurse must assess the relationship of pain to the inspiratory and expiratory phases of respiration (see Chapter 9 for further discussion on assessment of pain).

Wheezing

Wheezing is a high-pitched, musical sound which is continuous, meaning it is heard on either expiration (asthma) or inspiration (bronchitis). It is often the major finding in a patient with bronchoconstriction or airway narrowing (see later discussion under Thoracic Auscultation).

Hemoptysis

Hemoptysis is the expectoration of blood from the respiratory tract. It can present as small to moderate blood-stained sputum to a large hemorrhage and always warrants further investigation. The onset of hemoptysis is usually sudden, and it may be intermittent or continuous. The most common causes are:

- Pulmonary infection
- Carcinoma of the lung
- Abnormalities of the heart or blood vessels
- Pulmonary artery or vein abnormalities
- PE or infarction

The nurse must determine the source of the bleeding, as the term *hemoptysis* is reserved for blood coming from the respiratory tract. Potential sources of bleeding include the gums, nasopharynx, lungs, or stomach. The nurse may be the only witness to the episode, and when evaluating the bleeding episode, the following points should be considered:

- Bloody sputum from the nose or the nasopharynx is usually preceded by considerable sniffing, with blood possibly appearing in the nose.
- Blood from the lung is usually bright red, frothy, and mixed with sputum. Initial symptoms include a tickling sensation in the throat, a salty taste, a burning or bubbling sensation in the chest, and perhaps chest pain, in which case, the patient tends to splint the bleeding side. This blood has an alkaline pH (greater than 7).
- Blood from the stomach is vomited rather than expectorated, may be mixed with food, and is usually much darker and often referred to as "coffee ground emesis." This blood has an acid pH (less than 7).

Past Health, Social, and Family History

In addition to the presenting problem and associated symptoms, the history should also focus on the patient's health, personal, and social history, and the family health history. Specific questions are asked about childhood illnesses, immunizations (including the most recent influenza and pneumonia vaccinations), medical conditions, injuries, hospitalizations, surgeries, allergies, and current medications (including over-the-counter medications and herbal remedies). Personal and social history addresses issues such as diet, exercise, sleep, recreational habits, and religion. Psychosocial factors that may affect the patient are also explored (Chart 17-6).

The nurse assesses for risk factors and genetic factors that may contribute to the patient's lung condition (Charts 17-7 and 17-8). Many lung disorders are related to or exacerbated by tobacco smoke; therefore, smoking history (including exposure to secondhand smoke) is also obtained. Smoking history is

usually expressed in pack-years, which is the number of packs of cigarettes smoked per day times the number of years the patient has smoked. It is important to find out whether the patient is still smoking or when the patient quit smoking. The nurse should also ask patients whether they use electronic nicotine delivery systems (ENDS) including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars, or any other smokeless tobacco products. In 2016, the U.S. Food and Drug Administration (FDA) finalized a rule that extended its regulatory authority to all tobacco products, including e-cigarettes, cigars, hookah, and pipe tobacco. The new rule mandates health warnings on products, bans free samples, and restricts youth (those under the age of 18) access to newly regulated tobacco products. The FDA has not found ENDS to be safe or effective in helping smokers curb the habit, as previously marketed by some manufacturers. The FDA has approved five forms of nicotine replacement therapy including nicotine gum, nicotine skin patches, nicotine lozenges, nicotine oral inhaled products, and nicotine nasal spray (American Lung Association, 2020). The American Lung Association views ENDS as a public health threat and calls for additional research regarding the risks and long-term effects to better understand potential risks (American Lung Association, 2019). In January 2018, The National Academies of Sciences, Engineering, and Medicine released a report on the public health consequences of e-cigarettes. The report presented 47 conclusions from a review of 800 studies and concluded that using e-cigarettes causes health risks. E-cigarettes contain and emit a number of potentially toxic substances such as propylene glycol, acetaldehyde, acrolein, and formaldehyde, among others. Acrolein, also used as a weed killer, is known to cause acute lung injury, COPD, asthma, and lung cancer. Additionally, e-cigarette use is associated with an increased risk for cough, wheeze, and asthma exacerbations in adolescents (The National Academies of Sciences, Engineering, and Medicine, 2018). Differences in socioeconomic factors, rooted in race and ethnicity, may predispose certain groups to greater burdens related to lung disease and should also be considered (Chart 17-9).

Chart 17-6 **ASSESSMENT**

Assessing Psychosocial Factors Related to Respiratory Function and Disease

- What strategies does the patient use to cope with the signs, symptoms, and challenges associated with pulmonary disease?
- What effect has the pulmonary disease had on the patient's quality of life, goals, role within the family, and occupation?
- What changes has the pulmonary disease had on the patient's family and relationships with family members?
- Does the patient exhibit depression, anxiety, anger, hostility, dependency, withdrawal, isolation, avoidance, nonadherence, acceptance, or denial?
- What support systems does the patient use to cope with the illness?
- Are resources (relatives, friends, or community groups) available? Do the patient and the family use them effectively?

Chart 17-7 RISK FACTORS

Respiratory Disease

- Atypical immune responses in disease (e.g., asthma)
- Exposure to indoor pollutants (e.g., tobacco smoke, radon gas)
- Exposure to outdoor pollutants (e.g., smog, vehicle exhaust emissions, pollen)
- Genetic makeup
- Infection (e.g., influenza, pneumonia)
- Obesity
- Personal or family history of lung disease
- Smoking (e.g., cigarettes, e-cigarettes)

Adapted from American Lung Association. (2019). Protecting your lungs: Tips to keep your lungs healthy. Retrieved on 12/22/2019 at: www.lung.org/lung-health-and-diseases/protecting-your-lungs

If the patient is experiencing severe dyspnea, the nurse may need to modify the questions asked and the timing of the health history to avoid increasing the patient's breathlessness and anxiety. Once the history is complete, the nurse conducts a comprehensive assessment. Data obtained from both the history and the assessment guide the development of a nursing care plan and patient education.

Chart 17-8 GENETICS IN NURSING PRACTICE

Respiratory Disorders

Various conditions that affect gas exchange and respiratory function are influenced by genetic factors. Some are known to have a direct inherited pathway while others have a strong familial association, but the exact inheritance pattern is not entirely clear. The following are examples of respiratory disorders with a known or associated familial component:

- Asthma
- Cystic fibrosis
- Chronic obstructive pulmonary disease
- Alpha$_1$-antitrypsin deficiency
- Primary ciliary dyskinesia
- Pulmonary fibrosis
- Pulmonary hypertension
- Tuberous sclerosis

Nursing Assessments

Refer to Chapter 4, Chart 4-2: Genetics in Nursing Practice: Genetic Aspects of Health Assessment

Family History Assessment Specific to Genetic Respiratory Disorders

- Assess family history for three generations for family members with histories of respiratory impairment.
- Assess family history for individuals with early-onset chronic pulmonary disease and family history of hepatic disease in infants (clinical symptoms of alpha$_1$-antitrypsin deficiency).
- Inquire about family history of cystic fibrosis, an autosomal recessive inherited respiratory disorder.

Patient Assessment Specific to Genetic Respiratory Disorders

- Assess for symptoms such as changes in respiratory status and triggers that precede changes in respiratory function
- Frequency of respiratory tract infections or sinus infections
- Determine exposure to environmental risks (e.g., radon, asbestos) or occupational exposures (e.g., coal miner, sandblaster, painter)
- Determine presence of secondary risk factors (e.g., smoking or exposure or secondhand smoke)
- Assess for:
  - Clubbing of fingers
  - Skin color in general or the presence of white patches on the skin
  - Presence of angiofibromas or ungual fibromas (seen with primary ciliary dyskinesia)
- Assess for presence and frequency of:
  - Wheezing or coughing

- Mucous production (frequency, amount, and characteristics of the mucous)
- Mucosal edema

- Assess for multisystem effects (gastrointestinal disorders, pancreatic insufficiency, liver or kidney disorders)

Genetic Resources

American Lung Association, www.lung.org
Cystic Fibrosis Foundation, www.cff.org
COPD Foundation, www.copdfoundation.org
Primary Ciliary Dyskinesia, www.pcdfoundation.org

- See also Chapter 6, Chart 6-7: Components of Genetic Counseling

Physical Assessment of the Respiratory System

General Appearance

The patient's general appearance may give clues to respiratory status. In particular, the nurse inspects for clubbing of the fingers and notes skin color.

Clubbing of the Fingers

Clubbing of the fingers is a change in the normal nail bed. It appears as sponginess of the nail bed and loss of the nail bed angle (Fig. 17-7). It is a sign of lung disease that is found in patients with chronic hypoxic conditions, chronic lung infections, or malignancies of the lung. Clubbing can also be seen in congenital heart disease and other chronic infections or inflammatory conditions, such as endocarditis or inflammatory bowel disease (Hogan-Quigley, Palm, & Bickley, 2017).

Cyanosis

Cyanosis, a bluish coloring of the skin, is a very late indicator of hypoxia. The presence or absence of cyanosis is determined by the amount of unoxygenated hemoglobin in the blood. Cyanosis appears when there is at least 5 g/dL of unoxygenated hemoglobin. A patient with a hemoglobin level of 15 g/dL does not demonstrate cyanosis until 5 g/dL of that hemoglobin becomes unoxygenated, reducing the effective circulating hemoglobin to two thirds of the normal level.

Chart 17-9

Disparities in Pulmonary Health Related to Socioeconomics, Race, and Ethnicity: A Snapshot

- Individuals living in rural areas are more likely to use tobacco and be exposed to secondhand smoke at work and at home, to start smoking at a younger age, and to use more than 15 cigarettes daily, yet have less access to smoking cessation programs.
- Individuals with lower income and lower levels of education are more likely to use tobacco products.
- Adults living below the poverty level are more likely to experience severe asthma exacerbations, hospitalizations, and death.
- More Hispanics live and work in areas with greater levels of pollution, have higher prevalence rates of asthma than Caucasians, and yet are less likely to be diagnosed with asthma than all other racial and ethnic groups. Hispanics are less likely than non-Hispanic Whites to receive health insurance as a benefit from an employer.
- African American men are 37% more likely to get lung cancer than Caucasian men even though smoking rates between these two groups are comparable.
- American Indians/Alaska Natives and African Americans are at a higher risk of complications resulting from influenza and pneumonia.
- Death rates for African Americans are 55 percent higher for asthma than among Caucasians.
- Older African Americans and older Hispanics are less likely than older Caucasians to receive influenza vaccines (28% and 24% less, respectively) and pneumonia vaccines (37% and 46%, respectively).

Adapted from American Lung Association. Disparities in lung health series. Retrieved on 6/23/2019 at: www.lung.org/our-initiatives/research/lung-health-disparities

Figure 17-7 • Clubbed finger. In clubbing, the distal phalanx of each finger is rounded and bulbous. The nail plate is more convex, and the angle between the plate and the proximal nail fold increases to 180 degrees or more. The proximal nail fold, when palpated, feels spongy or floating. Among the many causes are chronic hypoxia and lung cancer.

A patient with anemia rarely manifests cyanosis, and a patient with polycythemia may appear cyanotic even if adequately oxygenated. Therefore, cyanosis is *not* a reliable sign of hypoxia.

Assessment of cyanosis is affected by room lighting, the patient's skin color, and the distance of the blood vessels from the surface of the skin. In the presence of a pulmonary condition, central cyanosis is assessed by observing the color of the tongue and lips. This indicates a decrease in oxygen tension in the blood. Peripheral cyanosis results from decreased blood flow to the body's periphery (fingers, toes, or earlobes), as in vasoconstriction from exposure to cold, and does not necessarily indicate a central systemic problem.

Upper Respiratory Structures

For a routine examination of the upper airway, only a simple light source, such as a penlight, is necessary. A more thorough examination requires the use of a nasal speculum.

Nose and Sinuses

The nurse inspects the external nose for lesions, asymmetry, or inflammation and then asks the patient to tilt the head backward. Gently pushing the tip of

the nose upward, the nurse examines the internal structures of the nose, inspecting the mucosa for color, swelling, exudate, or bleeding. The nasal mucosa is normally redder than the oral mucosa. It may appear swollen and hyperemic if the patient has a common cold; however, in allergic rhinitis, the mucosa appears pale and swollen.

Next, the nurse inspects the septum for deviation, perforation, or bleeding. Most people have a slight degree of septal deviation; such deviation usually causes no symptoms. However, actual displacement of the cartilage into either the right or left side of the nose may produce nasal obstruction.

While the head is still tilted back, the nurse inspects the inferior and middle turbinates. In chronic rhinitis, nasal polyps may develop between the inferior and middle turbinates; they are distinguished by their gray appearance. Unlike the turbinates, they are gelatinous and freely movable.

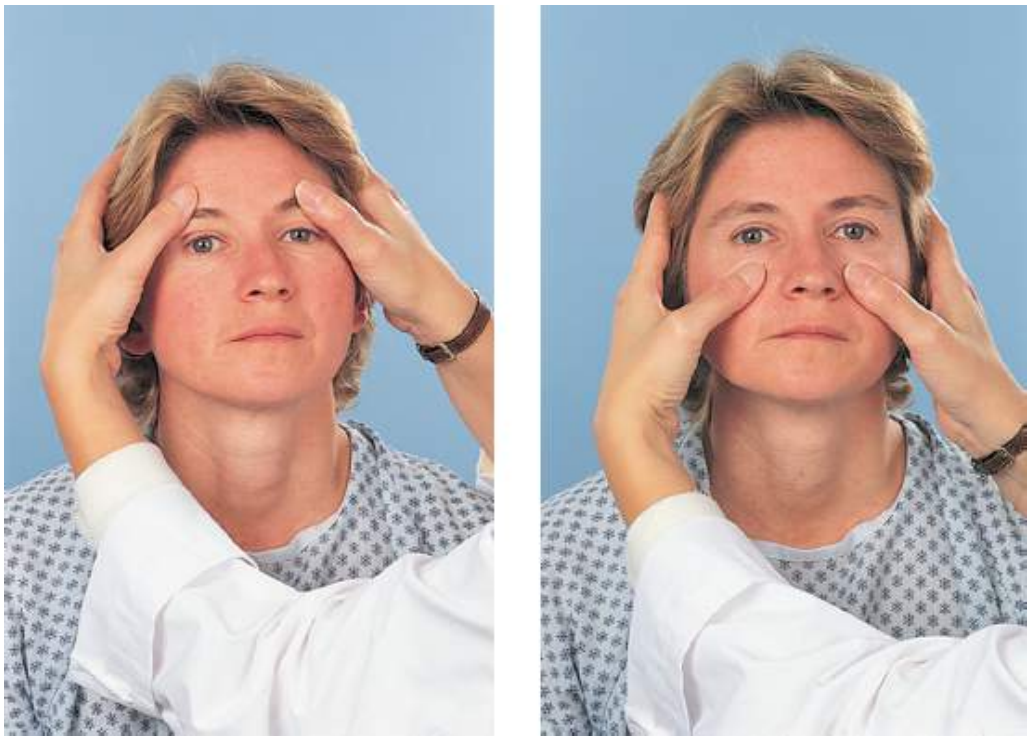


Figure 17-8 • Technique for palpating the frontal sinuses at left and the maxillary sinuses at right.

Next, the nurse may palpate the frontal and maxillary sinuses for tenderness (Fig. 17-8). Using the thumbs, the nurse applies gentle pressure in an upward fashion at the supraorbital ridges (frontal sinuses) and in the cheek area adjacent to the nose (maxillary sinuses). Tenderness in either area suggests inflammation. The frontal and maxillary sinuses can be inspected by transillumination (passing a strong light through a bony area, such as the sinuses, to inspect the cavity; see Fig. 17-9). If the light fails to penetrate, the cavity likely contains fluid or pus.

Mouth and Pharynx

After the nasal inspection, the nurse assesses the mouth and the pharynx, instructing the patient to open the mouth wide and take a deep breath. Usually, this flattens the posterior tongue and briefly allows a full view of the anterior and posterior pillars, tonsils, uvula, and posterior pharynx (see Chapter 39, Fig. 39-2). The nurse inspects these structures for color, symmetry, and evidence of exudate, ulceration, or enlargement. If a tongue blade is needed to depress the tongue to visualize the pharynx, it is pressed firmly beyond the midpoint of the tongue to avoid a gagging response.

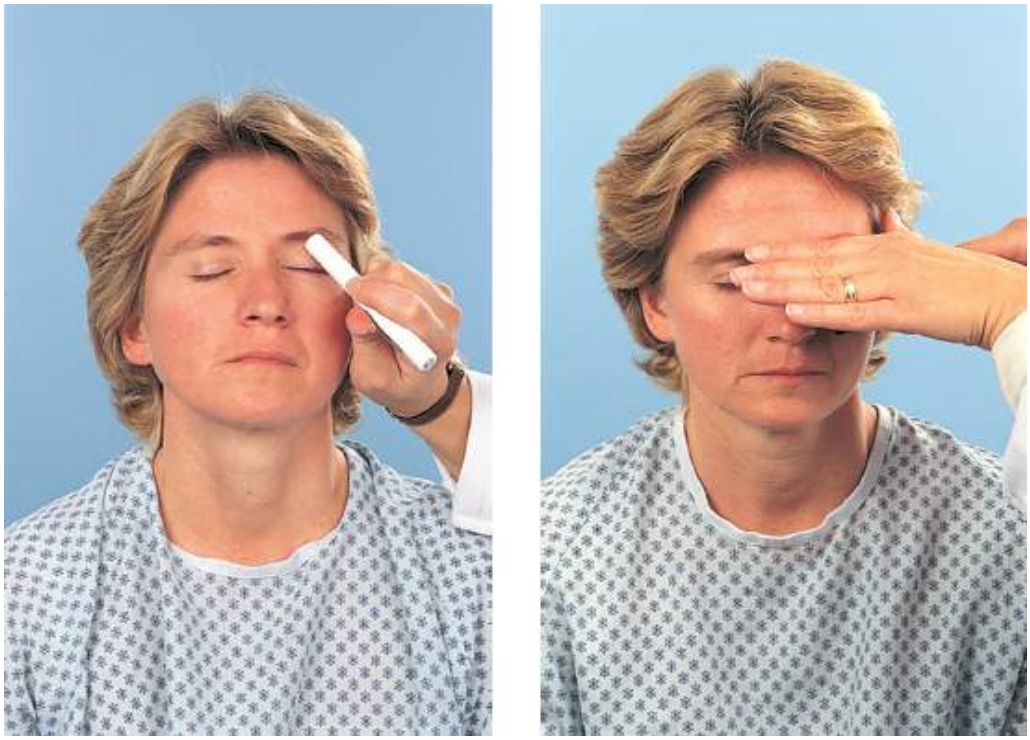


Figure 17-9 • At left, the nurse positions the light source for transillumination of the frontal sinus. At right, the nurse shields the patient's brow and shines the light. In normal conditions (a darkened room), the light should shine through the tissues and appear as a reddish glow (above the nurse's hand) over the sinus.

Trachea

Next, the position and mobility of the trachea are noted by direct palpation. This is performed by placing the thumb and the index finger of one hand on either side of the trachea just above the sternal notch. The trachea is highly sensitive and palpating too firmly may trigger a coughing or gagging response. The trachea is normally in the midline as it enters the thoracic inlet behind the sternum; however, it may be deviated by masses in the neck or the

mediastinum. Pulmonary disorders such as a pneumothorax or pleural effusion may also displace the trachea.

Lower Respiratory Structures and Breathing

Assessment of the lower respiratory structures includes inspection, palpation, percussion, and auscultation of the thorax. The patient should be positioned as necessary prior to the assessment.

Positioning

To assess the posterior thorax and the lungs, the patient should be in a sitting position with arms crossed in front of the chest and hands placed on the opposite shoulders (Hogan-Quigley et al., 2017). This position separates the scapulae widely and exposes more lung area for assessment. If the patient is unable to sit, with the patient supine, the nurse should roll the patient from side to side to complete the posterior examination. To assess the anterior thorax and lungs, the patient should be either supine or sitting. The supine position allows easier displacement of the patient's breast tissue, improving the nurse's ability to perform the chest examination.

Thoracic Inspection

Inspection of the thorax provides information about the respiratory system, the musculoskeletal structure, and the patient's nutritional status. The nurse observes the skin over the thorax for color and turgor and for evidence of loss of subcutaneous tissue. It is important to note asymmetry, if present. In documenting or reporting the findings, anatomic landmarks are used as points of reference (Chart 17-10).

Chest Configuration

Normally, the ratio of the anteroposterior diameter to the lateral diameter is 1:2. However, there are four main deformities of the chest associated with respiratory disease that alter this relationship: barrel chest, funnel chest (pectus excavatum), pigeon chest (pectus carinatum), and kyphoscoliosis.

Barrel Chest. Barrel chest occurs as a result of overinflation of the lungs, which increases the anteroposterior diameter of the thorax. It occurs with aging and is a hallmark sign of emphysema and COPD. In a patient with emphysema, the ribs are more widely spaced and the intercostal spaces tend to bulge on expiration. The appearance of the patient with advanced emphysema is thus quite characteristic, allowing the nurse to detect its presence easily, even from a distance.

Funnel Chest (Pectus Excavatum). Funnel chest occurs when there is a depression in the lower portion of the sternum. This may compress the heart

and great vessels, resulting in murmurs. Funnel chest may occur with rickets or Marfan syndrome.

Pigeon Chest (Pectus Carinatum). A pigeon chest occurs as a result of the anterior displacement of the sternum, which also increases the anteroposterior diameter. This may occur with rickets, Marfan syndrome, or severe kyphoscoliosis.

Kyphoscoliosis. Kyphoscoliosis is characterized by elevation of the scapula and a corresponding S-shaped spine. This deformity limits lung expansion within the thorax. It may occur with osteoporosis and other skeletal disorders that affect the thorax.

Breathing Patterns and Respiratory Rates

Observation of the rate, depth, and symmetry during respiration is a simple but important aspect of assessment. The normal adult who is at rest comfortably takes 12 to 20 breaths/min (Hogan-Quigley et al., 2017). Except for the occasional sigh, respirations are quiet with a regular rate, depth, and rhythm. The normal pattern associated with breathing is known as eupnea. Certain pathologic conditions may alter the rate and rhythm and are characteristic of certain disease states. For example, wheezing is commonly seen in the patient with asthma. Changes found during the act of breathing may be the first clinical sign that the patient's condition is deteriorating (IHI, 2019). The rate and depth of various patterns of respiration are presented in Table 17-3.

Concept Mastery Alert

There are subtle differences between Cheyne–Stokes and Biot's respiration patterns. Between regularly cycled periods of apnea, Cheyne–Stokes respirations demonstrate a regular pattern with the rate and depth of breathing increasing and then decreasing. In Biot's respiration, irregularly cycled periods of apnea are interspersed with cycles of normal rate and depth.

Temporary pauses of breathing, or **apnea,** may be noted. When episodes of apnea occur repeatedly during sleep, secondary to transient upper airway blockage, the condition is called **obstructive sleep apnea.** In thin people, it is quite normal to note a slight retraction of the intercostal spaces during quiet breathing. Bulging of the intercostal spaces during expiration implies obstruction of expiratory airflow, as in emphysema. Marked retraction on inspiration, particularly if asymmetric, implies blockage of a branch of the respiratory tree. Asymmetric bulging of the intercostal spaces, on either side of the thorax, is created by an increase in pressure within the hemithorax. This may be a result of air trapped under pressure within the pleural cavity, where it is not normally present (pneumothorax), or the pressure of fluid within the pleural space (pleural effusion).

Use of Accessory Muscles

In addition to breathing patterns and respiratory rates, the nurse should observe for the use of accessory muscles, such as the sternocleidomastoid, scalene, and trapezius muscles during inspiration, and the abdominal and internal intercostal muscles during expiration. These muscles provide additional support to assist the breathing effort during times of exertion as seen in exercise or certain disease states (Hogan-Quigley et al., 2017).

Chart 17-10

Locating Thoracic Landmarks

With respect to the thorax, location is defined both horizontally and vertically. With respect to the lungs, location is defined by lobe.

Horizontal Reference Points

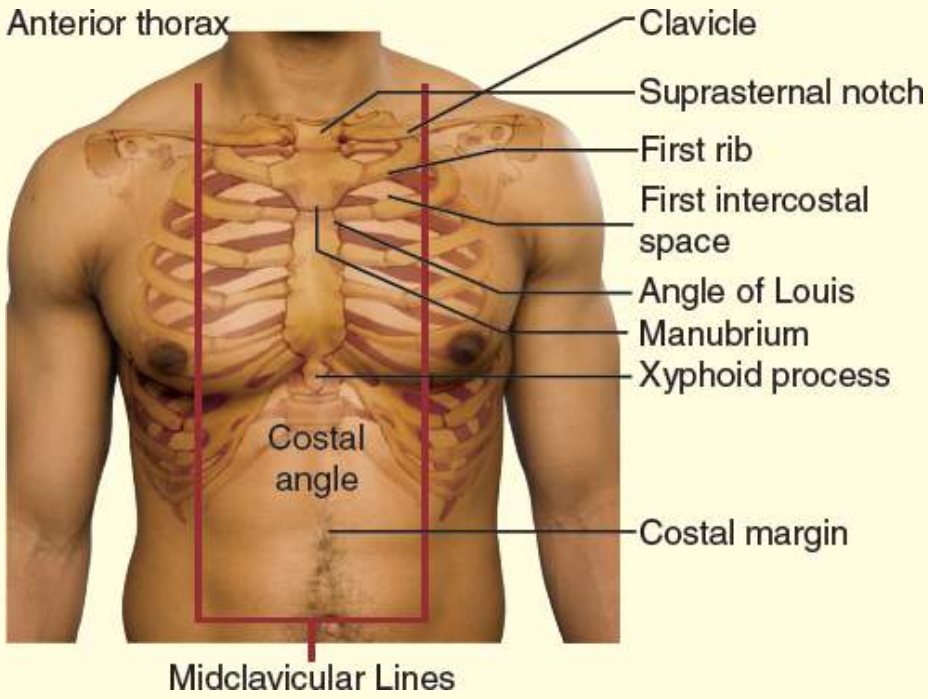
Horizontally, thoracic locations are identified according to their proximity to the rib or the intercostal space under the examiner's fingers. On the anterior surface, identification of a specific rib is facilitated by first locating the angle of Louis. This is where the manubrium joins the body of the sternum in the midline. The second rib joins the sternum at this prominent landmark.

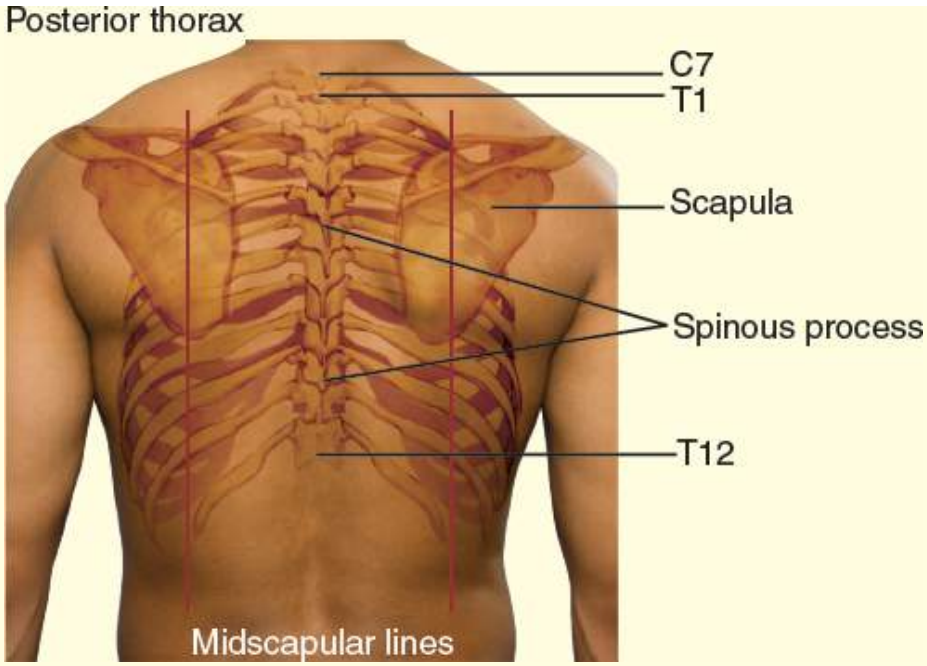
Other ribs may be identified by counting down from the second rib. The intercostal spaces are referred to in terms of the rib immediately above the intercostal space; for example, the fifth intercostal space is directly below the fifth rib.

Locating ribs on the posterior surface of the thorax is more difficult. The first step is to identify the spinous process. This is accomplished by finding the seventh cervical vertebra (*vertebra prominens*), which is the most prominent spinous process. When the neck is slightly flexed, the seventh cervical spinous process stands out. Other vertebrae are then identified by counting downward.

Vertical Reference Points

Several imaginary lines are used as vertical referents or landmarks to identify the location of thoracic findings. The *midsternal line* passes through the center of the sternum. The *midclavicular line* is an imaginary line that descends from the middle of the clavicle. The *point of maximal impulse* of the heart normally lies along this line on the left thorax.





When the arm is abducted from the body at 90 degrees, imaginary vertical lines may be drawn from the anterior axillary fold, from the middle of the axilla, and from the posterior axillary fold. These lines are called, respectively, the *anterior axillary line,* the *midaxillary line,* and the *posterior axillary line.* A line drawn vertically through the superior and inferior poles of the scapula is called the *scapular line,* and a line drawn down the center of the vertebral column is called the *vertebral line.* Using these landmarks, for example, the examiner communicates findings by referring to an area of dullness extending from the vertebral to the scapular line between the 7th and 10th ribs on the right.

Lobes of the Lungs

The lobes of the lung may be mapped on the surface of the chest wall in the following manner. The line between the upper and lower lobes on the left begins at the fourth thoracic spinous process posteriorly, proceeds around to cross the fifth rib in the midaxillary line, and meets the sixth rib at the sternum. This line on the right divides the right middle lobe from the right lower lobe. The line dividing the right upper lobe from the middle lobe is an incomplete one that begins at the fifth rib in the midaxillary line, where it intersects the line between the upper and lower lobes and traverses horizontally to the sternum. Thus, the upper lobes are dominant on the anterior surface of the thorax, and the lower lobes are dominant on the posterior surface. There is no presentation of the right middle lobe on the posterior surface of the chest.

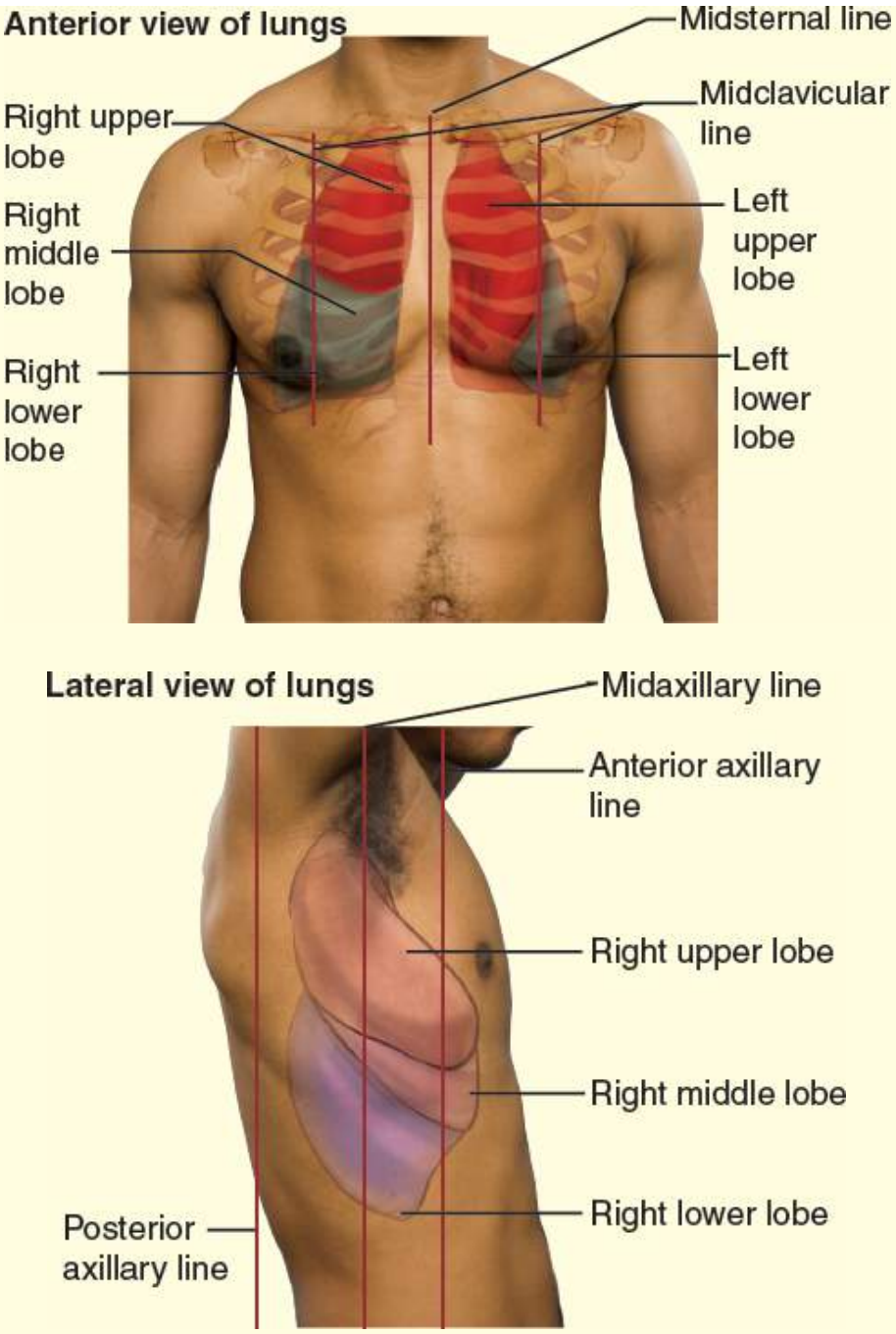
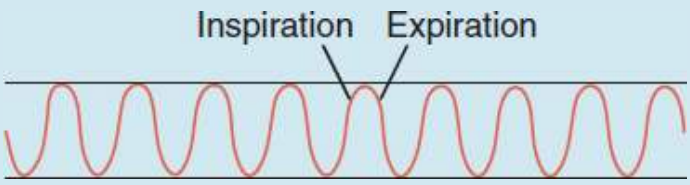
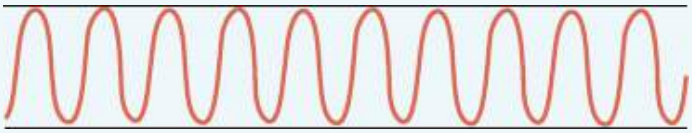
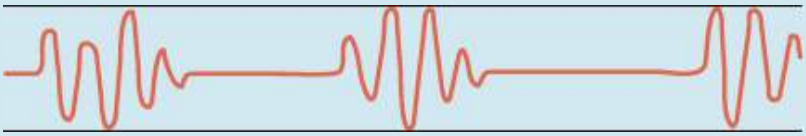
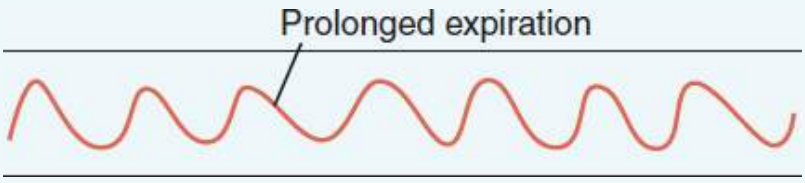

Anterior view of lungs
Midsternal line
Midclavicular line
Right upper lobe
Right middle lobe
Right lower lobe
Left upper lobe
Left lower lobe
Lateral view of lungs
Midaxillary line
Anterior axillary line
Right upper lobe
Right middle lobe
Right lower lobe
Posterior axillary line

TABLE 17-3 Rates and Depths of Respiration

Type	Description
Eupnea 	Normal, breathing at 12–20 breaths/min
Bradypnea 	Slower than normal rate (<10 breaths/min), with normal depth and regular rhythm Associated with increased intracranial pressure, brain injury, and drug overdose
Tachypnea 	Rapid, shallow breathing >24 breaths/min Associated with pneumonia, pulmonary edema, metabolic acidosis, septicemia, severe pain, or rib fracture
Hypoventilation 	Shallow, irregular breathing
Hyperpnea	Increased depth of respirations, see also hyperventilation
Hyperventilation 	Increased rate and depth of breathing that results in decreased $PaCO_2$ level Inspiration and expiration nearly equal in duration Associated with exertion, anxiety, and metabolic acidosis Called *Kussmaul's respiration* if associated with diabetic ketoacidosis or untreated kidney failure
Apnea	Period of cessation of breathing; time duration varies; apnea may occur briefly during other

	breathing disorders, such as with sleep apnea; life-threatening if sustained
Cheyne–Stokes 	Regular cycle where the rate and depth of breathing increase, then decrease until apnea (usually about 20 s) occurs Duration of apnea may vary and progressively lengthen; therefore, it is timed and reported. Associated with heart failure and damage to the respiratory center (drug induced, tumor, trauma)
Biot's respiration 	Periods of normal breathing (3–4 breaths), followed by a varying period of apnea (usually 10–60 s) Also called *ataxic breathing;* associated with complete irregularity Associated with respiratory depression resulting from drug overdose and brain injury, normally at the level of the medulla
Obstructive 	Prolonged expiratory phase of respiration Associated with airway narrowing and seen in asthma, chronic obstructive pulmonary disease, and bronchitis

Adapted from Hogan-Quigley, B., Palm, M. L., & Bickley, L. (2017). *Bates' nursing guide to physical examination and history taking* (2nd ed.). Philadelphia, PA: Wolters Kluwer Health Lippincott Williams & Wilkins.

Thoracic Palpation

The nurse palpates the thorax for tenderness, masses, lesions, respiratory excursion, and vocal fremitus. If the patient has reported an area of pain or if

lesions are apparent, the nurse performs direct palpation with the fingertips (for skin lesions and subcutaneous masses) or with the ball of the hand (for deeper masses or generalized flank or rib discomfort).

Respiratory Excursion

Respiratory excursion is an estimation of thoracic expansion and may disclose significant information about thoracic movement during breathing. The nurse assesses the patient for range and symmetry of excursion. For anterior assessment, the nurse places the thumbs along the costal margin of the chest wall and instructs the patient to inhale deeply. The nurse observes movement of the thumbs during inspiration and expiration. This movement is normally symmetric (Hogan-Quigley et al., 2017).

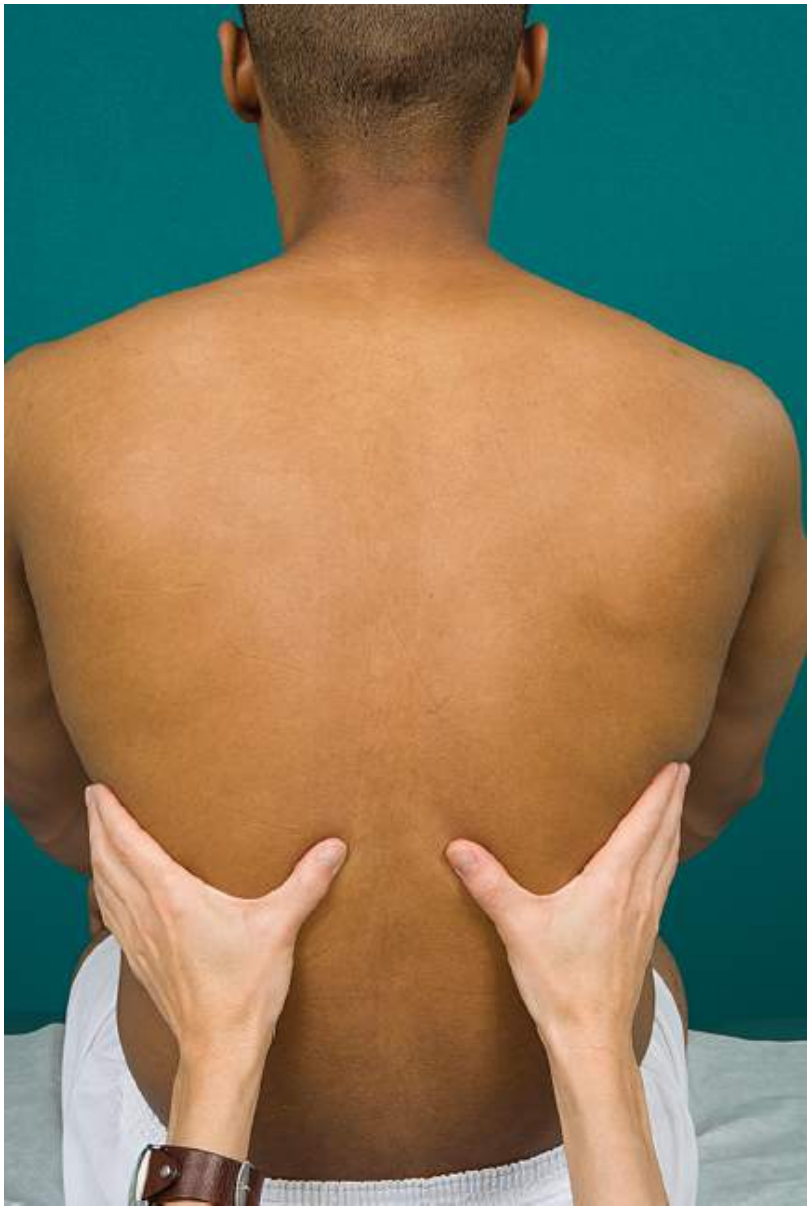


Figure 17-10 • Method for assessing posterior respiratory excursion. Place both hands posteriorly at the level of T9 or T10. Slide hands medially to pinch a small amount of skin between your thumbs. Observe for symmetry as the patient exhales fully following a deep inspiration.

Posterior assessment is performed by placing the thumbs adjacent to the spinal column at the level of the 10th rib (Fig. 17-10). The hands lightly grasp the lateral rib cage. Sliding the thumbs medially about 2.5 cm (1 inch) raises a small skin fold between the thumbs. The patient is instructed to take a full inspiration and to exhale fully. The nurse observes for normal flattening of the skin fold and feels the symmetric movement of the thorax.

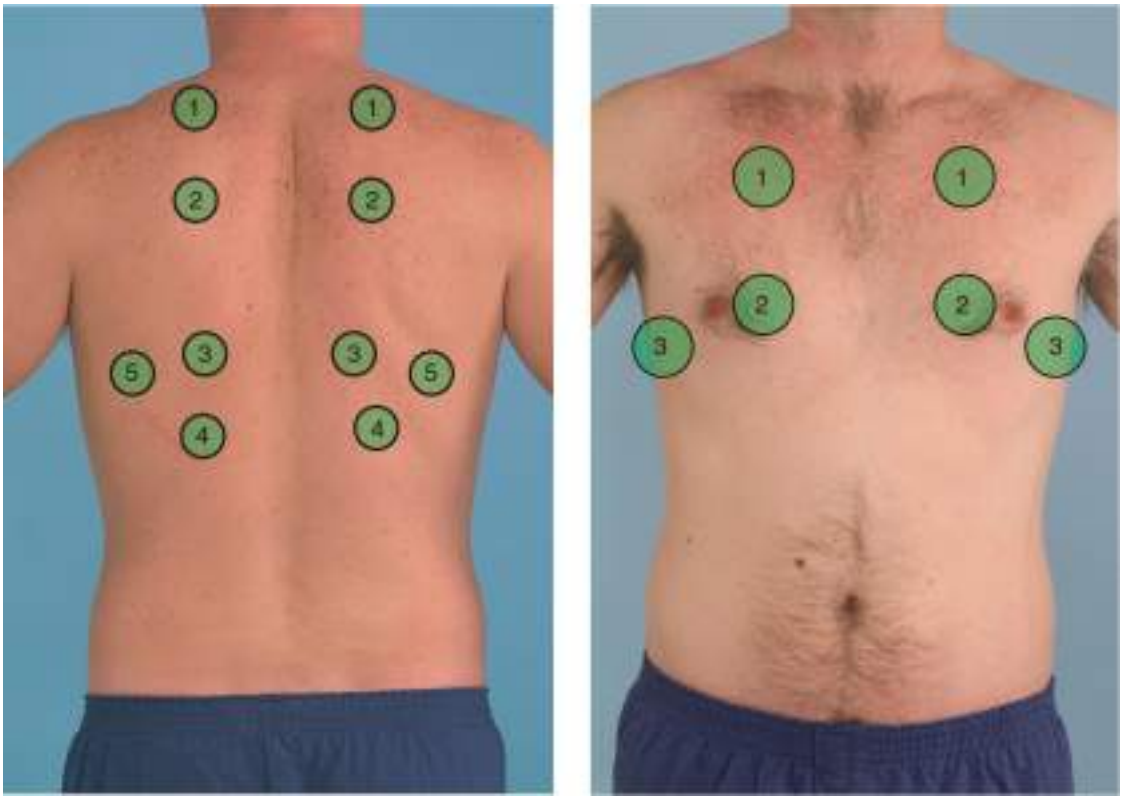


Figure 17-11 • Palpation sequence for tactile fremitus: posterior thorax (**left**) and anterior thorax (**right**).

Decreased chest excursion may be caused by chronic fibrotic disease. Asymmetric excursion may be due to splinting secondary to pleurisy, fractured ribs, trauma, or unilateral bronchial obstruction.

Tactile Fremitus

Tactile **fremitus** describes vibrations of the chest wall that result from speech detected on palpation. Normally, sounds generated by the larynx travel distally along the bronchial tree to set the chest wall in resonant motion. This is most pronounced with consonant sounds.

Normal fremitus varies on the basis of numerous factors. It is influenced by the thickness of the chest wall, especially muscle, and the subcutaneous tissue associated with obesity. It is also influenced by pitch; lower-pitched sounds travel better through the normal lung and produce greater vibration of the chest wall. Therefore, fremitus is more pronounced in men than in women because of the deeper male voice. Normally, fremitus is most pronounced where the large bronchi are closest to the chest wall, is more prominent on the right side, and is decreased or absent over the anterior chest wall which overlies the heart and great vessels (Hogan-Quigley et al., 2017).

The patient is asked to repeat "ninety-nine" or "one, one, one" as the nurse's hands move down the patient's thorax (Hogan-Quigley et al., 2017). The vibrations are detected with the palmar surfaces of the hands, or the ulnar

aspect of the extended hands, on the thorax. The hand or hands are moved in sequence down the thorax. Corresponding areas of the thorax are compared (Fig. 17-11). Bony areas are not assessed.

TABLE 17-4 Characteristics of Percussion Sounds

Sound	Relative Intensity	Relative Pitch	Relative Duration	Location Example	Examples
Flatness	Soft	High	Short	Thigh	Large pleural effusion
Dullness	Medium	Medium	Medium	Liver	Lobar pneumonia
Resonance	Loud	Low	Long	Normal lung	Simple chronic bronchitis
Hyperresonance	Very loud	Lower	Longer	None normally	Emphysema, pneumothorax
Tympany	Loud	High*	Medium	Gastric air bubble or puffed-out cheek	Large pneumothorax

*Distinguished mainly by its musical timbre.
Adapted from Hogan-Quigley, B., Palm, M. L., & Buckley, L. (2017). Bates' nursing guide to physical examination and history taking (2nd ed.). Philadelphia, PA: Wolters Kluwer Health Lippincott Williams & Wilkins.

Air does not conduct sound well; however, a solid substance such as tissue does, provided that it has elasticity and is not compressed. Therefore, an increase in solid tissue per unit volume of lung enhances fremitus, and an increase in air per unit volume of lung impedes sound. Patients with emphysema exhibit almost no tactile fremitus. A patient with consolidation of a lobe of the lung from pneumonia has increased tactile fremitus over that lobe.

Thoracic Percussion

Percussion produces audible and tactile vibration and allows the nurse to determine whether underlying tissues are filled with air, fluid, or solid material. Healthy lung tissue is resonant. Dullness over the lung occurs when air-filled lung tissue is replaced by fluid or solid tissue. Table 17-4 reviews percussion sounds and their characteristics. Percussion is also used to estimate the size and location of certain structures within the thorax (e.g., diaphragm, heart, liver).

Percussion usually begins with the posterior thorax. The nurse percusses across each shoulder top, locating the 5-cm width of resonance overlying the lung apices (Fig. 17-12). Then the nurse proceeds down the posterior thorax, percussing symmetric areas at intervals of 5 to 6 cm (2 to 2.5 inches). To perform percussion, the middle finger of the nondominant hand is firmly placed against the area of the chest wall to be percussed. The distal interphalangeal joint of this finger is struck with the tip of the middle finger of the dominant hand. This finger is partially flexed, and percussion occurs in a smooth, dartlike fashion. Bony structures (scapulae or ribs) are not percussed.

To perform percussion over the anterior chest, the nurse begins in the supraclavicular area and proceeds downward, from one intercostal space to the next. Dullness noted to the left of the sternum between the third and fifth intercostal spaces is a normal finding, because that is the location of the heart.

Similarly, there is a normal span of liver dullness below the lung at the right costal margin (Hogan-Quigley et al., 2017).

Diaphragmatic Excursion

The normal resonance of the lung stops at the diaphragm. The position of the diaphragm is different during inspiration and expiration.

To assess the position and motion of the diaphragm, the nurse instructs the patient to take a deep breath and hold it while the maximal descent of the diaphragm is percussed. The point at which the percussion note at the midscapular line changes from resonance to dullness is marked with a pen. The patient is then instructed to exhale fully and hold it while the nurse again percusses downward to the dullness of the diaphragm. This point is also marked. The distance between the two markings indicates the range of motion of the diaphragm.

Maximal excursion of the diaphragm may be as much as 8 to 10 cm (3 to 4 inches) in healthy, tall young men, but for most people, it is usually 5 to 7 cm (2 to 2.75 inches). Normally, the diaphragm is about 2 cm (0.75 inch) higher on the right because of the location of the liver. Decreased diaphragmatic excursion may occur with pleural effusion. Atelectasis, diaphragmatic paralysis, or pregnancy may account for a diaphragm that is positioned high in the thorax (Hogan-Quigley et al., 2017).

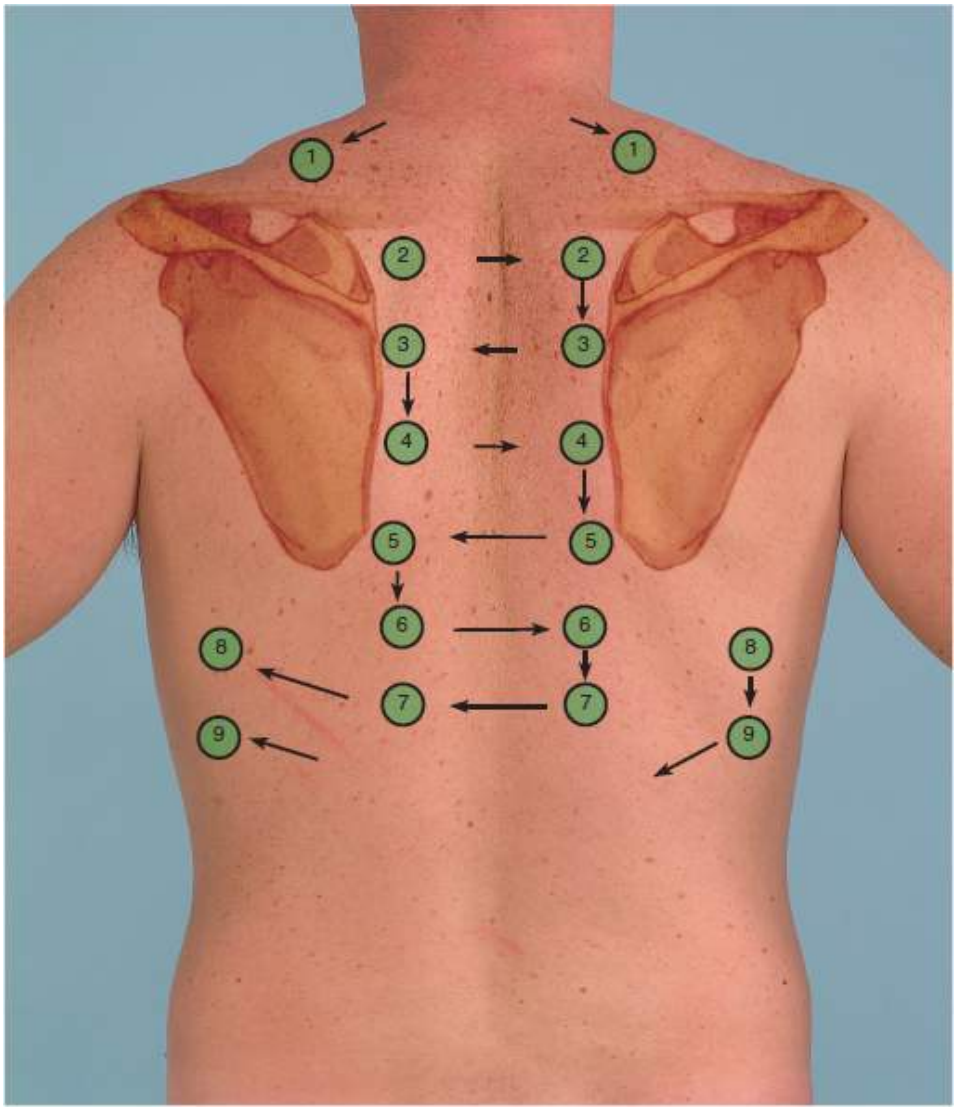


Figure 17-12 • Percussion of the posterior thorax. With the patient in a sitting position, symmetric areas of the lungs are percussed at 5-cm intervals. This progression starts at the apex of each lung and concludes with percussion of each lateral chest wall.

Thoracic Auscultation

Assessment concludes with auscultation of the anterior, posterior, and lateral thorax. Auscultation helps the nurse assess the flow of air through the bronchial tree and evaluate the presence of fluid or solid obstruction in the lung. The nurse auscultates for normal breath sounds, adventitious sounds, and voice sounds.

The nurse places the diaphragm of the stethoscope firmly against the bare skin of the chest wall as the patient breathes slowly and deeply through the mouth. Corresponding areas of the chest are auscultated in a systematic fashion from the apices to the bases and along midaxillary lines. The sequence of auscultation is similar to that used for percussion. The nurse may need to

listen to two full inspirations and expirations at each anatomic location for valid interpretation of the sound heard. Repeated deep breaths may result in symptoms of hyperventilation (e.g., lightheadedness); this is avoided by having the patient rest and breathe normally periodically during the examination.

Breath Sounds

Normal breath sounds are distinguished by their location over a specific area of the lung and are identified as vesicular, bronchovesicular, and bronchial (tubular) breath sounds (Table 17-5).

The location, quality, and intensity of breath sounds are determined during auscultation. When airflow is decreased by bronchial obstruction (atelectasis) or when fluid (pleural effusion) or tissue (obesity) separates the air passages from the stethoscope, breath sounds are diminished or absent. For example, the breath sounds of the patient with emphysema are faint or often completely inaudible. When they are heard, the expiratory phase is prolonged. In the patient with obesity, breath sounds may be inaudible. Bronchial and bronchovesicular sounds that are audible anywhere except over the main bronchus in the lungs signify pathology, usually indicating consolidation in the lung (e.g., pneumonia, heart failure). This finding requires further evaluation.

Adventitious Sounds

An abnormal condition that affects the bronchial tree and alveoli may produce adventitious (additional) sounds. Some adventitious sounds are divided into two categories: **crackles,** or nonmusical, discontinuous sounds; and **wheezes,** or continuous musical sounds (Table 17-6). **Rhonchi,** a type of wheezing, are lower-pitched continuous sounds heard over the lungs in partial airway obstruction. Depending on their location and severity, wheezes and rhonchi may be heard with or without a stethoscope. The duration of the sound is the important distinction to make in identifying the sound as discontinuous or continuous. Friction rubs may be either discontinuous or continuous. Stridor is a continuous, high-pitched musical sound which is heard over the neck. This sound is caused by an interruption of airflow and indicates a narrowing of the upper respiratory tract. Stridor warrants emergent attention.

Voice Sounds

The sound heard through the stethoscope as the patient speaks is known as vocal resonance. The nurse should assess voice sounds when abnormal breath sounds are auscultated. The vibrations produced in the larynx are transmitted to the chest wall as they pass through the bronchi and alveolar tissue. Voice sounds are evaluated by having the patient repeat “ninety-nine” or “eee” while the nurse listens with the stethoscope in corresponding areas of the chest from the apices to the bases. With normal physiology, the sounds are faint and indistinct. Pathology that increases lung density, such as pneumonia and

pulmonary edema, alters this normal physiologic response and may result in the following sounds:

- **Bronchophony** describes vocal resonance that is more intense and clearer than normal.
- **Egophony** describes voice sounds that are distorted. It is best appreciated by having the patient repeat the letter E. The distortion produced by consolidation transforms the sound into a clearly heard A rather than E.

TABLE 17-5 Breath Sounds

	Duration of Sounds	Intensity of Expiratory Sound	Pitch of Expiratory Sound	Locations Where Heard Normally
Vesicular*	Inspiratory sounds last longer than expiratory ones.	Soft	Relatively low	Entire lung field except over the upper sternum and between the scapulae
Bronchovesicular	Inspiratory and expiratory sounds are about equal.	Intermediate	Intermediate	Often in the first and second interspaces anteriorly and between the scapulae (over the main bronchus)
Bronchial	Expiratory sounds last longer than inspiratory ones.	Loud	Relatively high	Over the manubrium, if heard at all
Tracheal	Inspiratory and expiratory sounds are about equal.	Very loud	Relatively high	Over the trachea in the neck

*The thickness of the bars indicates intensity of breath sounds. The steeper their incline, the higher the pitch of the sounds.
Adapted from Hogan-Quigley, B., Palm, M. L., & Buckley, L. (2017). *Bates' nursing guide to physical examination and history taking* (2nd ed.). Philadelphia, PA: Wolters Kluwer Health Lippincott Williams & Wilkins.

TABLE 17-6 Abnormal (Adventitious) Breath Sounds

Breath Sound	Description	Etiology
Crackles		
Crackles in general	Nonmusical, discontinuous popping sounds that occur during inspiration (while usually heard on inspiration, they may also be heard on expiration); may or may not be cleared by coughing	Secondary to fluid in the airways or alveoli or to delayed opening of collapsed alveoli during inspiration Associated with heart failure and pulmonary fibrosis
Coarse crackles	Discontinuous popping sounds heard in early inspiration and throughout expiration; harsh, moist sound originating in the large bronchi; can be heard over any lung region; do not vary with body position	Associated with obstructive pulmonary disease
Fine crackles	Soft, high-pitched, discontinuous popping sounds heard in mid to late inspiration; sounds like hair rubbing together; originates in the alveoli, especially in dependent areas; may vary with body position	Associated with interstitial pneumonia, restrictive pulmonary disease (e.g., fibrosis); fine crackles in early inspiration are associated with bronchitis or pneumonia
Wheezes		
Wheezes in general	Continuous, musical, high-pitched, shrill sound usually heard on expiration but may be heard on inspiration depending on the cause	Associated with bronchial wall oscillation and narrowed airway diameter or partially obstructed airway Associated with chronic bronchitis or bronchiectasis
Rhonchi	Deep, lower-pitched rumbling sounds, snoring quality, heard primarily during expiration; may clear with coughing	Associated with secretions or tumor; variant of a wheeze; caused by air moving through narrowed tracheobronchial passages
Friction Rubs		
Pleural friction rub	Discontinuous, low-pitched, rubbing or grating sound, like two pieces of leather being rubbed together (sound imitated by rubbing thumb and finger together near the ear) Heard during inspiration and expiration May subside when patient holds breath; coughing will not clear sound Best heard in axillae and bases of lungs	Secondary to inflammation and loss of lubricating pleural fluid between the visceral and parietal pleurae
Other Breath Sounds		
Stridor	Continuous, high-pitched, musical sound, heard over the neck	Narrowing of the upper respiratory tract; immediate

intervention is warranted

Adapted from Hogan-Quigley, B., Palm, M. L., & Bickley, L. (2017). *Bates' nursing guide to physical examination and history taking* (2nd ed.). Philadelphia, PA: Wolters Kluwer Health Lippincott Williams & Wilkins.

- **Whispered pectoriloquy** describes the ability to clearly and distinctly hear whispered sounds that should not normally be heard.

Whenever an abnormality is detected on examination, it should be evident using more than one assessment method. A change in tactile fremitus is more subtle and can be missed, but bronchophony can be noted loudly and clearly.

Interpreting Findings

The physical findings for the most common respiratory diseases are summarized in Table 17-7.

Assessment of Respiratory Function in the Patient Who Is Acutely or Critically Ill

Assessment of respiratory status is essential for the well-being of the patient who is acutely or critically ill. Often, such a patient is intubated and receiving mechanical ventilation. The nurse analyzes findings from the health history and assessment while considering laboratory and diagnostic test results. After checking the ventilator settings to make sure that they are set as prescribed and that alarms are always in the "on" position, the nurse must assess for patient–ventilator synchrony and for agitation, restlessness, and other signs of respiratory distress (nasal flaring, excessive use of intercostals and accessory muscles, uncoordinated movement of the chest and abdomen, and a report by the patient of shortness of breath). The nurse must note changes in the patient's vital signs and evidence of hemodynamic instability and report them to the primary provider, because they may indicate that the mechanical ventilation is ineffective or that the patient's status has deteriorated. It is important for the nurse to position the patient to promote adequate oxygenation and ventilation and to prevent potential complications. For example, the patient may need to be positioned with the head of bed elevated to prevent aspiration, especially if the patient is receiving enteral feedings. Alternatively, in patients with ARDS who are experiencing refractory hypoxemia, prone positioning is recommended (see Chapter 19). In addition, the patient's mental status should be assessed and compared to previous status. Lethargy and somnolence may be signs of increasing carbon dioxide levels and should not be considered insignificant, even if the patient is receiving sedation or analgesic agents.

Chest auscultation, percussion, and palpation are essential and routine parts of the evaluation of the patient who is critically ill, with or without mechanical

ventilation. A recumbent patient must be turned to assess all lung fields. Dependent areas must be assessed for normal breath sounds and adventitious sounds. Failure to examine the dependent areas of the lungs can result in missing the findings associated with disorders such as atelectasis or pleural effusion.

TABLE 17-7 Assessment Findings in Common Respiratory Disorders

This table lists the typical changes seen in respiratory disorders. The changes described vary with the extent and severity of the disorder. Use the table for the direction of typical changes, not for absolute distinctions.

Condition	Percussion Note	Trachea	Breath Sounds	Adventitious Sounds	Tactile Fremitus and Transmitted Voice Sounds
Normal The tracheobronchial tree and alveoli are open; pleurae are thin and close together; mobility of the chest wall is unimpaired.	Resonant	Midline	Vesicular, except perhaps bronchovesicular and bronchial sounds over the large bronchi and trachea, respectively	None, except perhaps a few transient inspiratory crackles at the bases of the lungs	Normal
Chronic Bronchitis The bronchi are chronically inflamed and a productive cough is present. Airway obstruction may develop.	Resonant	Midline	Vesicular (normal)	Noisy or scattered coarse crackles in early inspiration and perhaps expiration; or wheezes or rhonchi	Normal
Left-Sided Heart Failure (Early) Increased pressure in the pulmonary veins causes congestion and interstitial edema (around the alveoli); bronchial mucosa may become edematous.	Resonant	Midline	Vesicular	Late inspiratory crackles in the dependent portions of the lungs; possibly wheezes	Normal
Lobar Pneumonia Alveoli fill with fluid or blood cells, as in pneumonia, pulmonary edema, or pulmonary hemorrhage.	Dull over the airless area	Midline	Bronchial over the involved area	Late inspiratory crackles over the involved area	Increased over the involved area, with bronchophony, egophony, and whispered pectoriloquy
Partial Lobar Obstruction Atelectasis: When a plug in a main stem bronchus (as from mucus or a foreign object) obstructs bronchial airflow, affected alveoli collapse and become airless.	Dull over the airless area	May be shifted toward involved side	Usually absent when bronchial plug persists. Exceptions include right upper lobe atelectasis, where adjacent tracheal sounds may be transmitted.	None	Usually absent when the bronchial plug persists. In exceptions (e.g., right upper lobe atelectasis) may be increased
Pleural Effusion Fluid accumulates in the pleural space and separates air-filled lung from the chest wall, blocking the transmission breath sounds.	Dull to flat over the fluid	Shifted toward the unaffected side in a large effusion	Decreased to absent, but bronchial breath sounds may be heard near top of large effusion	None, except a possible pleural rub	Decreased to absent, but may be increased toward the top of a large effusion
Pneumothorax When air leaks into the pleural space, usually unilaterally, the lung recoils away from the chest wall. Pleural air blocks transmission of sound.	Hyperresonant or tympanitic over the pleural air	Shifted toward the unaffected side if tension pneumothorax	Decreased to absent over the pleural air	None, except a possible pleural rub	Decreased to absent over the pleural air
Chronic Obstructive Pulmonary Disease (COPD) Slowly progressive disorder in which the distal airspaces enlarge and lungs become hyperinflated. Chronic inflammation may precede or follow the development of COPD.	Diffusely hyperresonant	Midline	Decreased to absent with delayed expiration	None, or the crackles, wheezes, and rhonchi of associated chronic bronchitis	Decreased
Asthma Widespread usually reversible airflow obstruction with bronchial hyperresponsiveness and underlying inflammation. During attacks, as air flow decreases lungs hyperinflate.	Resonant to diffusely hyperresonant	Midline	Often obscured by wheezes	Wheezes, possibly crackles	Decreased

Reprinted with permission from Hogan-Quigley, B., Palm, M. L., & Buckley, L. (2017). *Bates' nursing guide to physical examination and history taking* table (2nd ed., Table 13-8). Philadelphia, PA: Wolters Kluwer.

Tests of the patient's respiratory status are easily performed at the bedside by measuring the respiratory rate, end-tidal carbon dioxide ($ETCO_2$), tidal volume, minute ventilation, vital capacity, inspiratory force, and compliance. These tests are particularly important for patients who are at risk for pulmonary complications, including those who have undergone chest or abdominal surgery, have had prolonged anesthesia, or have preexisting pulmonary disease, and those who are older or have obesity. These tests are also used routinely for patients who are mechanically ventilated. Although some of these tests are performed by respiratory therapists, it is useful for nurses to understand the significance of these test results.

The patient whose chest expansion is limited by external restrictions such as obesity or abdominal distention, or who cannot breathe deeply because of postoperative pain, sedation, or drug overdose will inhale and exhale a low volume of air (referred to as low tidal volumes). Prolonged hypoventilation at low tidal volumes can produce alveolar collapse (atelectasis). Consequently, when the forced residual capacity decreases, compliance is reduced, and the patient must breathe faster to maintain the same degree of tissue oxygenation. These events can be exaggerated in patients who have preexisting pulmonary diseases; in older adult patients whose airways are less compliant because the small airways may collapse during expiration; or in patients with obesity or who have relatively low tidal volumes even when healthy. (More details of the assessment of the patient with various lung disorders are described in subsequent chapters in this unit.)

Quality and Safety Nursing Alert

The nurse should not rely only on visual inspection of the rate and depth of a patient's respiratory excursions to determine the adequacy of ventilation. Respiratory excursions may appear normal or exaggerated due to an increased work of breathing, but the patient may actually be moving only enough air to ventilate the dead space. If there is any question regarding adequacy of ventilation, the nurse should use auscultation or pulse oximetry (or both) for additional assessment of respiratory status.

Tidal Volume

The volume of each breath is referred to as the **tidal volume** (see Table 17-1 to review lung capacities and volumes). A spirometer is an instrument that can be used at the bedside to measure volumes. If the patient is breathing through an endotracheal (ET) tube or tracheostomy, the spirometer is directly attached to it and the exhaled volume is obtained from the reading on the gauge. In other

patients, the spirometer is attached to a facemask or a mouthpiece positioned so that it is airtight, and the exhaled volume is measured.

The tidal volume may vary from breath to breath. To ensure that the measurement is reliable, it is important to measure the volumes of several breaths and to note the range of tidal volumes, together with the average tidal volume.

Minute Ventilation

Because respiratory rates and tidal volumes vary widely from breath to breath, these data alone are unreliable indicators of adequate ventilation. However, the tidal volume multiplied by the respiratory rate provides what is called *minute ventilation* or *minute volume,* the volume of air exchanged per minute. This value is useful in detecting respiratory failure. In practice, the minute volume is not calculated but is measured directly using a spirometer. In a patient receiving mechanical ventilation, minute volume is often monitored by the ventilator and can be viewed on the monitoring screen.

Minute ventilation may be decreased by a variety of conditions that result in hypoventilation. When the minute ventilation falls, alveolar ventilation in the lungs also decreases and the $PaCO_2$ increases.

Vital Capacity

Vital capacity is measured by having the patient take in a maximal breath and exhale fully through a spirometer. The normal value depends on the patient's age, gender, body build, and weight.

Quality and Safety Nursing Alert

Most patients can generate a vital capacity twice the volume they normally breathe in and out (tidal volume). If the vital capacity is less than 10 mL/kg, the patient will be unable to sustain spontaneous ventilation and will require respiratory assistance.

When the vital capacity is exhaled at a maximal flow rate, the forced vital capacity (FVC) is measured. Most patients can exhale at least 80% of their vital capacity in 1 second (forced expiratory volume in 1 second, or FEV_1) and almost all of it in 3 seconds (FEV_3). A reduction in FEV_1 suggests abnormal pulmonary airflow. If the patient's FEV_1 and FVC are proportionately reduced, maximal lung expansion is restricted in some way. If the reduction in FEV_1 greatly exceeds the reduction in FVC (FEV_1/FVC less than 85%), the patient may have some degree of airway obstruction.

Inspiratory Force

Inspiratory force evaluates the effort the patient is making during inspiration. It does not require patient cooperation and, therefore, is a useful measurement in the patient who is unconscious. The equipment needed for this measurement includes a manometer that measures negative pressure and adapters that are connected to an anesthesia mask or a cuffed ET tube. The manometer is attached, and the airway is completely occluded for 10 to 20 seconds while the inspiratory efforts of the patient are registered on the manometer. The normal inspiratory pressure is about 100 cm H_2O. If the negative pressure registered after 15 seconds of occluding the airway is less than about 25 cm H_2O, mechanical ventilation is usually required because the patient lacks sufficient muscle strength for deep breathing or effective coughing.

Diagnostic Evaluation

A wide range of diagnostic studies may be performed in patients with respiratory conditions. The nurse should educate the patient on the purpose of the studies, what to expect, and any possible side effects related to these examinations prior to testing. The nurse should note trends in results because they provide information about disease progression as well as the patient's response to therapy.

Pulmonary Function Tests

Pulmonary function tests (PFTs) are routinely used in patients with chronic respiratory disorders to aid diagnosis. They are performed to assess respiratory function and to determine the extent of dysfunction, response to therapy, and as screening tests in potentially hazardous industries, such as coal mining and those that involve exposure to asbestos and other noxious irritants. PFTs are also used prior to surgery to screen patients who are scheduled for thoracic and upper abdominal surgical procedures, patients who are obese, and symptomatic patients with a history suggesting high risk. Such tests include measurements of lung volumes, ventilatory function, and the mechanics of breathing, diffusion, and gas exchange.

PFTs generally are performed by a respiratory therapist using a spirometer that has a volume-collecting device attached to a recorder that demonstrates volume and time simultaneously. Several tests are carried out because no single measurement provides a complete picture of pulmonary function. The most frequently used PFTs are described in Table 17-8. Technology is available that allows for more complex assessment of pulmonary function. Methods include exercise tidal flow–volume loops, negative expiratory pressure, nitric oxide, forced oscillation, and diffusing capacity for helium or

carbon monoxide. These assessment methods allow for detailed evaluation of expiratory flow limitations and airway inflammation (Pagana, Pagana, & Pagana, 2017).

PFT results are interpreted on the basis of the degree of deviation from normal, taking into consideration the patient's height, weight, age, gender, and ethnicity. Because there is a wide range of normal values, PFTs may not detect early localized changes. The patient with respiratory symptoms usually undergoes a complete diagnostic evaluation, even if the results of PFTs are "normal." Patients with respiratory disorders may be taught how to measure their peak flow rate (which reflects maximal expiratory flow) at home using a spirometer. This allows them to monitor the progress of therapy, to alter medications and other interventions as needed on the basis of caregiver guidelines, and to notify the primary provider if there is inadequate response to their own interventions. (Instructions for home care education are described in Chapter 20, which discusses asthma.)

TABLE 17-8 Pulmonary Function Tests

Term Used	Symbol	Description	Remarks
Forced vital capacity	FVC	Vital capacity performed with a maximally forced expiratory effort	Forced vital capacity is often reduced in chronic obstructive pulmonary disease because of air trapping
Forced expiratory volume (qualified by subscript indicating the time interval in seconds)	FEV_t (usually FEV_1)	Volume of air exhaled in the specified time during the performance of forced vital capacity; FEV_1 is volume exhaled in 1 s	A valuable clue to the severity of the expiratory airway obstruction
Ratio of timed forced expiratory volume to forced vital capacity	FEV_t/FVC%, usually FEV_1/FVC%	FEV_t expressed as a percentage of the forced vital capacity	Another way of expressing the presence or absence of airway obstruction
Forced expiratory flow	$FEF_{200–1200}$	Mean forced expiratory flow between 200 and 1200 mL of the FVC	An indicator of large airway obstruction
Forced midexpiratory flow	$FEF_{25–75\%}$	Mean forced expiratory flow during the middle half of the FVC	Slowed in small airway obstruction
Forced end-expiratory flow	$FEF_{75–85\%}$	Mean forced expiratory flow during the terminal portion of the FVC	Slowed in obstruction of smallest airways
Maximal voluntary ventilation	MVV	Volume of air expired in a specified period (12 s) during repetitive maximal effort	An important factor in exercise tolerance

Adapted from Fishbach, F. T., & Fishbach, M. A. (2018). *Fishbach's a manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Arterial Blood Gas Studies

Arterial blood gas (ABG) studies aid in assessing the ability of the lungs to provide adequate oxygen and remove carbon dioxide, which reflects ventilation, and the ability of the kidneys to reabsorb or excrete bicarbonate ions to maintain normal body pH, which reflects metabolic states. ABG levels are obtained through an arterial puncture at the radial, brachial, or femoral artery or through an indwelling arterial catheter. Pain (related to nerve injury or noxious stimulation), infection, hematoma, and hemorrhage are potential

complications that may be associated with obtaining ABGs (Pagana et al., 2017) (see Chapter 10 for discussion of ABG analysis).

Venous Blood Gas Studies

Venous blood gas (VBG) studies provide additional data on oxygen delivery and consumption. VBG levels reflect the balance between the amount of oxygen used by tissues and organs and the amount of oxygen returning to the right side of the heart in the blood. VBG levels can be obtained by drawing blood from the venous circulation; this test is performed to provide an estimation of this balance when the ability to draw ABGs is not feasible. Mixed venous oxygen saturation ($S\overline{v}O_2$) levels, the most accurate indicator of this balance, can be obtained only from blood samples drawn from a pulmonary artery catheter. However, central venous oxygen saturation ($Sc\overline{v}O_2$) levels, which are measured using blood drawn from a central venous catheter placed in the superior vena cava, closely approximate $S\overline{v}O_2$ levels and are, therefore, useful as an alternative measure in patients without pulmonary artery catheters (Morton, Reck, & Headly, 2018).

Pulse Oximetry

Pulse oximetry, or SpO_2, is a noninvasive method of continuously monitoring the oxygen saturation of hemoglobin (SaO_2). Although pulse oximetry does not replace blood gas analysis, it is an effective tool to monitor for changes in SaO_2 and can easily be used in the home and various health care settings.

A probe or sensor is attached to the fingertip (Fig. 17-13), forehead, earlobe, or bridge of the nose. The sensor detects changes in oxygen saturation levels by monitoring light signals generated by the oximeter and reflected by blood pulsing through the tissue at the probe. Normal SpO_2 values are more than 95%. Values less than 90% indicate that the tissues are not receiving enough oxygen, in which case further evaluation is needed. Advantages of pulse oximetry include the ability to obtain rapid results and continuous data using a noninvasive technique. Limitations of pulse oximetry include its inability to detect significant hyperoxemia (excess levels of oxygen), and to measure PaO_2 and ventilation. In order to ensure accurate readings, the nurse should verify correct placement of the probe and decrease or eliminate excess motion (e.g., from patient shivering or movement of the extremity). Readings are unreliable in settings of hypothermia, hemodynamic instability, or low perfusion states (e.g., shock, vasoconstriction, or decreased perfusion of the limb), and when a patient has dark skin or is wearing nail polish. In these situations, analysis of ABGs should be conducted, and when hyperoxemia is suspected, analysis of PaO_2 or $PaCO_2$ is required (Mechem, 2019).

Figure 17-13 • Measuring blood oxygenation with pulse oximetry reduces the need for invasive procedures, such as drawing blood for analysis of oxygen levels. **A.** Self-contained digital fingertip pulse oximeter, which incorporates the sensor and the display into one

unit. **B.** Tabletop model with sensor attached. Memory permits tracking heart rate and oxygen saturation over time.

End-Tidal Carbon Dioxide

End-tidal carbon dioxide ($ETCO_2$) monitoring is a noninvasive method of monitoring partial pressure of carbon dioxide (CO_2) at end exhalation. $ETCO_2$ monitoring is considered to be a reliable tool for detecting and monitoring life-threatening conditions because it provides immediate information about ventilation, perfusion, and metabolism by determining the concentration of CO_2. Changes in $ETCO_2$ and the concentration of CO_2 at the end of each breath can help to diagnose or indicate the severity of a disease or the outcome of a treatment. It is now part of the standard of care for all patients receiving general anesthesia, procedural sedation and/or analgesia, and is frequently part of routine monitoring in the prehospital and acute care settings (Krauss, Falk, & Ladde, 2018).

The application of $ETCO_2$ monitoring can indicate early respiratory depression and impaired airway function sooner than other devices, helping nurses to detect potential complications earlier (Aminiahidashti, Shafiee, Kiasari, et al., 2018). Data are reported as a number (capnometry) or as a number and a waveform (capnography). Capnography uses infrared technology to obtain results and monitors four phases of the respiratory cycle to depict the CO_2 concentrations of each phase.

A capnometry device, such as the colorimetric $ETCO_2$ detector, is a portable device which contains litmus paper that changes color when exposed to CO_2. An improper ET intubation, for instance with esophageal intubation, will not result in CO_2 exchange and thus the color of the litmus paper will not change (Krauss et al., 2018). $ETCO_2$ monitoring is the most reliable indicator that an ET tube is placed in the trachea during intubation (Krauss et al., 2018). Some additional indications for $ETCO_2$ monitoring include continuous monitoring of ET tube placement during patient transport, confirming return of spontaneous circulation with cardiopulmonary resuscitation, determining a prognosis in patients with trauma, and as an early indicator of respiratory compromise (Aminiahidashti et al., 2018; Krauss et al., 2018; Smallwood & Walsh, 2017). The clinician should use caution when interpreting results in patients who are mechanically ventilated with a bag or mask ventilation device, or who have received sodium bicarbonate, or who have ingested carbonated beverages or antacids, as any of these can result in false-positive results (Aminiahidashti et al., 2018).

Cultures

Throat, nasal, and nasopharyngeal cultures can identify pathogens responsible for respiratory infections, such as pharyngitis. Throat cultures are performed in adults with severe or ongoing sore throats accompanied by fever and lymph node enlargement and are most useful in detecting streptococcal infection. Rapid strep tests are now available that can provide results within 15 minutes, often replacing the need for throat cultures. Other sources of infection, such as *Staphylococcus aureus* or *Influenza,* are detected via nasal or nasopharyngeal cultures. Ideally, all cultures should be obtained prior to the initiation of antibiotic therapy. Results usually take between 48 and 72 hours, with preliminary reports available usually within 24 hours. Cultures may be repeated to assess a patient's response to therapy (Pagana et al., 2017).

Sputum Studies

Sputum is obtained for analysis to identify pathogenic organisms and to determine whether malignant cells are present. Periodic sputum examinations may be necessary for patients receiving antibiotics, corticosteroids, and immunosuppressive medications for prolonged periods because these agents are associated with opportunistic infections.

Sputum samples ideally are obtained early in the morning before the patient has had anything to eat or drink. The patient is instructed to clear the nose and the throat and rinse the mouth to decrease contamination of the sputum and not to simply spit saliva into the container. Rather, after taking a few deep breaths, the patient coughs deeply and expectorates sputum from the lungs into a sterile container.

If the patient cannot expel an adequate sputum sample following the above techniques, coughing can be induced by administering an aerosolized hypertonic solution via a nebulizer. Other methods of collecting sputum specimens include endotracheal or transtracheal aspiration or bronchoscopic removal. The nurse should label the specimen and send it to the laboratory as soon as possible to avoid contamination.

Imaging Studies

Imaging studies, including x-rays, computed tomography (CT), magnetic resonance imaging (MRI), and radioisotope or nuclear scanning may be part of any diagnostic workup, ranging from a determination of the extent of infection in sinusitis to tumor growth in cancer.

Chest X-Ray

Normal pulmonary tissue is radiolucent because it consists mostly of air and gases; therefore, densities produced by fluid, tumors, foreign bodies, and other pathologic conditions can be detected by x-ray examination. In the absence of

symptoms, a chest x-ray may reveal an extensive pathologic process in the lungs. The routine chest x-ray consists of two views: the posteroanterior projection and the lateral projection. Chest x-rays are usually obtained after full inspiration because the lungs are best visualized when they are well aerated. In addition, the diaphragm is at its lowest level and the largest expanse of lung is visible. Patients, therefore, need to be able to take a deep breath and hold it without discomfort. Chest x-rays are contraindicated in pregnant women.

Nursing Interventions

The nurse should notify the patient that chest x-rays do not require fasting, nor typically cause pain. However, in order to best visualize the lungs, the patient must be able to take a deep breath and hold it without discomfort, while the technician takes the images. The patient will be positioned in a standing, sitting, or recumbent position, in order to obtain the appropriate view of the chest (posterior–anterior, lateral, oblique, or decubitus position). The patient will be asked to wear a gown, remove metal objects from the chest, such as necklaces, and may be given a lead shield to minimize radiation exposure to the thyroid gland, ovaries, or testicles (Pagana et al., 2017).

Computed Tomography

A CT of the chest is an imaging method in which the lungs, mediastinum, and vascular structures within the chest are scanned in successive layers by a narrow-beam x-ray. The images produced provide a cross-sectional view of the chest. Whereas a chest x-ray shows major contrasts between body densities such as bone, soft tissue, and air, a CT scan can distinguish fine tissue density. A CT scan may be used to define pulmonary nodules and small tumors adjacent to pleural surfaces that are not visible on routine chest x-rays and to demonstrate mediastinal abnormalities and hilar adenopathy, which are difficult to visualize with other techniques. Contrast agents are useful when evaluating the mediastinum and its contents, particularly its vasculature. CT with contrast agent is not suitable for patients with compromised kidney function, or those with an allergy to iodine dye or shellfish, or who are pregnant, claustrophobic, or have severe obesity. Patients taking metformin should withhold the dose the day of the test in order to prevent lactic acidosis from developing (Pagana et al., 2017; Thompson & Kabrhel, 2018).

Advancements in CT scanning technology, referred to as multidetection, spiral, or helical CT, enable the chest to be scanned quickly while generating an extensive number of images that can generate a three-dimensional analysis (Pagana et al., 2017).

Nursing Interventions

The nurse should inform patients preparing for CT scans that they will be required to remain supine and still for a short period, typically less than 30 minutes, while a body scanner surrounds them and takes multiple images. Patients typically do not experience claustrophobia during CT scanning but can be given antianxiety medications preprocedure if this is a concern. If contrast agent is required, patients will need to stay *nil per os* (NPO) for 4 hours prior to the examination. In this case, the nurse should also assess for allergies to iodine or shellfish (Pagana et al., 2017). Vital signs should be monitored and documented before, during, and after the scan especially if sedation or analgesia is administered.

Pulmonary Angiography

Pulmonary angiography is used to investigate congenital abnormalities of the pulmonary vascular tree, and less frequently PE, when less invasive tests are inconclusive. This study has primarily been replaced by CT scan of the chest. To visualize the pulmonary vessels, a radiopaque agent is injected through a catheter, which has been initially inserted into a vein (e.g., jugular, subclavian, brachial, or femoral vein) and then threaded into the pulmonary artery. Contraindications include allergy to the radiopaque agent, pregnancy, and bleeding abnormalities, whereas potential complications include acute kidney injury, acidosis, cardiac arrhythmias, and bleeding (Pagana et al., 2017).

CT pulmonary angiography (CTPA) combines pulmonary angiography and CT scan imaging. CTPA images the pulmonary arteries and is used primarily if treatment is required for a PE. This procedure typically takes no longer than 30 minutes to complete (Pagana et al., 2017). The patient lies in a supine position on an x-ray table. A catheter is placed in the femoral vein, advanced into the inferior vena cava and into the pulmonary artery. Contrast agent and fluoroscopy are utilized for visualization of the pulmonary vasculature when CTPA is performed. The same contraindications for CT with contrast agent apply to CTPA (Pagana et al., 2017; Thompson & Kabrhel, 2018).

Nursing Interventions

Prior to the angiography, the nurse should verify that informed consent has been obtained; assess for known allergies that may suggest allergies to radiopaque agent (e.g., iodine and shellfish); assess anticoagulation status and renal function; ensure that the patient has not eaten or had anything to drink preprocedurally as prescribed (normally for 4 hours); and administer preprocedure medications that may include antianxiety medications, secretion-reducing agents, and antihistamines (Pagana et al., 2017). The nurse should instruct patients that they may experience a warm flushing sensation or chest pain during the injection of the dye. If an arterial puncture is necessary, the affected extremity will need to be immobilized for a certain amount of time depending on the size of the sheath used and the type of arterial closure device

employed. Introduction of the catheter into the right ventricle may trigger ventricular irritability. Therefore, during and after the procedure, the patient should be monitored for cardiac arrhythmias such as premature ventricular contractions (PVCs). Following the procedure, the nurse should closely monitor vital signs, level of consciousness, oxygen saturation, and the vascular access site for bleeding or hematoma, and perform frequent assessment of neurovascular status. It may be indicated to apply cold compresses to the puncture site to decrease swelling (Pagana et al., 2017).

Magnetic Resonance Imaging

MRI is similar to a CT scan except that magnetic fields and radiofrequency signals are used instead of radiation. MRI is able to better distinguish between normal and abnormal tissues than CT and, therefore, yields a much more detailed diagnostic image. MRI is used to characterize pulmonary nodules; to help stage bronchogenic carcinoma (assessment of chest wall invasion); and to evaluate inflammatory activity in interstitial lung disease, acute PE, and chronic thrombolytic pulmonary hypertension. Contraindications for MRI include severe obesity, claustrophobia, confusion and agitation, and having implanted metal or metal support devices that are considered unsafe (Pagana et al., 2017). Various labels and icons are used to indicate whether a medical device is safe or unsafe for use during MRI. Recent improvements in technology have contributed to the design of certain medical devices, such as infusion pumps and ventilators, deemed safe for the MRI room. The nurse should consult with specially trained MRI personnel to clarify the safety of various devices (Wells & Murphy, 2014). Gadolinium-based contrast agents used during MRI may potentially lead to nephrogenic systemic fibrosis in patients with reduced kidney function. Therefore, additional kidney function testing may be necessary, especially in adults older than 60 years of age (Pagana et al., 2017).

Nursing Interventions

Patients scheduled for MRI should be instructed to remove all metal items such as hearing aids, hair clips, and medication patches with metallic foil components (e.g., nicotine patches). Prior to the MRI, the nurse should assess for the presence of implanted metal devices, such as aneurysm clips or a cardiac implantable electronic device. Patients with any type of cardiac implantable electronic device need to be screened to determine if they can safely undergo MRI (Indik, Gimbel, Abe, et al., 2017).

The nurse should inform patients preparing for MRI that they will need to lie flat and remain still for between 30 and 90 minutes, while the table that they are on moves into a large tubular magnet. Patients should be notified that they will hear a loud humming or thumping noise. Earplugs are typically offered to patients to minimize this noise. Patients will be able to communicate

with the MRI staff via a microphone and earphones. The nurse should clarify with the primary provider or the technologist if the prescribed test requires the use of a contrast agent or if the patient should remain NPO pre-examination. Patients who experience claustrophobia should be offered antianxiety medications preprocedure or be scheduled at a facility that uses an open MRI system (Pagana et al., 2017).

Fluoroscopic Studies

Fluoroscopy, which allows live x-ray images to be generated via a camera to a video screen, is used to assist with invasive procedures, such as a chest needle biopsy or transbronchial biopsy, that are performed to identify lesions. It also may be used to study the movement of the chest wall, mediastinum, heart, and diaphragm; to detect diaphragm paralysis; and to locate lung masses. The specific procedure performed under fluoroscopy will guide those respective nursing interventions (e.g., see nursing interventions described in the Lung Biopsy Procedures section).

Radioisotope Diagnostic Procedures (Lung Scans)

Several types of lung scans—V./Q. scan, gallium scan, and positron emission tomography (PET)—are performed to assess normal lung functioning, pulmonary vascular supply, and gas exchange. Pregnancy is a contraindication for these scans.

A V./Q. lung scan is performed by injecting a radioactive agent into a peripheral vein and then obtaining a scan of the chest to detect radiation. The isotope particles pass through the right side of the heart and are distributed into the lungs in proportion to the regional blood flow, making it possible to trace and measure blood perfusion through the lung. This procedure is used clinically to measure the integrity of the pulmonary vessels relative to blood flow and to evaluate blood flow abnormalities, as seen in PE. The imaging time is 20 to 40 minutes, during which the patient lies under the camera with a mask fitted over the nose and the mouth. This is followed by the ventilation component of the scan. The patient takes a deep breath of a mixture of oxygen and radioactive gas, which diffuses throughout the lungs. A scan is performed to detect ventilation abnormalities in patients who have regional differences in ventilation. It may be helpful in the diagnosis of bronchitis, asthma, inflammatory fibrosis, pneumonia, emphysema, and lung cancer. Ventilation without perfusion is seen with PE.

A gallium scan is a radioisotope lung scan used to detect inflammatory conditions, abscesses, adhesions, and the presence, location, and size of tumors. It is used to stage bronchogenic cancer and to document tumor regression after chemotherapy or radiation. Gallium is injected intravenously,

and scans are obtained at intervals (e.g., 6, 24, and 48 hours) to evaluate gallium uptake by the pulmonary tissues.

PET is a radioisotope study with advanced diagnostic capabilities that is used to evaluate lung nodules for malignancy. PET can detect and display metabolic changes in tissue, distinguish normal tissue from diseased tissue (such as in cancer), differentiate viable from dead or dying tissue, and show regional blood flow. PET is more accurate in detecting malignancies than CT and has equivalent accuracy in detecting malignant nodules when compared with invasive procedures such as thoracoscopy. Images from PET scans are now being superimposed on CT and MRI images to enhance the accuracy of diagnosis (Pagana et al., 2017).

Nursing Interventions

For each of these nuclear scans, the nurse should educate the patient on what to expect. Intravenous access is required. Chest x-ray should be performed prior to a V./Q. scan. Patients should be told that V./Q. and gallium scans require only a small amount of radioisotopes; therefore, radiation safety measures are not indicated. Normally, the patient may eat or drink prior to V./Q. or gallium scans. Multiple factors can hinder the uptake of radioactive agents used for a PET scan. The nurse should instruct the patient to avoid caffeine, alcohol, and tobacco for 24 hours prior to the PET scan and abstain from food and fluids for 4 hours prior to the scan. Accurate results depend on an empty bladder; thus, a Foley catheter may be indicated. The nurse should encourage fluid intake postprocedure to facilitate the elimination of radioisotopes in the urine (Pagana et al., 2017).

Endoscopic Procedures

Endoscopic procedures include bronchoscopy, thoracoscopy, and thoracentesis.

Bronchoscopy

Bronchoscopy is the direct inspection and examination of the larynx, trachea, and bronchi through either a flexible fiberoptic bronchoscope or a rigid bronchoscope (Fig. 17-14). The fiberoptic scope is used more frequently in current practice.

Procedure

The purposes of diagnostic bronchoscopy are (1) to visualize tissues and determine the nature, location, and extent of the pathologic process; (2) to collect secretions for analysis and to obtain a tissue sample for diagnosis; (3) to determine whether a tumor can be resected surgically; and (4) to diagnose sources of hemoptysis.

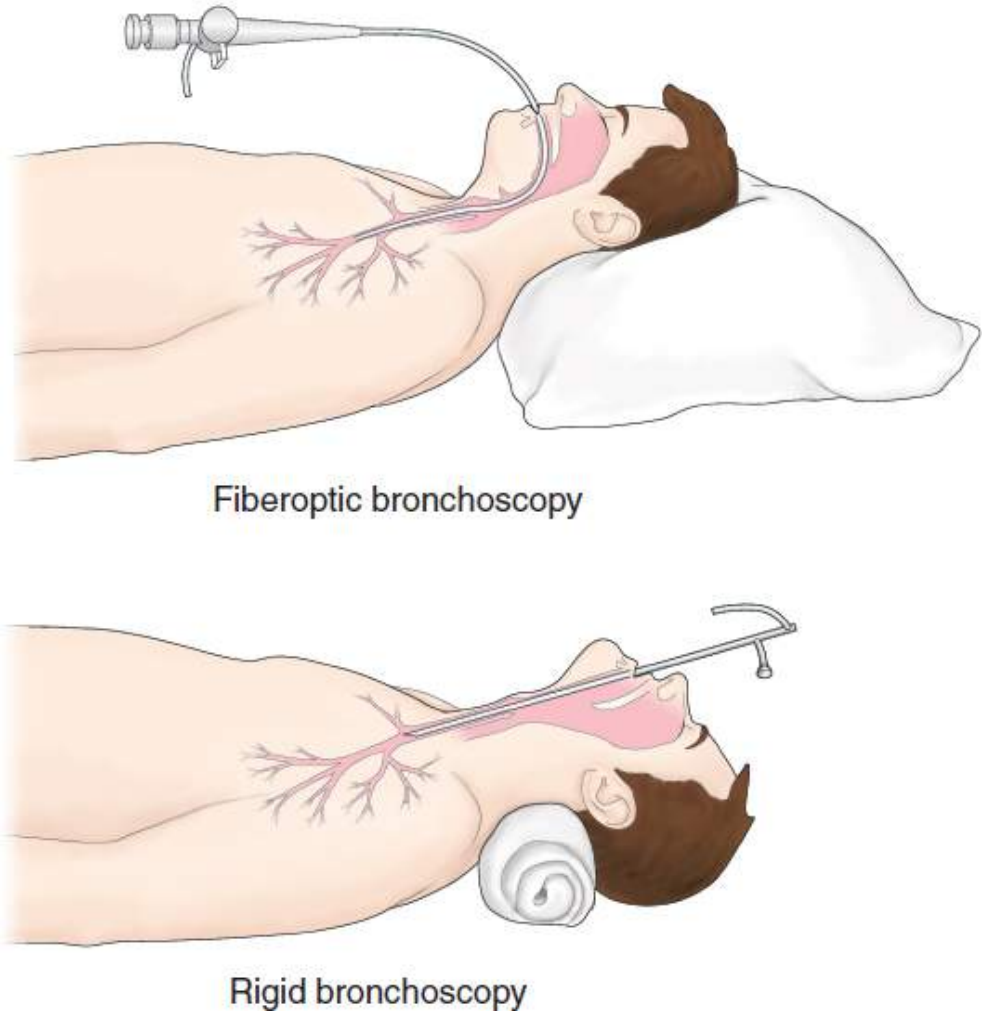


Figure 17-14 • Endoscopic bronchoscopy permits visualization of bronchial structures. The bronchoscope is advanced into bronchial structures orally. Bronchoscopy permits the clinician to not only diagnose but also treat various lung problems.

Therapeutic bronchoscopy is used to (1) remove foreign bodies or secretions from the tracheobronchial tree, (2) control bleeding, (3) treat postoperative atelectasis, (4) destroy and excise lesions, and (5) provide brachytherapy (endobronchial radiation therapy). It has also been used to insert stents to relieve airway obstruction that is caused by tumors or miscellaneous benign conditions or that occurs as a complication of lung transplantation.

The fiberoptic bronchoscope is a thin, flexible bronchoscope that can be directed into the segmental bronchi. Because of its small size, its flexibility, and its excellent optical system, it allows increased visualization of the peripheral airways and is ideal for diagnosing pulmonary lesions. Fiberoptic bronchoscopy allows biopsy of previously inaccessible tumors and can be performed at the bedside. It also can be performed through ET or tracheostomy tubes of patients on ventilators. Cytologic examinations can be performed without surgical intervention.

The rigid bronchoscope is a hollow metal tube with a light at its end. It is used mainly for removing foreign substances, investigating the source of massive hemoptysis, or performing endobronchial surgical procedures. Rigid bronchoscopy is performed in the operating room, not at the bedside.

Possible complications of bronchoscopy include a reaction to the local anesthetic, oversedation, prolonged fever, infection, aspiration, vasovagal response, laryngospasm, bronchospasm, hypoxemia, pneumothorax, and bleeding (Pagana et al., 2017).

Nursing Interventions

Before the procedure, the nurse should verify that informed consent has been obtained. Food and fluids are withheld for 4 to 8 hours before the test to reduce the risk of aspiration when the cough reflex is blocked by anesthesia. The patient must remove dentures and other oral prostheses. The nurse explains the procedure to the patient to reduce fear and decrease anxiety and then administers preoperative medications (usually atropine and a sedative or opioid) as prescribed to inhibit vagal stimulation (thereby guarding against bradycardia, arrhythmias, and hypotension), suppress the cough reflex, sedate the patient, and relieve anxiety.

Quality and Safety Nursing Alert

Sedation given to patients with respiratory insufficiency may precipitate respiratory arrest.

The examination is usually performed under local anesthesia or moderate sedation; however, general anesthesia may be used for rigid bronchoscopy. A topical anesthetic such as lidocaine is normally sprayed on the pharynx or dropped on the epiglottis and vocal cords and into the trachea to suppress the cough reflex and minimize discomfort.

After the procedure, the patient must take nothing by mouth until the cough reflex returns, because the preoperative sedation and local anesthesia impair the protective laryngeal reflex and swallowing. Once the patient demonstrates a cough reflex, the nurse may offer ice chips and eventually fluids. In the older adult patient, the nurse assesses for confusion and lethargy, which may be owing to the large doses of lidocaine given during the procedure. The nurse also monitors the patient's respiratory status and observes for hypoxia, hypotension, tachycardia, arrhythmias, hemoptysis, and dyspnea. Any abnormality is reported promptly. A small amount of blood-tinged sputum and fever may be expected within the first 24 hours (Pagana et al., 2017). The patient is not discharged from the postanesthesia care unit (PACU) until adequate cough reflex and respiratory status are present. The nurse instructs

the patient and caregivers to report any shortness of breath or bleeding immediately.

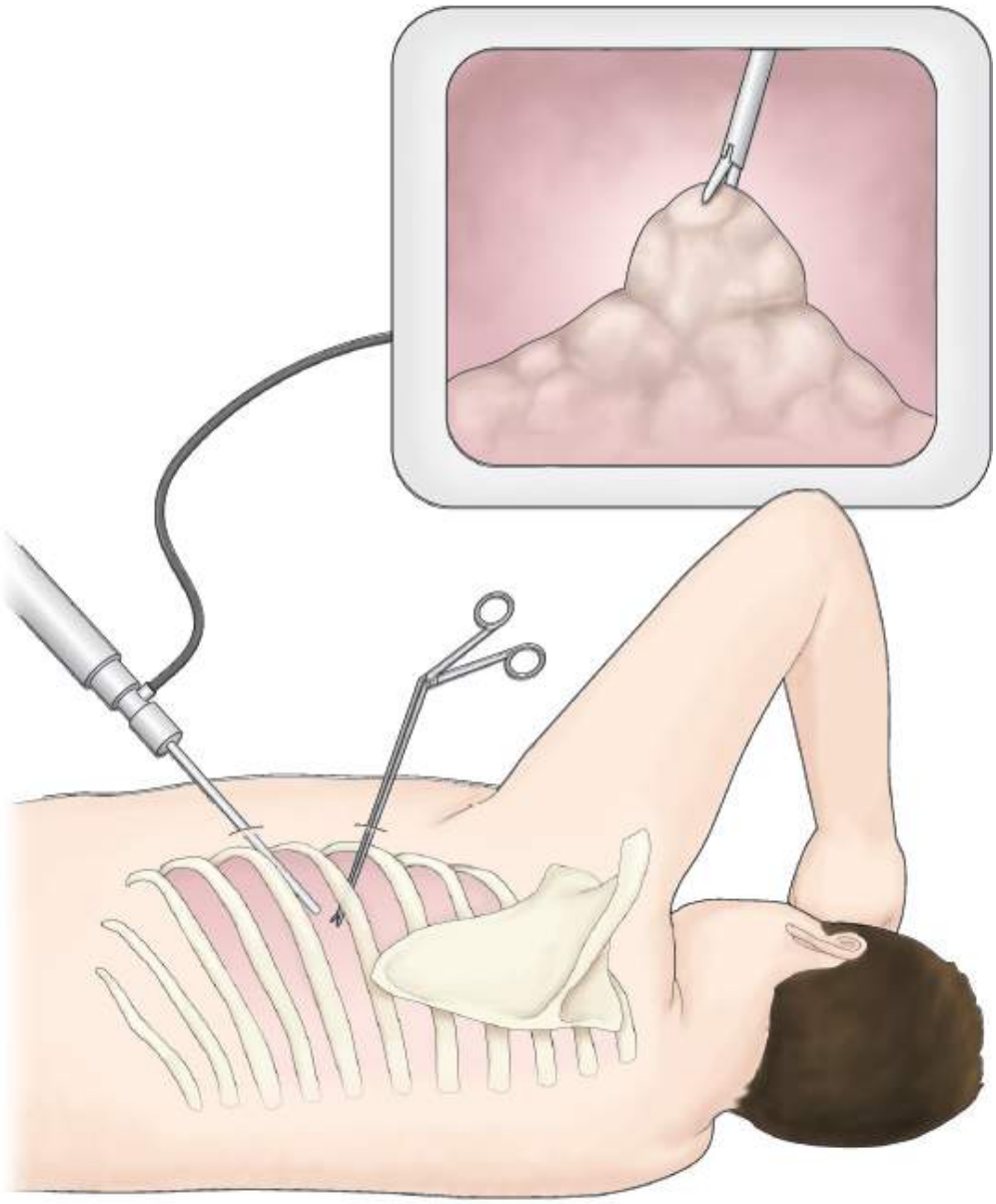


Figure 17-15 • Endoscopic thoracoscopy. Like bronchoscopy, thoracoscopy uses fiberoptic instruments and video cameras for visualizing thoracic structures. Unlike bronchoscopy, thoracoscopy usually requires the surgeon to make a small incision before inserting the endoscope. A combined diagnostic–treatment procedure, thoracoscopy includes excising tissue for biopsy.

Thoracoscopy

Thoracoscopy is a diagnostic procedure in which the pleural cavity is examined with an endoscope and fluid and tissues can be obtained for analysis (Fig. 17-15).

Procedure

This procedure is performed in the operating room, normally under anesthesia. Small incisions are made into the pleural cavity in an intercostal space at the location indicated by clinical and diagnostic findings. The fiberoptic mediastinoscope is inserted into the pleural cavity, any fluid present is aspirated, and the pleural cavity is inspected through the instrument. After the procedure, a chest tube may be inserted to facilitate re-expansion of the lung.

Thoracoscopy is primarily indicated in the diagnostic evaluation and treatment of pleural effusions, pleural disease, and tumor staging. Biopsies of the lesions and resection of tissues can be performed under visualization for diagnosis.

Thoracoscopic procedures have expanded with the availability of video monitoring, which permits improved visualization of the lung. Video-assisted thoracoscopy (VATS) may be used in the diagnosis and treatment of empyema, pleural effusion, pulmonary and pleural masses, and pneumothorax. Although VATS does not replace the need for thoracotomy in the treatment of some lung cancers, its use continues to grow, because it is less invasive than open surgical procedures, and hospitalization and recovery are shorter.

Nursing Interventions

The nurse should follow routine preoperative practices, such as ensuring that informed consent is obtained and that the patient remains NPO prior to the procedure. Postoperatively, the nurse should monitor vital signs, pain level, and respiratory status, and should look for signs of bleeding and infection at the incisional site. Shortness of breath may indicate a pneumothorax and should be reported immediately. If a chest tube was inserted during the procedure, monitoring of the chest drainage system and chest tube insertion site is essential (see Chapter 19).

Thoracentesis

In some respiratory disorders, pleural fluid may accumulate. Thoracentesis (aspiration of fluid and air from the pleural space) is performed for diagnostic or therapeutic reasons. Purposes of the procedure include removal of fluid and, very rarely, air from the pleural cavity; aspiration of pleural fluid for analysis; pleural biopsy; and instillation of medication into the pleural space. Studies of pleural fluid include Gram stain culture and sensitivity, acid-fast staining and culture, differential cell count, cytology, pH, total protein, lactic dehydrogenase, glucose, amylase, triglycerides, and cancer markers such as carcinoembryonic antigen.

For the procedural guidelines for assisting with a thoracentesis, go to thepoint.lww.com/Brunner15e.

Biopsy

Biopsy—the excision of a small amount of tissue—may be performed to permit examination of cells from the upper and lower respiratory structures and adjacent lymph nodes. Local, topical, or moderate sedation, or general anesthesia, may be given, depending on the site and the procedure.

Pleural Biopsy

Pleural biopsy is accomplished by needle biopsy of the pleura, thoracoscopy, or pleuroscopy, a visual exploration through a fiberoptic pleuroscope inserted into the pleural space or through a thoracotomy. Pleural biopsy is performed when there is pleural exudate of undetermined origin or when there is a need to culture or stain the tissue to identify tuberculosis or fungi.

Lung Biopsy Procedures

Lung biopsy is performed to obtain tissue for examination when other diagnostic testing indicates potential interstitial lung disease, such as cancer, infection, or sarcoidosis. Several nonsurgical lung biopsy techniques are used because they yield accurate information with low morbidity: transbronchial brushing or needle aspiration, transbronchial lung biopsy, and percutaneous (through-the-skin) needle biopsy. Possible complications for all methods include pneumothorax, pulmonary hemorrhage, and empyema (Pagana et al., 2017).

Procedure

In transbronchial brushing, a fiberoptic bronchoscope is introduced into the bronchus under fluoroscopy. A small brush attached to the end of a flexible wire is inserted through the bronchoscope. Under direct visualization, the area under suspicion is brushed back and forth, causing cells to slough off and adhere to the brush. The catheter port of the bronchoscope may be used to irrigate the lung tissue with saline solution to secure material for additional studies. The brush is removed from the bronchoscope, and a slide is made for examination under the microscope. The brush may be cut off and sent to the pathology laboratory for analysis. This procedure is especially useful in the immunologically compromised patient.

In transbronchial needle aspiration, a catheter with a needle is inserted into the tissue through the bronchoscope and aspirated, whereas in transbronchial lung biopsy, biting or cutting forceps are introduced by a fiberoptic bronchoscope to excise the tissue.

In percutaneous needle biopsy, a cutting needle or a spinal-type needle is used to obtain a tissue specimen for histologic study under fluoroscopic or CT guidance. Analgesia may be given before the procedure. The skin over the biopsy site is cleansed and anesthetized and a small incision is made. The biopsy needle is inserted through the incision into the pleura with the patient holding their breath in midexpiration. The surgeon guides the needle into the periphery of the lesion and obtains a tissue sample from the mass.

Nursing Interventions

After the procedure, recovery and home care are similar to those for bronchoscopy and thoracoscopy. Nursing care involves monitoring the patient for complications such as shortness of breath, bleeding, or infection. In preparation for discharge, the patient and the family are instructed to report pain, shortness of breath, visible bleeding, redness of the biopsy site, or purulent drainage (pus) to the primary provider immediately. Patients who have undergone biopsy are often anxious because of the need for the biopsy and the potential findings; the nurse must consider this in providing postbiopsy care and patient education.

Lymph Node Biopsy

The scalene lymph nodes, which are enmeshed in the deep cervical pad of fat overlying the scalenus anterior muscle, drain the lungs and mediastinum and may show histologic changes from intrathoracic disease. If these nodes are palpable on physical examination, a scalene node biopsy may be performed. A biopsy of these nodes may be performed to detect spread of pulmonary disease to the lymph nodes and to establish a diagnosis or prognosis in such diseases as Hodgkin lymphoma, sarcoidosis, fungal disease, tuberculosis, and carcinoma.

Procedure

Mediastinoscopy is the endoscopic examination of the mediastinum for exploration and biopsy of mediastinal lymph nodes that drain the lungs; this examination does not require a thoracotomy. Biopsy is usually performed through a suprasternal incision. Mediastinoscopy is carried out to detect mediastinal involvement of pulmonary malignancy and to obtain tissue for diagnostic studies of other conditions (e.g., sarcoidosis).

An anterior mediastinotomy is thought to provide better exposure and diagnostic possibilities than a mediastinoscopy. An incision is made in the area of the second or third costal cartilage. The mediastinum is explored, and

biopsies are performed on any lymph nodes found. Chest tube drainage is required after the procedure. Mediastinotomy is particularly valuable to determine whether a pulmonary lesion is resectable.

Nursing Interventions

Postprocedure care focuses on providing adequate oxygenation, monitoring for bleeding, and providing pain relief. The patient may be discharged a few hours after the chest drainage system is removed. The nurse should instruct the patient and the family about monitoring for changes in respiratory status, taking into consideration the impact of anxiety about the potential findings of the biopsy on their ability to remember those instructions.

CRITICAL THINKING EXERCISES

1 ebp You are caring for an 82-year-old male who was transferred to the medical-surgical unit from the postanesthesia care unit (PACU), status post appendectomy. The patient is currently alert to time, person, and place and his vital signs are as follows: temperature 37.5°C (99.0°F), HR 79 bpm, BP 125/74, RR 16 breaths/min, and SaO_2 96% on oxygen at 2 L/min via nasal cannula. The patient is receiving morphine via patient-controlled analgesia (PCA) for pain management. What changes in his assessment would indicate that he is at risk for developing respiratory depression? What evidence-based scales and diagnostic tests could help you to identify this potential complication?

2 pq A patient with a significant pulmonary history is admitted to the medical unit where you work with complaints of shortness of breath. He reports that he worked in the coal mines for 42 years and smokes cigarettes every day. As part of the history, he tells you, "For the past couple of days, I can't seem to catch my breath." He informs you that he coughs up "yellow stuff" throughout the day and it has been "thicker" than usual. What components of his assessment are most important for you to perform first?

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

American Association for Respiratory Care (AARC), www.aarc.org
American Lung Association, www.lung.org
American Thoracic Society, www.thoracic.org
Centers for Disease Control and Prevention (CDC), www.cdc.gov
Cystic Fibrosis Foundation, www.cff.org
National Heart, Lung, and Blood Institute, National Institutes of Health, www.nhlbi.nih.gov
U.S. Food and Drug Administration, www.fda.gov

18 Management of Patients with Upper Respiratory Tract Disorders

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe nursing management of patients with upper airway disorders and of patients with epistaxis.
2. Compare and contrast the upper respiratory tract infections according to cause, incidence, clinical manifestations, management, and the significance of preventive health care.
3. Use the nursing process as a framework for care of the patient with upper airway infection and the patient undergoing laryngectomy.

NURSING CONCEPTS

Infection
Oxygenation

GLOSSARY

alaryngeal communication: alternative modes of speaking that do not involve the normal larynx; used by patients whose larynx has been surgically removed

aphonia: impaired ability to use one's voice due to disease or injury to the larynx

apnea: cessation of breathing

dysphagia: difficulty swallowing

epistaxis: hemorrhage from the nose due to rupture of tiny, distended vessels in the mucous membrane of any area of the nose

herpes simplex: a cutaneous viral infection with painful vesicles and erosions on the tongue, palate, gingiva, buccal membranes, or lips (*synonym:* cold sore)

laryngectomy: surgical removal of all or part of the larynx and surrounding structures

laryngitis: inflammation of the larynx; may be caused by voice abuse, exposure to irritants, or infectious organisms

nuchal rigidity: stiffness of the neck or inability to bend the neck

pharyngitis: inflammation of the throat

rhinitis: inflammation of the mucous membranes of the nose

rhinitis medicamentosa: rebound nasal congestion commonly associated with overuse of over-the-counter nasal decongestants

rhinorrhea: drainage of a large amount of fluid from the nose

rhinosinusitis: inflammation of the nares and paranasal sinuses, including frontal, ethmoid, maxillary, and sphenoid sinuses; replaces the term *sinusitis*

tonsillitis: inflammation of the tonsils

xerostomia: dryness of the mouth

Upper respiratory tract disorders are those that involve the nose, paranasal sinuses, pharynx, larynx, trachea, or bronchi. Many of these conditions are relatively minor, and their effects are limited to mild and temporary discomfort and inconvenience for the patient. However, others are acute, severe, and life-threatening and may require permanent alterations in breathing and speaking. Therefore, the nurse must have expert assessment skills, an understanding of the wide variety of disorders that may affect the upper airway, and an awareness of the impact of these alterations on patients. Patient education is an important aspect of nursing care because many of these disorders are treated outside the hospital or at home by patients themselves. When caring for patients with acute, life-threatening disorders, the nurse needs highly developed assessment and clinical management skills, along with a focus on rehabilitation needs.

UPPER AIRWAY INFECTIONS

Upper airway infections (otherwise known as upper respiratory infections [URIs]) are the most common cause of illness and affect most people on occasion. Some infections are acute, with symptoms that last several days; others are chronic, with symptoms that may last for weeks or months or recur. A URI is often defined as an infection of the mucous membranes of the nose, sinuses, pharynx, upper trachea, or larynx (Pokorski, 2015).

The common cold is the most frequently occurring example of a URI. URIs occur when microorganisms such as viruses and bacteria are inhaled. There are many causative organisms, and people are susceptible throughout life. Viruses, the most common cause of URIs, affect the upper respiratory passages and lead to subsequent mucous membrane inflammation. URIs are the most common reason for seeking health care and for absences from school and work (Pokorski, 2015).

URIs affect the nasal cavity; ethmoidal air cells; and frontal, maxillary, and sphenoid sinuses; as well as the pharynx, larynx, and upper portion of the trachea. On average, adults typically develop two to four URIs per year because of the wide variety of respiratory viruses that circulate in the community (Weinberger, Cockrill, & Mandel, 2019). Although patients are rarely hospitalized for the treatment of URIs, nurses working in community settings or long-term care facilities may encounter patients who have these infections. It is important for nurses to recognize the signs and symptoms of URIs and provide appropriate care. Nurses in these settings also can influence patient outcomes through patient education. Special considerations with regard to URIs in older adults are summarized in Chart 18-1.

Rhinitis

Rhinitis is a group of disorders characterized by inflammation and irritation of the mucous membranes of the nose. These conditions can have a significant impact on quality of life and contribute to sinus, ear, and sleep problems and learning disorders. Rhinitis often coexists with other respiratory disorders, such as asthma. It affects between 10% and 30% of the population worldwide annually. Viral rhinitis, especially the common cold, affects approximately one billion individuals yearly (Meneghetti, 2018).

Rhinitis may be acute or chronic, and allergic or nonallergic. Allergic rhinitis is further classified as seasonal or perennial rhinitis and is commonly associated with exposure to airborne particles such as dust, dander, or plant pollens in people who are allergic to these substances. Seasonal rhinitis occurs during pollen seasons, and perennial rhinitis occurs throughout the year. See

Chapter 33 for detailed descriptions of allergic disorders, including allergic rhinitis.

Pathophysiology

Rhinitis may be caused by a variety of factors, including changes in temperature or humidity; odors; infection; age; systemic disease; use of over-the-counter (OTC) and prescribed nasal decongestants; and the presence of a foreign body. Allergic rhinitis may occur with exposure to allergens such as foods (e.g., peanuts, walnuts, Brazil nuts, wheat, shellfish, soy, cow's milk, eggs), medications (e.g., penicillin, sulfa medications, aspirin), and particles in the indoor and outdoor environment (Chart 18-2). The most common cause of nonallergic rhinitis is the common cold (Peters, 2015).

Chart 18-1

Upper Respiratory Tract Disorders in Older Adults

- Upper respiratory infections in older adults may have more serious consequences if patients have concurrent medical problems that compromise their respiratory or immune status.
- Influenza causes exacerbations of chronic obstructive pulmonary disease and reduced pulmonary function.
- Antihistamines and decongestants used to treat upper respiratory disorders must be used cautiously in older adults because of their side effects and potential interactions with other medications.
- The prevalence of nonallergic rhinosinusitis is greater among older adults than among adults of other age groups. Rhinosinusitis is the sixth most common chronic disease among older adults. With anticipated future growth in the older adult population, the need for endoscopic sinus surgery will increase. Older patients with nonallergic rhinosinusitis present with symptoms similar to those of younger adults and experience a similar degree of improvement and quality of life after endoscopic sinus surgery.
- The structure of the nose changes with aging; it lengthens and the tip droops from loss of cartilage. This can cause restriction in airflow and predispose older adult patients to geriatric rhinitis, characterized by increased thin, watery sinus drainage. These structural changes may also adversely affect the sense of smell.
- Laryngitis in older adults is common and may be secondary to gastroesophageal reflux disease (GERD). Older adults are more likely to have impaired esophageal peristalsis and a weaker esophageal sphincter. Treatment measures include sleeping with the head of the bed elevated and the use of medications such as histamine-2 receptor blockers (e.g., famotidine) or proton pump inhibitors (e.g., omeprazole).
- Age-related loss of muscle mass and thinning of the mucous membranes can cause structural changes in the larynx that may change characteristics of the voice. In general, the pitch of voice becomes higher in older adult men and lower in older adult women. The voice also “thins” (decreased projection) and may sound tremulous. These changes should be discriminated from signs that could indicate pathologic conditions.

Adapted from Eliopoulos, C. (2018). *Gerontological nursing* (9th ed.). Philadelphia, PA: Wolters Kluwer; Lehmann, A. E., Scangas, G. A., Sethi, R. K., et al. (2018). Impact of age on sinus surgery outcomes. *The Laryngoscope, 128*, 2681–2687; Valdes, C. J., & Tewfik, M. A. (2018). Rhinosinusitis and allergies in elderly patients. *Clinics in Geriatric Medicine, 34*(2), 217–231.

Drug-induced rhinitis may occur with antihypertensive agents, such as angiotensin-converting enzyme (ACE) inhibitors and beta-blockers; "statins," such as atorvastatin and simvastatin; antidepressants and antipsychotics such as risperidone; aspirin; and some antianxiety medications (Comerford & Durkin, 2020). Figure 18-1 shows the pathologic processes involved in rhinitis and rhinosinusitis. Other causes of rhinovirus are identified in Table 18-1.

Chart 18-2

Examples of Common Indoor and Outdoor Allergens

Common Indoor Allergens

- Dust mite feces
- Dog dander
- Cat dander
- Cockroach droppings
- Molds

Common Outdoor Allergens

- Trees (e.g., oak, elm, western red cedar, ash, birch, sycamore, maple, walnut, cypress)
- Weeds (e.g., ragweed, tumbleweed, sagebrush, pigweed, cockle weed, Russian thistle)
- Grasses (e.g., timothy, orchard, sweet vernal, bermuda, sour dock, redtop, bluegrass)
- Molds (*Alternaria, Cladosporium, Aspergillus*)

Adapted from Patel, B. (2017). Aeroallergens. Retrieved on 5/27/2019 at: www.emedicine.medscape.com/article/137911-overview

Clinical Manifestations

The signs and symptoms of rhinitis include **rhinorrhea** (excessive nasal drainage, runny nose); nasal congestion; nasal discharge (purulent with bacterial rhinitis); sneezing; and pruritus of the nose, roof of the mouth, throat, eyes, and ears. Headache may occur, particularly if rhinosinusitis is also present (see later discussion of rhinosinusitis). Nonallergic rhinitis can occur throughout the year.

TABLE 18-1 Causes of Rhinosinusitis

Category	Causes
Vasomotor	Idiopathic
	Abuse of nasal decongestants (rhinitis medicamentosa)
	Psychological stimulation (anger, sexual arousal)
	Irritants (smoke, air pollution, exhaust fumes, cocaine)
Mechanical	Tumor
	Deviated septum
	Crusting
	Hypertrophied turbinates
	Foreign body
	Cerebrospinal fluid leak
Chronic inflammatory	Polyps (in cystic fibrosis)
	Sarcoidosis
	Wegener granulomatosis
	Midline granuloma
Infectious	Acute viral infection
	Acute or chronic rhinosinusitis
	Rare nasal infections (syphilis, tuberculosis)
Hormonal	Pregnancy
	Use of oral contraceptives
	Hypothyroidism

Adapted from Peters, A. (2015). Rhinosinusitis: Synopsis. Retrieved on 6/2/2019 at: www.worldallergy.org/professional/allergic_diseases_center/rhinosinusitis/sinusitissynopsis.php

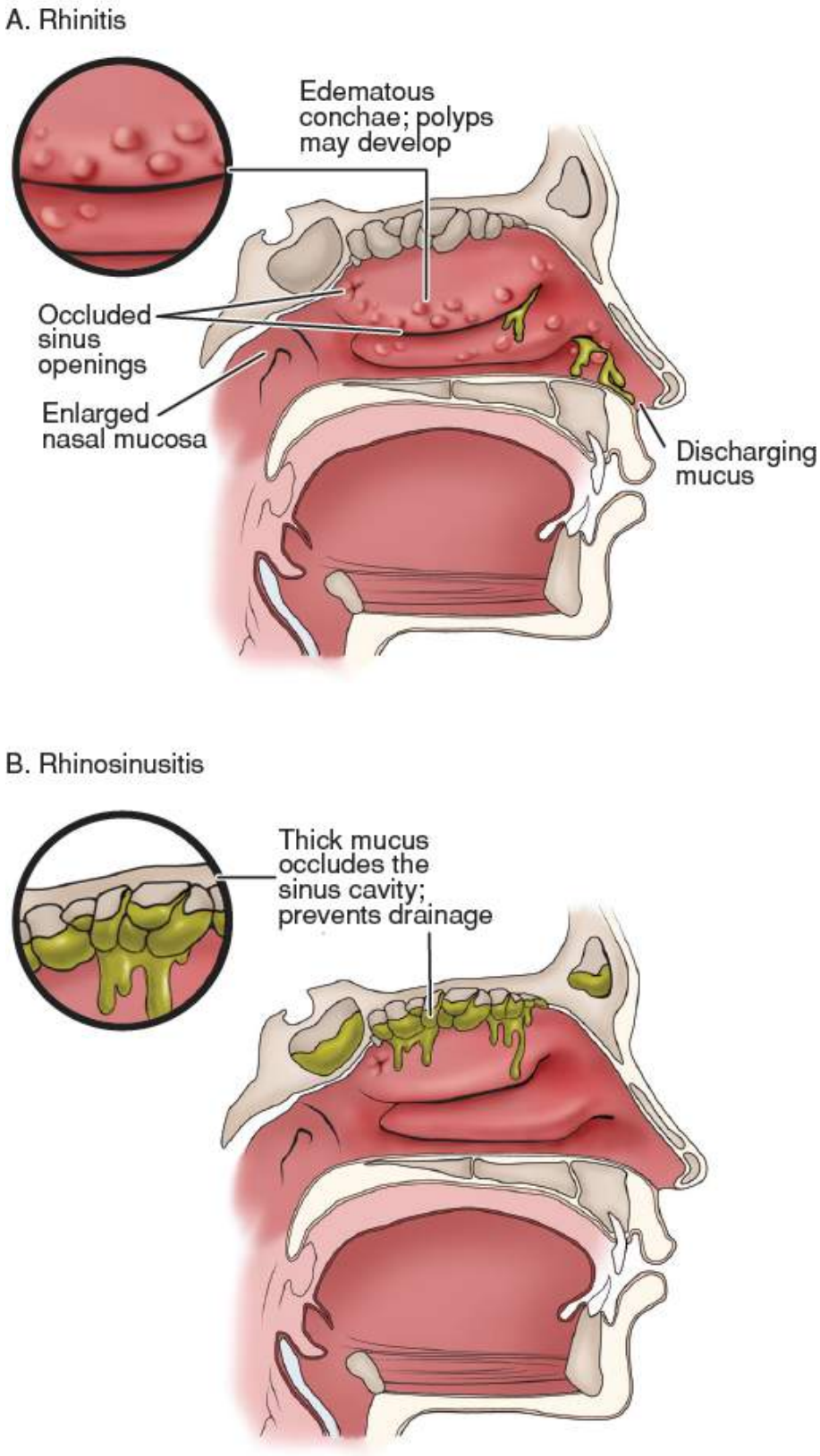

Figure 18-1 • Pathophysiologic processes in rhinitis and rhinosinusitis. Although pathophysiologic processes are similar in

rhinitis and rhinosinusitis, they affect different structures. **A.** In rhinitis, the mucous membranes lining the nasal passages become inflamed, congested, and edematous. The swollen nasal conchae block the sinus openings, and mucus is discharged from the nostrils. **B.** Rhinosinusitis is also marked by inflammation and congestion, with thickened mucous secretions filling the sinus cavities and occluding the openings.

Medical Management

The management of rhinitis depends on the cause, which may be identified through the history and physical examination. The nurse asks the patient about recent symptoms as well as possible exposure to allergens in the home, environment, or workplace. If viral rhinitis is the cause, medications may be prescribed to relieve the symptoms. In allergic rhinitis, allergy tests may be performed to identify possible allergens. Depending on the severity of the allergy, desensitizing immunizations and corticosteroids may be required (see Chapter 33 for more details). If symptoms suggest a bacterial infection, an antimicrobial agent is used. Patients with nasal septal deformities or nasal polyps may be referred to an ear, nose, and throat specialist.

Pharmacologic Therapy

Medication therapy for allergic and nonallergic rhinitis focuses on symptom relief. Antihistamines and nasal sprays may be useful. Antihistamines remain the most common treatment and are given for sneezing, pruritus, and rhinorrhea. (Examples of commonly prescribed antihistamines are discussed in more detail in Chapter 33.) Brompheniramine/pseudoephedrine is an example of combination antihistamine/decongestant medications. Cromolyn, a mast cell stabilizer that inhibits the release of histamine and other chemicals, is also used in the treatment of rhinitis. Oral decongestant agents may be used for nasal obstruction. The use of saline nasal spray can act as a mild decongestant and can liquefy mucus to prevent crusting. Two inhalations of intranasal ipratropium can be given in each nostril two to three times per day for symptomatic relief of rhinorrhea. In addition, intranasal corticosteroids may be used for severe congestion, and ophthalmic agents (cromolyn ophthalmic solution 4%) may be used to relieve irritation, itching, and redness of the eyes. Appropriate allergy treatments may include leukotriene modifiers (e.g., montelukast, zafirlukast, zileuton), and immunoglobulin E modifiers (e.g., omalizumab), which are also components of asthma treatment guidelines (discussed further in Chapter 20). The choice of medications depends on the symptoms, adverse reactions, adherence factors, risk of drug interactions, and cost to the patient (Hauk, 2018).

Nursing Management

Educating Patients About Self-Care

The nurse instructs the patient with allergic rhinitis to avoid or reduce exposure to allergens and irritants, such as dusts, molds, animals, fumes, odors, powders, sprays, and tobacco smoke. Patient education is essential when assisting the patient in the use of all medications. To prevent possible drug interactions, the patient is cautioned to read drug labels before taking any OTC medication.

The nurse instructs the patient about the importance of controlling the environment at home and at work. Saline nasal sprays or aerosols may be helpful in soothing mucous membranes, softening crusted secretions, and removing irritants. The nurse instructs the patient in correct administration of nasal medications. To achieve maximal relief, the patient is instructed to blow the nose before applying any medication into the nasal cavity. In addition, the patient is taught to keep the head upright; spray quickly and firmly into each nostril away from the nasal septum; and wait at least 1 minute before administering the second spray. The container should be cleaned after each use and should never be shared with other people to avoid cross-contamination.

In the case of infectious rhinitis, the nurse reviews hand hygiene technique with the patient as a measure to prevent transmission of organisms. This is especially important for those in contact with vulnerable populations such as the very young, older adults, or people who are immunosuppressed (e.g., patients with human immune deficiency virus [HIV] infection, those taking immunosuppressive medications). In older adults and other high-risk populations, the nurse reviews the importance of receiving an influenza vaccination each year to achieve immunity before the beginning of the flu season.

Viral Rhinitis (Common Cold)

Viral rhinitis is the most frequent viral infection in the general population (Meneghetti, 2018). The term *common cold* often is used when referring to a URI that is self-limited and caused by a virus. The term *cold* refers to an infectious, acute inflammation of the mucous membranes of the nasal cavity characterized by nasal congestion, rhinorrhea, sneezing, sore throat, and general malaise. More broadly, the term refers to an acute URI, whereas terms such as *rhinitis, pharyngitis,* and *laryngitis* distinguish the sites of the symptoms. The term is also used when the causative virus is influenza (the flu). Colds are highly contagious because virus is shed for about 2 days before the symptoms appear and during the first part of the symptomatic phase.

Colds caused by rhinoviruses tend to occur in the early fall and spring. Other viruses tend to cause winter colds (Centers for Disease Control and Prevention [CDC], 2019). Seasonal changes in relative humidity may affect the prevalence of colds. The most common cold-causing viruses survive better when humidity is low, in the colder months of the year.

Colds are caused by as many as 200 different viruses. Rhinoviruses are the most likely causative organisms. Other viruses implicated in the common cold include coronavirus, adenovirus, respiratory syncytial virus, influenza virus, and parainfluenza virus. Each virus may have multiple strains; as a result, people are susceptible to colds throughout life (Buensalido, 2019b). Some virus strains may be particularly virulent, causing more severe manifestations than those implicated with common colds, such as the SARS-CoV-2 virion, which caused the COVID-19 pandemic. Development of a vaccine against the multiple strains of virus is almost impossible. Immunity after recovery is variable and depends on many factors, including a person's natural host resistance and the specific virus that caused the cold. Despite popular belief, cold temperatures and exposure to cold rainy weather do not increase the incidence or severity of the common cold.

Clinical Manifestations

Signs and symptoms of viral rhinitis may include low-grade fever, nasal congestion, rhinorrhea and nasal discharge, halitosis, sneezing, tearing watery eyes, "scratchy" or sore throat, general malaise, chills, and often headache and muscle aches. As the illness progresses, cough usually appears. In some people, the virus exacerbates **herpes simplex,** commonly called a *cold sore* (Chart 18-3).

The symptoms of viral rhinitis may last from 1 to 2 weeks. If severe systemic respiratory symptoms occur, it is no longer considered viral rhinitis but one of the other acute URIs. Allergic conditions can affect the nose, mimicking the symptoms of a cold.

Medical Management

Management consists of symptomatic therapy that includes adequate fluid intake, rest, prevention of chilling, and the use of expectorants as needed. Warm salt-water gargles soothe the sore throat, and nonsteroidal anti-inflammatory drugs (NSAIDs), such as aspirin or ibuprofen, relieve aches and pains. Antihistamines are used to relieve sneezing, rhinorrhea, and nasal congestion. Petroleum jelly can soothe irritated, chapped, and raw skin around the nares (Buensalido, 2019b).

Guaifenesin, an expectorant, is available without a prescription and is used to promote removal of secretions. Antimicrobial agents (antibiotics) should not

be used, because they do not affect the virus or reduce the incidence of bacterial complications. In addition, their inappropriate use has been implicated in the development of organisms resistant to therapy.

Chart 18-3

Colds and Cold Sores (Herpes Simplex Virus)

Overview

Herpes labialis is an infection that is caused by herpes simplex virus type 1 (HSV-1). Herpes labialis is extremely contagious and can be spread through contaminated razors, towels, and dishes. It is activated by overexposure to sunlight or wind, colds, influenza and similar infections, heavy alcohol use, and physical or emotional stress.

Statistics

- Once the patient is infected with this virus, it can lie latent in the cells. The incubation period is between 2 and 12 d.
- Between 50% and 80% of Americans are infected by age 30 y, because HSV-1 is typically transmitted during childhood through nonsexual contact.
- Estimates suggest that 80% of people infected are asymptomatic.

Clinical Manifestations

- Herpes labialis is characterized by an eruption of small, painful blisters on the skin of the lips, mouth, gums, tongue, or the skin around the mouth. The blisters are commonly referred to as cold sores or fever blisters.
- Early symptoms of herpes labialis include burning, itching, and increased sensitivity or tingling sensation. These symptoms may occur several days before the appearance of lesions.
- Lesions appear as macules or papules, progressing to small blisters (vesicles) filled with clear, yellowish fluid. They are raised, red, and painful and can break and ooze. The lesions typically extend through the epidermis and penetrate into the underlying dermis, consistent with a partial-thickness wound.
- Eventually, yellow crusts slough over the lesions to reveal pink, healing skin.
- Typically, the virus is no longer detectable in the lesion or wound 5 d after the vesicle has developed.

Medical and Nursing Management

- Antiviral medications (e.g., acyclovir, valacyclovir) may be prescribed to minimize the symptoms and the duration or length of flare-up.
- Acetaminophen may be given for analgesia.
- Topical anesthetics such as lidocaine can help in the control of discomfort.
- Occlusive dressings have been shown to speed the healing process. Occlusive ointments with antiviral properties (e.g., docosanol) might be considered for lip and mucosal lesions.

Patient Education

- Patients should understand that the virus can be transmitted by people who are asymptomatic.
- Patients should seek treatment with antiviral medications and ointments when they are first experiencing symptoms (e.g., tingling, burning, or itching sensations) as early treatment with these drugs can result in a speedier recovery.
- Although herpes simplex virus type 2 (HSV-2) typically causes painful vesicular and ulcerative lesions in the genital and anal areas, HSV-1 may also cause genital herpes. Oral–genital contact can spread oral herpes to the genitals (and vice versa). People with active herpetic lesions should avoid oral sex.

Photo reprinted with permission from Ayoade, F. (2018). Herpes simplex. Retrieved on 5/27/2019 at: www.emedicine.medscape.com/article/218580-overview

Topical nasal decongestants (e.g., phenylephrine nasal and oxymetazoline nasal) should be used with caution. Topical therapy delivers medication directly to the nasal mucosa, and its overuse can produce **rhinitis medicamentosa**, or rebound rhinitis. Most patients treat the common cold with OTC medications that produce moderate clinical benefits, such as relief of symptoms.

In addition, alternative medicines (e.g., echinacea, zinc lozenges, and zinc nasal spray) are frequently used to treat the common cold; however, evidence regarding their effectiveness in shortening the symptomatic phase is limited (Mousa, 2017). The inhalation of steam or heated, humidified air has been a mainstay of home remedies to treat the common cold; however, the value of this therapy has not been demonstrated.

Nursing Management

Educating Patients About Self-Care

Most viruses can be transmitted in several ways: direct contact with infected secretions, inhalation of large particles from others' coughing or sneezing, or inhalation of small particles (aerosol) that may be suspended in the air for up to an hour. Implementation of appropriate hand hygiene measures (see Chapter 66, Chart 66-1 for further information) remains the most effective measure to prevent transmission of organisms. The nurse educates the patient about how to break the chain of infection with appropriate hand hygiene and the use of tissues to avoid the spread of the virus with coughing and sneezing, and to cough or sneeze into the upper arm if tissues are not readily available. The nurse instructs the patient about methods to treat symptoms of the common cold and provides both verbal and written information to assist in the prevention and management of URIs.

Rhinosinusitis

Rhinosinusitis, formerly called *sinusitis,* is an inflammation of the paranasal sinuses and nasal cavity. The American Academy of Otolaryngology–Head and Neck Surgery Foundation (2018; Rosenfeld, Andes, Bhattacharyya, et al., 2015) recommends the use of the term *rhinosinusitis* because sinusitis is almost always accompanied by inflammation of the nasal mucosa. Rhinosinusitis affects about 35 million people in the United States each year and accounts for 16 million office visits (Brook, 2018a).

Uncomplicated rhinosinusitis occurs without extension of inflammation outside of the paranasal sinuses and nasal cavity. Rhinosinusitis is classified by duration of symptoms as acute (less than 4 weeks), subacute (4 to 12 weeks), and chronic (more than 12 weeks). Rhinosinusitis can be caused by a bacterial or viral infection.

Acute Rhinosinusitis

Acute rhinosinusitis is classified as acute bacterial rhinosinusitis (ABRS) or acute viral rhinosinusitis (AVRS). Recurrent acute rhinosinusitis is characterized by four or more acute episodes of ABRS per year (Patel & Hwang, 2019) and is discussed with chronic rhinosinusitis (CRS).

Pathophysiology

Acute rhinosinusitis usually follows a viral URI or cold, such as an unresolved viral or bacterial infection, or an exacerbation of allergic rhinitis. Normally, the sinus openings into the nasal passages are clear and infections resolve

promptly. However, if their drainage is obstructed by a deviated septum or by hypertrophied turbinates, spurs, or nasal polyps or tumors, sinus infection may persist as a secondary infection or progress to an acute suppurative process (causing purulent discharge).

Nasal congestion, caused by inflammation, edema, and transudation of fluid secondary to URI, leads to obstruction of the sinus cavities (see Fig. 18-1). This provides an excellent medium for bacterial growth. Other conditions and activities that can block the normal flow of sinus secretions include abnormal structures of the nose, enlarged adenoids, diving and swimming, tooth infection, trauma to the nose, tumors, and the pressure of foreign objects. Some people are more prone to rhinosinusitis because exposure to environmental hazards such as paint, sawdust, and chemicals may result in chronic inflammation of the nasal passages.

Bacterial organisms account for more than 60% of the cases of acute rhinosinusitis. Typical pathogens include *Streptococcus pneumoniae, Haemophilus influenzae,* and less commonly *Staphylococcus aureus,* and *Moraxella catarrhalis* (Brook, 2018b). Biofilms, which consist of organized, heterogeneous communities of bacteria, have been found to be 10 to 1000 times more resistant to antibiotic treatment and more likely to contribute to host resistance when compared with other bacteria. They serve as bacterial reservoirs that can cause systemic illness when released into the circulation. Although antibiotics kill bacteria in the biofilm margin, cells deep in the biofilm are not affected, allowing for regrowth once antibiotic therapy has been discontinued. Pathogens in the upper respiratory tract that form biofilms include those species listed earlier as well as *Pseudomonas aeruginosa.*

Other organisms that are occasionally isolated include *Chlamydia pneumoniae, Streptococcus pyogenes,* viruses, and fungi (*Aspergillus fumigatus*). Fungal infections occur most often in patients who are immunosuppressed (Brook, 2018b). The most common organisms found with health care-associated (nosocomial) infections include *P. aeruginosa, Escherichia coli, Proteus mirabilis, Klebsiella pneumoniae,* and *Enterobacter* species, accounting for 60% of those cases (Brook, 2018b).

Clinical Manifestations

Symptoms of ABRS include purulent nasal drainage (anterior, posterior, or both) accompanied by nasal obstruction or a combination of facial pain, pressure, or a sense of fullness (referred to collectively as facial pain–pressure–fullness), or both (Rosenfeld et al., 2015; Sedaghat, 2017). The facial pain–pressure–fullness may involve the anterior face or the periorbital region. The patient may also report cloudy or colored nasal discharge congestion, blockage, or stuffiness as well as a localized or diffuse headache. Patients with ABRS may present with a high fever (i.e., 39°C [102°F] or higher). In

addition, the occurrence of symptoms for 10 days or more after the initial onset of upper respiratory symptoms indicates ABRS (Brook, 2018a).

The symptoms of AVRS are similar to those of ABRS, except the patient does not present with a high fever, nor with the same intensity of symptoms (e.g., there tends to be an absence of facial pain–pressure–fullness), nor with symptoms that persist for as long a period of time. Symptoms of AVRS occur for fewer than 10 days after the onset of upper respiratory symptoms and do not worsen (Papadakis, McPhee, & Rabow, 2018).

Assessment and Diagnostic Findings

A careful history and physical examination are performed. The head and neck, particularly the nose, ears, teeth, sinuses, pharynx, and chest, are examined. There may be tenderness to palpation over the infected sinus area. The sinuses are percussed using the index finger, tapping lightly to determine whether the patient experiences pain. Although less frequently performed, transillumination of the affected area may reveal a decrease in the transmission of light with rhinosinusitis (see Chapter 17). Diagnostic imaging (x-ray, computed tomography [CT], magnetic resonance imaging [MRI]) is not recommended and generally not needed for the diagnosis of acute rhinosinusitis if the patient meets clinical diagnostic criteria (Aring & Chan, 2016; Rosenfeld et al., 2015). When a complication or alternative diagnosis is suspected, diagnostic imaging may be indicated to help identify inflammatory changes, bone destruction, and anatomic variations that can guide sinus surgery (if indicated).

To confirm the diagnosis of maxillary and frontal rhinosinusitis and identify the pathogen, sinus aspirates may be obtained. Flexible endoscopic culture techniques and swabbing of the sinuses have been used for this purpose (Papadakis et al., 2018).

Complications

If untreated, acute rhinosinusitis may lead to severe complications. Local complications include osteomyelitis and mucocele (cyst of the paranasal sinuses). Osteomyelitis requires prolonged antibiotic therapy and at times removal of necrotic bone. Intracranial complications, although rare, include cavernous sinus thrombosis, meningitis, brain abscess, ischemic brain infarction, and severe orbital cellulitis (Papadakis et al., 2018). Mucoceles may require surgical treatment to establish intranasal drainage or complete excision with ablation of the sinus cavity. Brain abscesses occur by direct spread and can be life-threatening. Frontal epidural abscesses are usually quiescent but can be detected by CT scan.

Medical Management

Treatment of acute rhinosinusitis depends on the cause; a 14-day course of antibiotics is prescribed for bacterial cases (Tewfik, 2018). The goals of treatment for acute rhinosinusitis are to shrink the nasal mucosa, relieve pain, and treat infection. Because of the inappropriate use of antibiotics for nonbacterial illness, including AVRS, and the resulting resistance that has occurred, oral antibiotics are only prescribed when there is sufficient empiric evidence that the patient has ABRS (e.g., high fever or symptoms that persist for at least 10 days or worsening symptoms following a viral respiratory illness).

Antibiotics should be given as soon as the diagnosis of ABRS is established. Amoxicillin or amoxicillin–clavulanic acid are the antibiotics of choice. For patients who are allergic to penicillin, doxycycline or respiratory quinolones such as levofloxacin or moxifloxacin can be prescribed (CDC, 2017). Other antibiotics prescribed previously to treat ABRS, including cephalosporins (e.g., cephalexin, cefuroxime, cefaclor, and cefixime), macrolides (e.g., clarithromycin and azithromycin), and trimethoprim–sulfamethoxazole are no longer recommended because they are not effective in treating antibiotic-resistant organisms that are now more commonly implicated in ABRS (Tewfik, 2018). Intranasal saline lavage is an effective adjunct therapy to antibiotics in that it may relieve symptoms, reduce inflammation, and help clear the passages of stagnant mucus. Neither decongestants nor antihistamines are recommended adjunctive medications for treating ABRS (Tewfik, 2018).

Treatment of AVRS typically involves nasal saline lavage and decongestants (guaifenesin/pseudoephedrine). Decongestants or nasal saline sprays can increase patency of the ostiomeatal unit and improve drainage of the sinuses. Topical decongestants should not be used for longer than 3 or 4 days. Oral decongestants must be used cautiously in patients with hypertension. OTC antihistamines, such as diphenhydramine and cetirizine, and prescription antihistamines, such as fexofenadine, are used if an allergic component is suspected.

Intranasal corticosteroids have been shown to produce complete or marked improvement in acute symptoms of either bacterial or viral rhinosinusitis; however, they are only recommended for use in patients with a previous history of allergic rhinitis (Rosenfeld et al., 2015). Examples of intranasal corticosteroids, side effects, and contraindications are presented in Table 18-2.

Nursing Management

Educating Patients About Self-Care

Patient education is an important aspect of nursing care for the patient with acute rhinosinusitis. The nurse instructs the patient about symptoms of complications that require immediate follow-up. Referral to the primary provider is indicated if periorbital edema and severe pain on palpation occur. The nurse instructs the patient about methods to promote drainage of the sinuses, including humidification of the air in the home and the use of warm compresses to relieve pressure. The patient is advised to avoid swimming, diving, and air travel during the acute infection. Patients using tobacco are instructed to immediately stop smoking or using any form of tobacco. Many patients use nasal sprays incorrectly, which can lead to several side effects that include nasal irritation, nasal burning, bad taste, and drainage in the throat or even **epistaxis** (hemorrhage from the nose). Therefore, if an intranasal corticosteroid is prescribed, it is important to instruct the patient about the correct use of prescribed nasal sprays through demonstration, explanation, and return demonstration to evaluate the patient's understanding of the correct method of administration. The nurse also educates the patient about the side effects of prescribed and OTC nasal sprays and about rhinitis medicamentosa (rebound congestion). Once the decongestant is discontinued, the nasal passages close and congestion results. Appropriate medications to use for pain relief include acetaminophen and NSAIDs such as ibuprofen, naproxen sodium, and aspirin for adults older than 20 years as long as there are no contraindications to use.

TABLE 18-2 Select Nasal Corticosteroids and Common Side Effects

Nasal Corticosteroids	Side Effects	Contraindications (for All Nasal Corticosteroids)
Beclomethasone	Nasal irritation, headache, nausea, lightheadedness, epistaxis, rhinorrhea, watering eyes, sneezing, dry nose and throat	Avoid in patients with recurrent epistaxis, glaucoma, and cataracts. Patients who have been exposed to measles/varicella or who have adrenal insufficiency should avoid these medications.
Budesonide	Epistaxis, pharyngitis, cough, nasal irritation, bronchospasm	
Mometasone	Headache, viral infection, pharyngitis, epistaxis, cough, dysmenorrhea, musculoskeletal pain, arthralgia	
Triamcinolone	Pharyngitis, epistaxis, cough, headache	

Adapted from Comerford, K. C., & Durkin, M. T. (Eds.). (2020). *Nursing2020 drug handbook*. Philadelphia, PA: Wolters Kluwer; Peters, A. (2015). Rhinosinusitis: Synopsis. Retrieved on 5/8/2019 at: www.worldallergy.org/professional/allergic_diseases_center/rhinosinusitis/sinusitissynopsis.php

The nurse tells patients with recurrent rhinosinusitis to begin decongestants, such as pseudoephedrine, at the first sign of rhinosinusitis. This promotes drainage and decreases the risk of bacterial infection. Patients should also check with their primary provider or pharmacist before using OTC medications because many cold medications can worsen symptoms or other health problems, specifically hypertension.

The nurse stresses the importance of following the recommended antibiotic regimen because a consistent blood level of the medication is critical to treat the infection. The nurse educates the patient about the early signs of a sinus infection and recommends preventive measures such as following healthy practices and avoiding contact with people with URIs.

The nurse explains to the patient that fever, severe headache, and **nuchal rigidity** (stiffness of the neck or inability to bend the neck) are signs of the potential complication of meningitis. Patients with chronic symptoms of rhinosinusitis who do not have marked improvement in 4 weeks with continuous medical treatment may be candidates for functional endoscopic sinus surgery (FESS, see later discussion) (Tajudeen & Kennedy, 2017).

Quality and Safety Nursing Alert

Patients with nasotracheal and nasogastric tubes in place are at the risk for development of sinus infections (Brook, 2018a; Brook, 2018b). Thus, accurate assessment of patients with these tubes is critical. Removal of the nasotracheal or nasogastric tube as soon as the patient's condition permits allows the sinuses to drain, possibly avoiding septic complications.

Chronic Rhinosinusitis and Recurrent Acute Rhinosinusitis

The prevalence of CRS is about 146 per 1000 population in the United States and occurs most commonly in young and middle-aged adults (Brook, 2018b). It is diagnosed when the patient has experienced 12 weeks or longer of two or more of the following symptoms: mucopurulent drainage, nasal obstruction, facial pain–pressure–fullness, or hyposmia (decreased sense of smell). It is estimated that in about 40% of patients, CRS is accompanied by nasal polyps (Rosenfeld et al., 2015). Recurrent acute rhinosinusitis is diagnosed when four or more episodes of ABRS occur per year with no signs or symptoms of rhinosinusitis between the episodes. The use of antibiotics in patients with recurrent acute rhinosinusitis is higher than in patients with CRS. Both CRS and recurrent acute rhinosinusitis affect quality of life as well as physical and social function (Hamilos, 2018).

Pathophysiology

Mechanical obstruction in the ostia of the frontal, maxillary, and anterior ethmoid sinuses (known collectively as the ostiomeatal complex) is the usual cause of CRS and recurrent acute rhinosinusitis. Obstruction prevents adequate drainage of the nasal passages, resulting in accumulation of secretions and an ideal medium for bacterial growth. Persistent blockage in an adult may occur because of infection, allergy, or structural abnormalities. Other associated conditions and factors may include cystic fibrosis, ciliary dyskinesia, neoplastic disorders, gastroesophageal reflux disease, tobacco use, and environmental pollution (Brook, 2018a).

Both aerobic and anaerobic bacteria have been implicated in CRS and recurrent rhinosinusitis. Common aerobic bacteria include alpha-hemolytic streptococci, microaerophilic streptococci, and *S. aureus*. Common anaerobic bacteria include gram-negative bacilli, *Peptostreptococcus,* and *Fusobacterium*.

In addition, immunodeficiency should be considered in patients with CRS or acute recurrent rhinosinusitis. Acute fulminant/invasive rhinosinusitis is a

life-threatening illness and is commonly attributed to *Aspergillus* in immunocompromised patients. Chronic fungal sinusitis also poses a risk. Chronic invasive fungal sinusitis occurs in immunocompromised patients along with fungus ball/mycetoma and allergic fungal sinusitis—the more common forms of chronic fungal sinusitis—which are considered noninvasive conditions in immunocompromised patients. The fungus ball is characterized by the presence of a noninvasive accumulation of a dense conglomeration of fungal hyphae in one sinus cavity, usually the maxillary sinus. The fungus generally remains contained in the fungus ball, which consists of mucopurulent cheesy or claylike materials within the sinus, but can become invasive when immunosuppression occurs, leading to encephalopathy (Ramadan, 2018). Symptoms include nasal stuffiness, nasal discharge, and facial pain. Vision loss, headache, and cranial nerve palsies have been identified in patients with a sphenoid sinus fungal ball (Ramadan, 2018).

Clinical Manifestations

Clinical manifestations of CRS include impaired mucociliary clearance and ventilation, cough (because the thick discharge constantly drips backward into the nasopharynx), chronic hoarseness, chronic headaches in the periorbital area, periorbital edema, and facial pain. As a result of chronic nasal congestion, the patient is usually required to breathe through the mouth. Snoring, sore throat, and, in some situations, adenoidal hypertrophy may also occur. Symptoms are generally most pronounced on awakening in the morning. Fatigue and nasal congestion are also common. Many patients experience a decrease in smell and taste and a sense of fullness in the ears.

Assessment and Diagnostic Findings

The health assessment focuses on onset and duration of symptoms. It addresses the quantity and quality of nasal discharge and cough, the presence of pain, factors that relieve or aggravate the pain, and allergies. It is essential to obtain any history of comorbid conditions, including asthma and history of tobacco use and smoking or use of electronic nicotine delivery systems (ENDS) including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars. A history of fever, fatigue, previous episodes and treatments and previous response to therapies is also obtained.

In the physical assessment, the external nose is evaluated for any evidence of anatomic abnormality. A crooked-appearing external nose may imply septal deviation internally. The nasal mucous membranes are assessed for erythema, pallor, atrophy, edema, crusting, discharge, polyps, erosions, and septal perforations or deviations. Appropriate lighting improves visualization of the nasal cavity and should be used in every examination. Pain on examination of

the teeth, with tapping with a tongue blade, suggests tooth infection (Bickley & Szilagyi, 2017).

Assessment of the posterior oropharynx may reveal purulent or mucoid discharge, which is indicative of an infection caused by CRS. The patient's eyes are examined for conjunctival erythema, tearing, photophobia, and edema of the lids. Additional assessment techniques include transillumination of the sinuses and palpation of the sinuses. The frontal and maxillary sinuses are palpated, and the patient is asked whether this produces tenderness. The pharynx is inspected for erythema and discharge and palpated for cervical node adenopathy (Hamilos, 2018).

Imaging studies such as x-ray, sinoscopy, ultrasound, CT scanning, and MRI may be used in the diagnosis of CRS. X-ray is an inexpensive and readily available tool to assess disorders of the paranasal sinuses. A CT scan of the paranasal sinuses can identify mucosal abnormalities, sinus ostial obstruction, anatomic variants, sinonasal polyposis, and neoplastic disease. In addition, nasal endoscopy allows for visualization of the posterior nasal cavity, nasopharynx, and sinus drainage pathways and can identify posterior septal deviation and polyps. Osseous destruction, extrasinus extension of the disease process, and local invasion suggest malignancy (Rosenfeld et al., 2015).

Complications

Complications of CRS, although uncommon, include severe orbital cellulitis, subperiosteal abscess, cavernous sinus thrombosis, meningitis, encephalitis, and ischemic infarction. CRS can lead to intracranial infection either by direct spread through bone or via venous channels, resulting in epidural abscess, subdural empyema, meningitis, and brain abscess. Clinical sequelae can include personality changes with frontal lobe abscesses, headache, symptoms of elevated intracranial pressure to include alterations of consciousness, visual changes, focal neurologic deficits, seizures, and, ultimately, coma and death.

Frontal rhinosinusitis can lead to osteomyelitis of the frontal bones. Patients typically present with headache, fever, and a characteristic doughy edema over the involved bone. Ethmoid rhinosinusitis may result in orbital cellulitis, which usually begins with edema of the eyelids and rapidly progresses to ptosis (droopy eyelid), proptosis (bulging eye), chemosis (edema of the bulbar conjunctiva), and diminished extraocular movements. Patients are usually febrile and acutely ill and require immediate attention, because pressure on the optic nerve can lead to loss of vision and spread of infection can lead to intracranial infection (Brook, 2018a). Cavernous sinus thrombophlebitis can result from extension of infection along venous channels from the orbit, ethmoid or frontal sinuses, or nose. Symptoms may include altered consciousness, lid edema, and proptosis, as well as third, fourth, and sixth cranial nerve palsies.

Medical Management

Medical management of CRS and recurrent acute rhinosinusitis is similar to that of acute rhinosinusitis. General measures include encouraging adequate hydration and recommending the use of OTC nasal saline sprays, antispasmodic agents such as acetaminophen or NSAIDs, and decongestants such as oxymetazoline and pseudoephedrine (Brook, 2018b; Tewfik, 2018). Patients are instructed to sleep with the head of the bed elevated and to avoid exposure to cigarette smoke and fumes. Patients are cautioned to avoid caffeine and alcohol, which can cause dehydration.

Prescribed antibiotics may include amoxicillin–clavulanic acid, erythromycin–sulfisoxazole, second- or third-generation cephalosporins such as cefuroxime or cefixime, or newer fluoroquinolones such as moxifloxacin (Brook, 2018b). The course of antibiotic treatment for CRS and recurrent ABRS is typically as long as 2 to 4 weeks to effectively eradicate the offending organism, and may be indicated for up to 12 months in some cases (Brook, 2018b). Corticosteroid nasal sprays such as fluticasone or beclomethasone may be indicated in patients with concomitant allergic rhinitis or nasal polyps. Patients with allergic rhinitis may also benefit from the addition of a mast cell stabilizer such as cromolyn. For patients with concomitant asthma, leukotriene inhibitors such as montelukast and zafirlukast may be used (Brook, 2018b).

Surgical Management

If standard medical therapy fails and symptoms persist, FESS may be indicated to correct structural deformities that obstruct the ostia (openings) of the sinuses. FESS is a minimally invasive surgical procedure that is associated with reduced postoperative discomfort and improvement in the patient's quality of life. In particular, FESS is associated with either complete or moderate relief of symptoms in more than 85% to 91% of patients (Patel, 2016). Some of the specific procedures performed include excising and cauterizing nasal polyps, correcting a deviated septum, incising and draining the sinuses, aerating the sinuses, and removing tumors. Computer-assisted or computer-guided surgery is used to increase the precision of the surgical procedure and to minimize complications. Antimicrobial agents are typically prescribed after surgery (Patel, 2016).

Surgical intervention is first-line treatment in acute invasive fungal rhinosinusitis to excise the fungus ball and necrotic tissue and drain the sinuses. Patients require aggressive surgical débridement and drainage as well as systemic antifungal medications (Ramadan, 2018).

Nursing Management

Patients usually perform care measures for rhinosinusitis at home; therefore, nursing management consists of good patient education.

Educating Patients About Self-Care

Many people with sinus infections tend to blow their nose frequently and with force to clear their nasal passages. Doing so often increases the symptoms; therefore, the patient is instructed to blow the nose gently and to use tissue to remove the nasal drainage. Increasing fluid intake, applying local heat (hot wet packs), and elevating the head of the bed promote drainage of the sinuses. The nurse also instructs the patient about the importance of following the prescribed medication regimen. Instructions on the early signs of a sinus infection are provided, and preventive measures are reviewed. The nurse instructs the patient about signs and symptoms that require follow-up and provides these instructions verbally and in writing. Instructions in alternative formats (e.g., large font, patient's language) may be needed to increase the patient's understanding and adherence to the treatment plan. The nurse encourages the patient to follow up with their primary provider if symptoms persist (American Academy of Otolaryngology–Head and Neck Surgery Foundation, 2018).

Quality and Safety Nursing Alert

URIs, specifically CRS and recurrent acute rhinosinusitis, may be linked to primary or secondary immune deficiency or treatment with immunosuppressive therapy (e.g., for cancer or organ transplantation). Typical symptoms may be blunted or absent due to immunosuppression. Immunocompromised patients are at the increased risk for acute or chronic fungal infections; these infections can progress rapidly and become life-threatening (Brook, 2018a; Brook, 2018b). Thus, assessment, early reporting of symptoms to the patient's primary provider, and immediate initiation of treatment are essential.

Pharyngitis

Acute Pharyngitis

Acute **pharyngitis** is a sudden painful inflammation of the pharynx, the back portion of the throat that includes the posterior third of the tongue, soft palate, and tonsils. It is commonly referred to as a sore throat. In the United States,

approximately 12 million health care visits are due to acute pharyngitis each year (Chow & Doron, 2018). Because of environmental exposure to viral agents and poorly ventilated rooms, the incidence of viral pharyngitis peaks during winter and early spring in regions that have warm summers and cold winters. Viral pharyngitis spreads easily in the droplets of coughs and sneezes, as well as from unclean hands that have been exposed to the contaminated fluids.

Pathophysiology

Viral infection causes most cases of acute pharyngitis. Responsible viruses include the adenovirus, influenza virus, Epstein–Barr virus, and herpes simplex virus. Bacterial infection accounts for the remainder of cases. Five percent to 15% of adults with pharyngitis have group A beta-hemolytic streptococcus (GABHS), which is commonly referred to as group A streptococcus (GAS) or streptococcal pharyngitis. Streptococcal pharyngitis warrants the use of antibiotic treatment. When GAS causes acute pharyngitis, the condition is known as strep throat. The body responds by triggering an inflammatory response in the pharynx. This results in pain, fever, vasodilation, edema, and tissue damage, manifested by redness and swelling in the tonsillar pillars, uvula, and soft palate. A creamy exudate may be present in the tonsillar pillars (Fig. 18-2). Other organisms implicated in acute pharyngitis include groups B and G streptococci, *Neisseria gonorrhoeae, Mycoplasma pneumoniae, C. pneumoniae, Arcanobacterium haemolyticum,* and HIV (Chow & Doron, 2018).

Uncomplicated viral infections usually subside promptly, within 3 to 10 days after onset. However, pharyngitis caused by bacteria, such as GAS, is a more severe illness. If left untreated, the complications can be severe and life-threatening. Complications include rhinosinusitis, otitis media, peritonsillar abscess, mastoiditis, and cervical adenitis. In rare cases, the infection may lead to sepsis, pneumonia, meningitis, rheumatic fever, and glomerulonephritis (Buensalido, 2019a).

Clinical Manifestations

The signs and symptoms of acute pharyngitis include a fiery-red pharyngeal membrane and tonsils, lymphoid follicles that are swollen and flecked with white-purple exudate, enlarged and tender cervical lymph nodes, and no cough. Fever (higher than 38.3°C [101°F]) and malaise also may be present. Occasionally, patients with GAS pharyngitis exhibit vomiting, anorexia, and a scarlatina-form rash with urticaria known as scarlet fever.

People who have streptococcal pharyngitis suddenly develop a painful sore throat 1 to 5 days after being exposed to the streptococcus bacteria. They

usually report malaise, fever (with or without chills), headache, myalgia, painful cervical adenopathy, and nausea. The tonsils appear swollen and erythematous, and they may or may not have an exudate. The roof of the mouth is often erythematous and may demonstrate petechiae. Bad breath is common.

Assessment and Diagnostic Findings

Accurate diagnosis of pharyngitis is essential to determine the cause (viral or bacterial) and to initiate treatment early. Rapid antigen detection testing (RADT) uses swabs that collect specimens from the posterior pharynx and tonsil. RADT is reported to be 90% to 95% sensitive, thus facilitating earlier treatment and earlier symptom improvement and reductions in pathogen transmission. Negative results should be confirmed by a throat culture (Acerra, 2018). In most communities, preliminary culture reports are available in 24 hours. Once a definitive diagnosis of GAS is made, administration of appropriate antibiotics hastens symptom resolution and reduces the transmission of the illness.

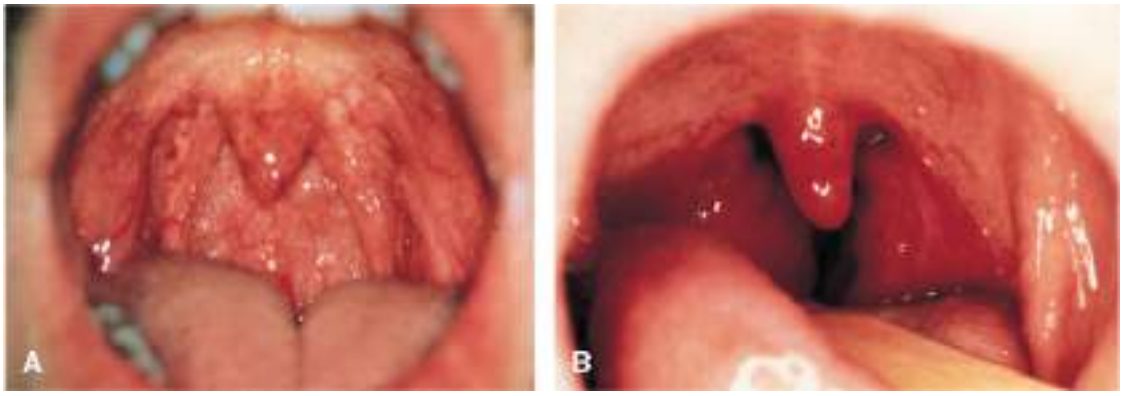

Figure 18-2 • Pharyngitis—inflammation without exudate. **A.** Redness and vascularity of the pillars and uvula are mild to moderate. **B.** Redness is diffuse and intense. Each patient would probably complain of a sore throat. Reprinted with permission from the Wellcome Trust, National Medical Slide Bank, London, UK.

Medical Management

Viral pharyngitis is treated with supportive measures because antibiotics have no effect on the causal organism. Bacterial pharyngitis is treated with a variety of antimicrobial agents (Uyeki, Bernstein, Bradley, et al., 2018).

Pharmacologic Therapy

If the cause of pharyngitis is bacterial, penicillin is usually the treatment of choice. Penicillin V potassium given orally for 10 days is the regimen of choice. Penicillin injections are recommended only if there is a concern that the patient will not adhere to therapy (Papadakis et al., 2018).

For patients who are allergic to penicillin or have organisms that are resistant to erythromycin (one fifth of GAS and most *S. aureus* organisms are resistant to penicillin and erythromycin), cephalosporins and macrolides (clarithromycin and azithromycin) may be used. Once-daily azithromycin may be given for only 3 days due to its long half-life (Acerra, 2018). A 5- or 10-day course of cephalosporin may be prescribed. Five-day administration of cefpodoxime and cefuroxime has also been successful in producing bacteriologic cures.

Severe sore throats can also be relieved by analgesic medications. For example, aspirin or acetaminophen can be taken at 4- to 6-hour intervals; if required, acetaminophen with codeine can be taken three or four times daily. In severe cases, gargles with benzocaine may relieve symptoms.

Nutritional Therapy

A liquid or soft diet is provided during the acute stage of the disease, depending on the patient's appetite and the degree of discomfort that occurs with swallowing. Cool beverages, warm liquids, and flavored frozen desserts such as ice pops are often soothing. Occasionally, the throat is so sore that liquids cannot be taken in adequate amounts by mouth. In severe situations, intravenous (IV) fluids may be needed. Otherwise, the patient is encouraged to drink as much fluid as possible (at least 2 to 3 L/day).

Nursing Management

Nursing care for patients with viral pharyngitis focuses on symptomatic management. For patients who demonstrate signs of strep throat and have a history of rheumatic fever, who have scarlet fever, or who have symptoms suggesting peritonsillar abscess, nursing care focuses on prompt initiation and correct administration of prescribed antibiotic therapy. The nurse instructs the patient about signs and symptoms that warrant prompt contact with the primary provider. These include dyspnea, drooling, inability to swallow, and inability to fully open the mouth.

The nurse instructs the patient to stay in bed during the febrile stage of illness and to rest frequently once up and about. Used tissues should be disposed of properly to prevent the spread of infection. The nurse (or the patient or family member, if the patient is not hospitalized) should examine the skin once or twice daily for possible rash, because acute pharyngitis may precede some other communicable diseases (e.g., rubella).

Depending on the severity of the pharyngitis and the degree of pain, warm saline gargles or throat irrigations are used. The benefits of this treatment depend on the degree of heat that is applied. The nurse educates the patient about these procedures and about the recommended temperature of the solution, which should be high enough to be effective and as warm as the patient can tolerate, usually 40.6° to 43.3°C (105° to 110°F). Irrigating the throat may reduce spasm in the pharyngeal muscles and relieve soreness of the throat.

An ice collar also can relieve severe sore throats. Mouth care may promote the patient's comfort and prevent the development of fissures (cracking) of the lips and oral inflammation when bacterial infection is present. The nurse instructs the patient to resume activity gradually and to delay returning to work or school until after 24 hours of antibiotic therapy. A full course of antibiotic therapy is indicated in patients with strep infection because of the potential complications such as nephritis and rheumatic fever, which may have their onset 2 or 3 weeks after the pharyngitis has subsided. The nurse instructs the patient and family about the importance of taking the full course of antibiotic therapy and informs them about the symptoms to watch for that may indicate complications.

In addition, the nurse instructs the patient about preventive measures that include not sharing eating utensils, glasses, napkins, food, or towels; cleaning telephones after use; using a tissue to cough or sneeze; disposing of used tissues appropriately; coughing or sneezing into the upper arm if tissues are not readily available; and avoiding exposure to tobacco and secondhand smoke. The nurse also instructs the patient with pharyngitis, especially streptococcal pharyngitis, to replace their toothbrush with a new one.

Chronic Pharyngitis

Chronic pharyngitis is a persistent inflammation of the pharynx. It is common in adults who work in dusty surroundings, use their voice to excess, suffer from chronic cough, or habitually use alcohol and tobacco.

There are three types of chronic pharyngitis:

- Hypertrophic—characterized by general thickening and congestion of the pharyngeal mucous membrane
- Atrophic—probably a late stage of the first type (the membrane is thin, whitish, glistening, and at times wrinkled)
- Chronic granular—characterized by numerous swollen lymph follicles on the pharyngeal wall

Clinical Manifestations

Patients with chronic pharyngitis complain of a constant sense of irritation or fullness in the throat, mucus that collects in the throat and can be expelled by coughing, and difficulty swallowing. This is often associated with intermittent postnasal drip that causes minor irritation and inflammation of the pharynx. A sore throat that is worse with swallowing in the absence of pharyngitis suggests the possibility of thyroiditis, and patients with this symptom are referred for the evaluation of possible thyroiditis.

Medical Management

Treatment of chronic pharyngitis is based on relieving symptoms; avoiding exposure to irritants; and correcting any upper respiratory, pulmonary, gastrointestinal, or cardiac condition that might be responsible for a chronic cough.

Nasal congestion may be relieved by short-term use of nasal sprays or medications containing ephedrine sulfate or phenylephrine. For a patient with a history of allergy, one of the antihistamine decongestant medications, such as pseudoephedrine or brompheniramine/pseudoephedrine, is prescribed orally every 4 to 6 hours. Aspirin (for patients older than 20 years) or acetaminophen is recommended for its analgesic properties.

For adults with chronic pharyngitis, tonsillectomy may be offered as an option, although its effectiveness in reaping long-term improvement in symptoms has not been established (Burton, Glasziou, Chong, et al., 2014). For further information, see the Tonsillitis and Adenoiditis section.

Nursing Management

Educating Patients About Self-Care

The nurse recommends avoidance of alcohol, tobacco, ENDS use, secondhand smoke, and exposure to cold or to environmental or occupational pollutants. The patient may minimize exposure to pollutants by wearing a disposable facemask, preferably an N95 mask, which can filter out 95% of small particles, including dusts and molds (National Institute for Occupational Safety and Health, 2018). The nurse encourages the patient to drink plenty of fluids. Gargling with warm saline solution may relieve throat discomfort. Lozenges keep the throat moistened (Stead, 2017).

Tonsillitis and Adenoiditis

The tonsils are composed of lymphatic tissue and are situated on each side of the oropharynx. The faucial or palatine tonsils and lingual tonsils are located behind the pillars of fauces and tongue, respectively. They frequently serve as the site of infection (**tonsillitis**). Acute tonsillitis can be confused with pharyngitis. Chronic tonsillitis is less common and may be mistaken for other disorders such as allergy, asthma, and rhinosinusitis.

The adenoids or pharyngeal tonsils consist of lymphatic tissue near the center of the posterior wall of the nasopharynx. Infection of the adenoids frequently accompanies acute tonsillitis. Frequently occurring bacterial pathogens include GABHS, the most common organism. The most common viral pathogen is Epstein–Barr virus, although cytomegalovirus may also cause tonsillitis and adenoiditis. Often thought of as a childhood disorder, tonsillitis can occur in adults.

Clinical Manifestations

The symptoms of tonsillitis include sore throat, fever, snoring, and difficulty swallowing. Enlarged adenoids may cause mouth breathing, earache, draining ears, frequent head colds, bronchitis, foul-smelling breath, voice impairment, and noisy respiration. Unusually enlarged adenoids fill the space behind the posterior nares, making it difficult for the air to travel from the nose to the throat and resulting in nasal obstruction. Infection can extend to the middle ears by way of the auditory (eustachian) tubes and may result in acute otitis media, which can lead to spontaneous rupture of the tympanic membranes (eardrums) and further extension of the infection into the mastoid cells, causing acute mastoiditis. The infection also may reside in the middle ear as a chronic, low-grade, smoldering process that eventually may cause permanent deafness.

Assessment and Diagnostic Findings

The diagnosis of acute tonsillitis is primarily clinical, with attention given to whether the illness is viral or bacterial in nature. As in acute pharyngitis, RADT is quick and convenient; however, it is less sensitive than the throat swab culture.

A thorough physical examination is performed and a careful history is obtained to rule out related or systemic conditions. The tonsillar site is cultured to determine the presence of bacterial infection. When cytomegalovirus infection is present, the differential diagnosis should include HIV, hepatitis A, and rubella. In adenoiditis, if recurrent episodes of suppurative otitis media result in hearing loss, comprehensive audiometric assessment is warranted (see Chapter 59).

Medical Management

Tonsillitis is treated with supportive measures that include increased fluid intake, antispasmodic agents, salt-water gargles, and rest. Bacterial infections are treated with penicillin (first-line therapy) or cephalosporins. Viral tonsillitis is not effectively treated with antibiotic therapy.

Tonsillectomy (with or without adenoidectomy) continues to be a commonly performed surgical procedure and remains the treatment of choice for patients with chronic tonsillitis (Shah, 2018). Adults who have undergone a tonsillectomy to treat recurrent streptococcal infections experience a decrease in the number of episodes of streptococcal or other throat infections or days with throat pain (Busaba & Doron, 2018).

Tonsillectomy is indicated if the patient has had repeated episodes of tonsillitis despite antibiotic therapy; hypertrophy of the tonsils and adenoids that could cause obstruction and obstructive sleep apnea (OSA); repeated attacks of purulent otitis media; and suspected hearing loss due to serous otitis media that has occurred in association with enlarged tonsils and adenoids. Indications for adenoidectomy include chronic nasal airway obstruction, chronic rhinorrhea, obstruction of the auditory tube with related ear infections, and abnormal speech. Surgery is also indicated if the patient has developed a peritonsillar abscess that occludes the pharynx, making swallowing difficult and endangering the patency of the airway (particularly during sleep). The presence of persistent tonsillar asymmetry should prompt an excisional biopsy to rule out lymphoma (Papadakis et al., 2018). Antibiotic therapy may be initiated for patients undergoing tonsillectomy or adenoidectomy. Therapy may include oral penicillin or a cephalosporin (e.g., cefdinir or moxifloxacin).

Nursing Management

Providing Postoperative Care

Continuous nursing observation is required in the immediate postoperative and recovery periods because of the risk of hemorrhage, which may also compromise the patient's airway (Drake & Carr, 2017). In the immediate postoperative period, the most comfortable position is prone, with the patient's head turned to the side to allow drainage from the mouth and pharynx. The nurse must not remove the oral airway until the patient's gag and swallowing reflexes have returned. The nurse applies an ice collar to the neck, and a basin and tissues are provided for the expectoration of blood and mucus.

Symptoms of postoperative complications include fever, throat pain, ear pain, and bleeding. Pain can be effectively controlled with analgesic medications. Postoperative bleeding may be seen as bright red blood if the patient expectorates it before swallowing it. If the patient swallows the blood, it becomes brown because of the action of the acidic gastric juice. If the patient

vomits large amounts of dark blood or bright-red blood at frequent intervals, or if the pulse rate and temperature rise and the patient is restless, the nurse notifies the surgeon immediately. The nurse should have the following items ready for the examination of the surgical site for bleeding: a light, a mirror, gauze, curved hemostats, and a waste basin.

Occasionally, suture or ligation of a bleeding vessel is required. In such cases, the patient is taken to the operating room and given general anesthesia. After ligation, continuous nursing observation and postoperative care are required, as in the initial postoperative period. If there is no bleeding, water and ice chips may be given to the patient as soon as desired. The patient is instructed to refrain from too much talking and coughing, because these activities can produce throat pain (see Chapter 16 for further discussion of postoperative nursing care).

Educating Patients About Self-Care

Tonsillectomy and adenoidectomy are usually performed as outpatient surgery, and the patient is sent home from the recovery room once awake, oriented, and able to drink liquids and void. The patient and family must understand the signs and symptoms of hemorrhage. Bleeding may occur up to 8 days after surgery. The nurse instructs the patient about the use of liquid acetaminophen with or without codeine for pain control and explains that the pain will subside during the first 3 to 5 days. The nurse informs the patient about the need to take the full course of any prescribed antibiotic for the first postoperative week (Drake & Carr, 2017).

Alkaline mouthwashes and warm saline solutions are useful in coping with the thick mucus and halitosis that may be present after surgery. The nurse should explain to the patient that a sore throat, stiff neck, minor ear pain, and vomiting may occur in the first 24 hours. The patient should eat an adequate diet with soft foods, which are more easily swallowed than hard foods. The patient should avoid spicy, hot, acidic, or rough foods. Milk and milk products (ice cream and yogurt) may be restricted because they make removal of mucus more difficult for some patients. The nurse instructs the patient about the need to maintain good hydration. The patient is advised to avoid vigorous toothbrushing or gargling because these activities can cause bleeding. The nurse encourages the use of a cool-mist vaporizer or humidifier in the home postoperatively. The patient should avoid smoking and heavy lifting or exertion for 10 days.

Peritonsillar Abscess

Peritonsillar abscess (also called *quinsy*) is the most common major suppurative complication of sore throat accounting for roughly 30% of soft tissue head and neck abscesses. It most commonly afflicts adults between the ages of 20 and 40 years, with the incidence roughly the same between men and women (Flores, 2018). This collection of purulent exudate between the tonsillar capsule and the surrounding tissues, including the soft palate, may develop after an acute tonsillar infection that progresses to a local cellulitis and abscess. Several bacteria are typically implicated in the pathogenesis of these abscesses, including *S. pyogenes, S. aureus, Neisseria* species, and *Corynebacterium* species (Flores, 2018; Shah, 2018). In more severe cases, the infection can spread over the palate and to the neck and chest. Edema can cause airway obstruction, which can be life-threatening and is a medical emergency. Peritonsillar abscess can be life-threatening with mediastinitis, intracranial abscess, and empyemas resulting from spread of infection. Early detection and aggressive management are essential (Flores, 2018).

Clinical Manifestations

The patient with a peritonsillar abscess is acutely ill with a severe sore throat, fever, trismus (inability to open the mouth), and drooling. Inflammation of the medial pterygoid muscle that lies lateral to the tonsil results in spasm, severe pain, and difficulty in opening the mouth fully. The pain may be so intense that the patient has difficulty swallowing saliva. The patient's breath often smells rancid. Other symptoms include a raspy voice, odynophagia (a severe sensation of burning, squeezing pain while swallowing), **dysphagia** (difficulty swallowing), and otalgia (pain in the ear). Odynophagia is caused by the inflammation of the superior constrictor muscle of the pharynx that forms the lateral wall of the tonsil. This causes pain on lateral movement of the head. The patient may also have tender and enlarged cervical lymph nodes. Examination of the oropharynx reveals erythema of the anterior pillar and soft palate as well as a purulent tonsil on the side of the peritonsillar abscess. The tonsil is pushed inferomedially, and the uvula is shifted contralaterally (Flores, 2018).

Assessment and Diagnostic Findings

Emergency department (ED) physicians frequently are the providers who diagnose patients with peritonsillar abscesses. When this occurs in the ED setting, the ED physician decides whether aspiration—an invasive procedure—should be carried out based on the patient's clinical picture. Intraoral ultrasound and transcutaneous cervical ultrasound are used in the diagnosis of peritonsillar cellulitis and abscesses (Gosselin, 2018).

Medical Management

Antimicrobial agents and corticosteroid therapy are used for the treatment of peritonsillar abscess. Antibiotics (usually penicillin) are extremely effective in controlling the infection, and if they are prescribed early in the course of the disease, the abscess may resolve without needing to be incised. However, if the abscess does not resolve, treatment choices include needle aspiration, incision and drainage under local or general anesthesia, and drainage of the abscess with simultaneous tonsillectomy. Following needle aspiration (discussed later) intramuscular administration of clindamycin can be used in the outpatient setting, thus reducing both antibiotic and hospital costs. The use of topical anesthetic agents and throat irrigations may be prescribed to promote comfort along with administration of prescribed analgesic agents (Flores, 2018).

Patients with complications require hospitalization for IV antibiotics, imaging studies, observation, and proper airway management. Rarely, the patient with a peritonsillar abscess presents with acute airway obstruction and requires immediate airway management. Procedures may include intubation, cricothyroidotomy, or tracheotomy (Flores, 2018).

Surgical Management

Needle aspiration may be preferred over a more extensive procedure due to its high efficacy, low cost, and patient tolerance. The mucous membrane over the swelling is first sprayed with a topical anesthetic and then injected with a local anesthetic. Single or repeated needle aspirations are performed to decompress the abscess. Alternatively, the abscess may be incised and drained (Flores, 2018). These procedures are performed best with the patient in the sitting position to make it easier to expectorate the pus and blood that accumulate in the pharynx. The patient experiences almost immediate relief. Incision and drainage is also an effective option but is more painful than needle aspiration.

Tonsillectomy is considered for patients who are poor candidates for needle aspiration or incision and drainage (Flores, 2018).

Nursing Management

If the patient requires intubation, cricothyroidotomy, or tracheotomy to treat airway obstruction, the nurse assists with the procedure and provides support to the patient before, during, and after the procedure. The nurse also assists with the needle aspiration when indicated.

The nurse encourages the patient to use prescribed topical anesthetic agents and assists with throat irrigations or the frequent use of mouthwashes or gargles, using saline or alkaline solutions at a temperature of 40.6° to 43.3°C (105° to 110°F). Gentle gargling after the procedure with a cool normal saline gargle may relieve discomfort. The patient must be upright and clearly

expectorate forward. The nurse instructs the patient to gargle *gently* at intervals of 1 or 2 hours for 24 to 36 hours. Liquids that are cool or at room temperature are usually well tolerated. Adequate fluids must be provided to treat dehydration and prevent its recurrence.

The nurse also observes the patient for complications and instructs the patient about signs and symptoms of complications that require prompt attention by the patient's primary provider. At discharge, the nurse provides verbal and written instructions regarding foods to avoid, when to return to work, and the need to refrain from or cease smoking. The need for continuation of good oral hygiene is also reinforced.

Laryngitis

Laryngitis, an inflammation of the larynx, can occur as a result of voice abuse, exposure to dust, chemicals, smoke and other pollutants; or as part of a URI. It also may be caused by isolated infection involving only the vocal cords. Laryngitis can also be associated with gastroesophageal reflux (referred to as reflux laryngitis).

Laryngitis is very often caused by the pathogens that cause the common cold and pharyngitis; the most common cause is a virus, and laryngitis is often associated with allergic rhinitis or pharyngitis. Bacterial invasion may be secondary. The onset of infection may be associated with exposure to sudden temperature changes, dietary deficiencies, malnutrition, or an immunosuppressed state. Viral laryngitis is common in the winter and is easily transmitted to others.

Clinical Manifestations

Signs of acute laryngitis include hoarseness or **aphonia** (loss of voice) and severe cough. Chronic laryngitis is marked by persistent hoarseness. Other signs of acute laryngitis include sudden onset made worse by cold dry wind. The throat feels worse in the morning and improves when the patient is indoors in a warmer climate. At times, the patient presents with a dry cough and a dry, sore throat that worsens in the evening hours. If allergies are present, the uvula will be visibly edematous. Many patients also complain of a "tickle" in the throat that is made worse by cold air or cold liquids.

Medical Management

Management of acute laryngitis includes resting the voice, avoiding irritants (including smoking), resting, and inhaling cool steam or an aerosol. If the laryngitis is part of a more extensive respiratory infection caused by a bacterial

organism or if it is severe, appropriate antibacterial therapy is instituted. The majority of patients recover with conservative treatment; however, laryngitis tends to be more severe in older adult patients and may be complicated by pneumonia.

For chronic laryngitis, the treatment includes resting the voice, eliminating any primary respiratory tract infection, eliminating smoking, and avoiding secondhand smoke. Corticosteroids, such as beclomethasone, may be given. These preparations have few systemic or long-lasting effects and may reduce local inflammatory reactions. Treatment of reflux laryngitis typically involves use of proton pump inhibitors such as omeprazole given once daily.

Nursing Management

The nurse instructs the patient to rest the voice and to maintain a well-humidified environment. If laryngeal secretions are present during acute episodes, expectorant agents are suggested, along with a daily fluid intake of 2 to 3 L to thin secretions. The nurse instructs the patient about the importance of taking prescribed medications, including proton pump inhibitors, and using continuous positive airway therapy at bedtime, if prescribed for OSA. In cases involving infection, the nurse informs the patient that the symptoms of laryngitis often extend a week to 10 days after completion of antibiotic therapy. The nurse instructs the patient about signs and symptoms that require contacting the primary provider. These signs and symptoms include loss of voice with sore throat that makes swallowing saliva difficult, hemoptysis, and noisy respirations. Continued hoarseness after voice rest or laryngitis that persists for longer than 5 days must be reported because of the possibility of malignancy.

NURSING PROCESS

The Patient with Upper Airway Infection

Assessment

A health history may reveal signs and symptoms of headache, sore throat, pain around the eyes and on either side of the nose, difficulty in swallowing, cough, hoarseness, fever, stuffiness, and generalized discomfort and fatigue. Determining when the symptoms began, what precipitated them, what if anything relieves them, and what aggravates them is part of the assessment. The nurse should also determine any history of allergy or the existence of a concomitant illness. Inspection may reveal swelling, lesions, or asymmetry of the nose as well as bleeding or discharge. The nurse inspects the nasal mucosa for abnormal findings such as increased redness, swelling, exudate, and nasal polyps, which may develop in chronic rhinitis. The mucosa of the nasal turbinates may also be swollen (boggy) and pale bluish-gray. The nurse palpates the frontal and maxillary sinuses for tenderness, which suggests inflammation and then inspects the throat by having the patient open the mouth wide and take a deep breath. Redness, asymmetry, or evidence of drainage, ulceration, or enlargement of the tonsils and pharynx is abnormal. Palpation of the neck lymph nodes for enlargement and tenderness is necessary.

Diagnosis

NURSING DIAGNOSES

Based on the assessment data, nursing diagnoses may include the following:

- Impaired airway clearance associated with excessive mucus production secondary to retained secretions and inflammation
- Acute pain associated with upper airway irritation secondary to an infection
- Impaired verbal communication associated with physiologic changes and upper airway irritation secondary to infection or swelling
- Hypovolaemia associated with decreased fluid intake and increased fluid loss secondary to diaphoresis associated with a fever
- Lack of knowledge regarding prevention of URIs, treatment regimen, surgical procedure, or postoperative self-care

COLLABORATIVE PROBLEMS/POTENTIAL COMPLICATIONS

Based on the assessment data, potential complications include:

- Sepsis
- Meningitis or brain abscess
- Peritonsillar abscess, otitis media, or rhinosinusitis

Planning and Goals

The major goals for the patient may include maintenance of a patent airway, relief of pain, maintenance of effective means of communication, normal hydration, knowledge of how to prevent upper airway infections, and absence of complications.

Nursing Interventions

Maintaining a Patent Airway

An accumulation of secretions can block the airway in patients with an upper airway infection. As a result, changes in the respiratory pattern occur and the work of breathing increases to compensate for the blockage. The nurse can implement several measures to loosen thick secretions or to keep the secretions moist so that they can be easily expectorated. Increasing fluid intake helps thin the mucus. The use of room vaporizers or steam inhalation also loosens secretions and reduces inflammation of the mucous membranes. To enhance drainage from the sinuses, the nurse instructs the patient about positioning; this depends on the location of the infection or inflammation. For example, drainage for rhinosinusitis or rhinitis is achieved in the upright position. In some conditions, topical or systemic medications, when prescribed, help relieve nasal or throat congestion.

Promoting Comfort

URIs usually produce localized discomfort. In rhinosinusitis, pain may occur in the area of the sinuses, or a general headache may be produced. In pharyngitis, laryngitis, or tonsillitis, a sore throat occurs. The nurse encourages the patient to take antispasmodic agents, such as acetaminophen with codeine, as prescribed, to relieve this discomfort. A pain intensity rating scale (see Chapter 9) may be used to assess effectiveness of pain relief measures. Other helpful measures include topical anesthetic agents for symptomatic relief of herpes simplex blisters (see Chart 18-3) and sore throats, hot packs to relieve the congestion of rhinosinusitis and promote drainage, and warm water gargles or irrigations to relieve the pain of a sore throat. The nurse encourages rest to relieve the generalized discomfort and fever that accompany many upper airway conditions (especially rhinitis, pharyngitis, and laryngitis). For postoperative care after tonsillectomy and adenoidectomy, an ice collar may reduce swelling and decrease bleeding.

Promoting Communication

Upper airway infections may result in hoarseness or loss of speech. The nurse instructs the patient to refrain from speaking as much as possible and, if possible, to communicate in writing instead. Additional strain on the vocal cords may delay full return of the voice. The nurse encourages the patient and family to use alternative forms of communication, such as a

memo pad, bell, or a smartphone or other electronic devices to signal for assistance.

Encouraging Fluid Intake

Upper airway infections lead to fluid loss. Sore throat, malaise, and fever may interfere with a patient's willingness to eat and drink. The nurse provides a list of easily ingested foods to increase caloric intake during the acute phase of illness. These include soups, gelatin, pudding, yogurt, cottage cheese, high-protein drinks, water, ice, and ice pops. The nurse encourages the patient to drink 2 to 3 L of fluid per day during the acute stage of airway infection, unless contraindicated, to thin the secretions and promote drainage. Liquids (hot or cold) may be soothing, depending on the disorder.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care. Prevention of most upper airway infections is challenging because of the many potential causes. But because most URIs are transmitted by hand-to-hand contact, the nurse educates the patient and family about techniques to minimize the spread of infection to others, including implementing hand hygiene measures. The nurse advises the patient to avoid exposure to people who are at the risk for serious illness if respiratory infection is transmitted (older adults, people who are immunosuppressed, and those with chronic health problems).

The nurse instructs patients and their families about strategies to relieve symptoms of URIs and reinforces the need to complete the treatment regimen, particularly when antibiotics are prescribed.

Continuing and Transitional Care. Referral for home, community-based, or transitional care is rare. However, it may be indicated for people whose health status was compromised before the onset of the respiratory infection and for those who cannot manage self-care without assistance. In such circumstances, the home health nurse assesses the patient's respiratory status and progress in recovery. The nurse may advise older adult patients and those at increased risk from a respiratory infection to consider annual influenza and pneumococcal vaccination. A follow-up appointment with the primary provider may be indicated for patients with compromised health status to ensure that the respiratory infection has resolved.

Monitoring and Managing Potential Complications

Although major complications of URIs are rare, the nurse must be aware of them and assess the patient for them. Because most patients with URIs are managed at home, patients and their families must be instructed to monitor for signs and symptoms and to seek immediate medical care if the patient's condition does not improve or if the patient's physical status appears to be worsening.

Sepsis or meningitis may occur in patients with compromised immune status or in those with an acute bacterial infection. The patient and caregiver are instructed to seek medical care if the patient's condition fails to improve within several days after the onset of symptoms, if unusual symptoms develop, or if the patient's condition deteriorates. They are instructed about signs and symptoms that require further attention: persistent or high fever, increasing shortness of breath, confusion, and increasing weakness and malaise. The patient with sepsis requires expert care to treat the infection, stabilize vital signs, and prevent or treat septic shock (see Chapter 11). Deterioration of the patient's condition necessitates intensive care measures (e.g., hemodynamic monitoring and administration of vasoactive medications, IV fluids, nutritional support, and corticosteroids) to monitor the patient's status and to support the patient's vital signs. High doses of antibiotics may be given to treat the causative organism. The nurse's role is to monitor the patient's vital signs, hemodynamic status, and laboratory values; administer needed treatment; alleviate the patient's physical discomfort; and provide explanations, education, and emotional support to the patient and family.

Peritonsillar abscess may develop after an acute infection of the tonsils. The patient requires treatment to drain the abscess and receives antibiotics for infection and topical anesthetic agents and throat irrigations to relieve pain and sore throat. Follow-up is necessary to ensure that the abscess resolves; tonsillectomy may be required. The nurse assists the patient in administering throat irrigations and instructs the patient and family about the importance of adhering to the prescribed treatment regimen and recommended follow-up appointments.

In some severe situations, peritonsillar abscess may progress to meningitis or brain abscess. The nurse assesses for changes in mental status ranging from subtle personality changes through drowsiness to coma, nuchal rigidity, and focal neurologic signs that signal increasing cerebral edema around the abscess (see Chapter 64). Seizures, typically tonic–clonic, occur in this setting. Intensive care measures are necessary. High doses of antibiotics may be used to treat the causative organism. The nurse's role is similar to caring for the patient with sepsis in an intensive care setting. The nurse monitors the patient's neurologic status and reports changes immediately.

Otitis media and rhinosinusitis may develop with URI. The patient and family are instructed about the signs and symptoms of otitis media and rhinosinusitis and about the importance of follow-up with the primary provider to ensure adequate evaluation and treatment of these conditions.

Evaluation

Expected patient outcomes may include the following:

1. Maintains a patent airway by managing secretions
   a. Reports decreased congestion
   b. Assumes best position to facilitate drainage of secretions
   c. Uses self-care measures appropriately and consistently to manage secretions during the acute phase of illness
2. Reports relief of pain and discomfort using pain intensity scale
   a. Uses comfort measures: antispasmodic agents, hot packs, gargles, rest
   b. Demonstrates adequate oral hygiene
3. Demonstrates ability to communicate needs, wants, level of comfort
4. Maintains adequate fluid and nutrition intake
5. Utilizes strategies to prevent upper airway infections and allergic reactions
   a. Demonstrates hand hygiene technique
   b. Identifies the value of the influenza vaccine
6. Demonstrates an adequate level of knowledge and performs self-care adequately
7. Becomes free of signs and symptoms of infection
   a. Exhibits normal vital signs (temperature, pulse, respiratory rate)
   b. Absence of purulent drainage
   c. Free of pain in ears, sinuses, and throat
   d. Absence of signs of inflammation
8. Absence of complications
   a. No signs of sepsis: fever, hypotension, deterioration of cognitive status
   b. Vital signs and hemodynamic status normal
   c. No evidence of neurologic involvement
   d. No signs of development of peritonsillar abscess
   e. Resolution of URI without development of otitis media or rhinosinusitis
   f. No signs and symptoms of brain abscess

OBSTRUCTION AND TRAUMA OF THE UPPER RESPIRATORY AIRWAY

Obstructive Sleep Apnea

OSA is a disorder characterized by recurrent episodes of upper airway obstruction and a reduction in ventilation. It is defined as **apnea** (cessation of breathing) during sleep usually caused by repetitive upper airway obstruction. The estimated prevalence of OSA is approximately 26% of adults between the ages of 30 and 70 years (Wickramasinghe, 2019). It is believed that between 4% and 9% of women and 9% and 24% of men in the United States have OSA, and that up to 90% are not diagnosed; these increased rates have been linked to the increase in rates of obesity (Wickramasinghe, 2019) (see Chapter 42). OSA interferes with people's ability to obtain adequate rest, thus affecting memory, learning, and decision making.

Risk factors for OSA include obesity, male gender, postmenopausal status in women, and advanced age. The major risk factor is obesity; a larger neck circumference and increased amounts of peripharyngeal fat narrow and compress the upper airway. Because OSA is often found in patients with hypertension, all adult patients with hypertension should be screened for OSA (Showalter & O'Keefe, 2019). Other associated factors include alterations in the upper airway, such as structural changes (e.g., tonsillar hypertrophy, abnormal posterior positioning of one or both jaws, and variations in craniofacial structures) that contribute to the collapsibility of the upper airway (Wickramasinghe, 2019).

Pathophysiology

The pharynx is a collapsible tube that can be compressed by the soft tissues and structures surrounding it. The tone of the muscles of the upper airway is reduced during sleep. Mechanical factors such as reduced diameter of the upper airway or dynamic changes in the upper airway during sleep may result in obstruction. These sleep-related changes may predispose to upper airway collapse when small amounts of negative pressure are generated during inspiration.

Repetitive apneic events result in hypoxia (decreased oxygen saturation) and hypercapnia (increased concentration of carbon dioxide), which triggers a sympathetic response. As a consequence, patients with OSA have a high prevalence of hypertension. In addition, OSA is associated with an increased risk of myocardial infarction and stroke, which may be mitigated with appropriate treatment (Wickramasinghe, 2019).

Clinical Manifestations

OSA is characterized by frequent and loud snoring with breathing cessation for 10 seconds or longer, for at least five episodes per hour, followed by awakening abruptly with a loud snort as the blood oxygen level drops. Patients

with sleep apnea may have anywhere from five apneic episodes per hour to several hundred per night.

Classic signs and symptoms of OSA include the "3 S's"—namely, *s*noring, *s*leepiness, and *s*ignificant-other report of sleep apnea episodes. Common signs and symptoms of OSA are presented in Chart 18-4. Symptoms typically progress with increases in weight and aging (Wickramasinghe, 2019). Patients are typically unaware of nocturnal upper airway obstruction during sleep. They frequently complain of insomnia, including difficulty in going to sleep, nighttime awakenings, and early morning awakenings with an inability to go back to sleep, as well as chronic fatigue and hypersomnolence (daytime sleepiness). When obtaining the health history, the nurse asks the patient about sleeping during normal activities such as eating or talking. Patients with this symptom are considered to have pathologic hypersomnolence (Wickramasinghe, 2019).

Chart 18-4 ASSESSMENT

Assessing for Obstructive Sleep Apnea

Be alert for the following signs and symptoms of obstructive sleep apnea:

- Excessive daytime sleepiness
- Frequent nocturnal awakening
- Insomnia
- Loud snoring
- Morning headaches
- Intellectual deterioration
- Personality changes, irritability
- Impotence
- Systemic hypertension
- Arrhythmias
- Pulmonary hypertension, cor pulmonale
- Polycythemia
- Enuresis

Adapted from Wickramasinghe, H. (2019). Obstructive sleep apnea. Retrieved on 5/27/2019 at: www.emedicine.medscape.com/article/295807-overview

Assessment and Diagnostic Findings

The diagnosis of sleep apnea is based on clinical features plus a polysomnographic finding (i.e., sleep study), which is the definitive test for OSA. The test is an overnight study, performed in a specialized sleep disorders

center, which continuously measures multiple physiologic signals while the patient sleeps. These signals are analyzed as they are related to stages of sleep; measures include those taken by electroencephalogram (EEG), electro-oculogram, and chin electromyogram (EMG). In addition, cardiac rhythms and arrhythmias are monitored with a single-lead electrocardiogram (ECG) and leg movements are recorded by an anterior tibialis EMG. Airflow at the nose and mouth is monitored using both a thermal sensor and a nasal pressure transducer, breathing effort is monitored using inductance plethysmography, and hemoglobin oxygen saturation is monitored by oximetry. The breathing pattern is analyzed for the presence of apneas and hypopneas. Characteristic findings consistent with OSA include apneic episodes occurring in the presence of respiratory muscle effort, clinically significant apneic episodes lasting 10 seconds or longer, and apneic episodes most prevalent during the rapid eye movement (REM) stage of sleep. Sleep disruption from automated patient arousal is usually seen at the termination of an episode of apnea (Wickramasinghe, 2019).

Medical Management

Patients usually seek medical treatment because their sleeping partners express concern or because they experience excessive sleepiness at inappropriate times or settings (e.g., while driving a car). A variety of treatments are used. Weight loss, avoidance of alcohol, positional therapy (using devices that prevent patients from sleeping on their backs), and oral appliances such as mandibular advancement devices (MADs) are the first steps (American Sleep Apnea Association, 2019; Joshi, 2018). When applied correctly, an MAD advances the mandible so that it is slightly anterior to the upper front teeth, preventing airway obstruction by the tongue and soft tissue during sleep. A randomized controlled trial that compared the effectiveness of these devices among patients with OSA with the more conventional therapy, continuous positive airway pressure (CPAP), found no difference in short-term outcomes between MAD and CPAP, including daytime sleepiness and quality of life, suggesting that MAD is as effective a treatment as CPAP in patients with mild-to-moderate OSA (Petri, Christensen, Svanholt, et al., 2019; Viscuso & Arena, 2016). In more severe cases involving hypoxemia and severe hypercapnia, the treatment includes CPAP or bilevel positive airway pressure (BiPAP) therapy with supplemental oxygen via nasal cannula. CPAP is used to prevent airway collapse, whereas BiPAP makes breathing easier and results in a lower average airway pressure (Patil, Ayappa, Caples, et al., 2019; the use of CPAP and BiPAP is discussed in more detail in Chapter 19).

Surgical Management

Surgical procedures also may be performed to correct OSA. Simple tonsillectomy may be effective for patients with larger tonsils when deemed clinically necessary, or when other options have failed or are refused by patients (Morgan, 2017). Uvulopalatopharyngoplasty is the resection of pharyngeal soft tissue and removal of approximately 15 mm of the free edge of the soft palate and uvula. Effective in about 50% of patients, it is more effective in eliminating snoring than apnea. Nasal septoplasty may be performed for gross anatomic nasal septal deformities. Maxillomandibular surgery may be performed to advance the maxilla and mandible forward in order to enlarge the posterior pharyngeal region (Morgan, 2017). Tracheostomy relieves upper airway obstruction but has numerous adverse effects, including speech difficulties and increased risk of infections. These procedures, as well as other maxillofacial surgeries, are reserved for patients with concomitant cardiovascular disease and life-threatening arrhythmias or severe disability who have not responded to conventional therapy (Papadakis et al., 2018).

Pharmacologic Therapy

Some medications are useful in managing symptoms associated with OSA. Modafinil is approved by the U.S. Food and Drug Administration (FDA) for use in patients who have residual daytime sleepiness despite optimal use of CPAP. The most improvement has been seen in patients who have taken modafinil at daily doses of 200 to 400 mg. Armodafinil is also now approved by the FDA for use in these patients. It is more potent than modafinil because it is pure R-modafinil, which is the most psychoactive compound of modafinil (Wickramasinghe, 2019). Protriptyline given at bedtime may increase the respiratory drive and improve upper airway muscle tone. Medroxyprogesterone acetate and acetazolamide might be prescribed for sleep apnea associated with chronic alveolar hypoventilation; however, their benefits have not been well established. The patient must understand that these medications are not a substitute for CPAP, BiPAP, or MAD. Administration of low-flow nasal oxygen at night can help relieve hypoxemia in some patients but has little effect on the frequency or severity of apnea.

Nursing Management

The patient with OSA may not recognize the potential consequences of the disorder. Therefore, the nurse explains the disorder in terms that are understandable to the patient and relates symptoms (daytime sleepiness) to the underlying disorder. The nurse also instructs the patient and family about treatments, including the correct and safe use of CPAP, BiPAP, MAD, and oxygen therapy, if prescribed. The nurse educates the patient about the risk of untreated OSA and the benefits of treatment approaches.

Epistaxis

Epistaxis, a hemorrhage from the nose, is caused by the rupture of tiny, distended vessels in the mucous membrane of any area of the nose. Rarely does epistaxis originate in the densely vascular tissue over the turbinates. Most commonly, the site is the anterior septum, where three major blood vessels enter the nasal cavity: (1) the anterior ethmoidal artery on the forward part of the roof (Kiesselbach plexus), (2) the sphenopalatine artery in the posterosuperior region, and (3) the internal maxillary branches (the plexus of veins located at the back of the lateral wall under the inferior turbinate).

Several risk factors are associated with epistaxis (Chart 18-5).

Medical Management

Management of epistaxis depends on its cause and the location of the bleeding site. A nasal speculum, penlight, or headlight may be used to identify the site of bleeding in the nasal cavity. Most nosebleeds originate from the anterior portion of the nose. Initial treatment may include applying direct pressure. The patient sits upright with the head tilted forward to prevent swallowing and aspiration of blood and is directed to pinch the soft outer portion of the nose against the midline septum for 5 or 10 minutes continuously. Application of nasal decongestants (phenylephrine, one or two sprays) to act as vasoconstrictors may be necessary. If these measures are unsuccessful in stopping the bleeding, the nose must be examined using good illumination and suction to determine the site of bleeding. Visible bleeding sites may be cauterized with silver nitrate or electrocautery (high-frequency electrical current). A supplemental patch of Surgicel or Gelfoam may be used (Papadakis et al., 2018).

Chart 18-5 RISK FACTORS

Epistaxis

- Local infections (vestibulitis, rhinitis, rhinosinusitis)
- Systemic infections (scarlet fever, malaria)
- Drying of nasal mucous membranes
- Nasal inhalation of corticosteroids (e.g., beclomethasone) or illicit drugs (e.g., cocaine)
- Trauma (digital trauma, blunt trauma, fracture, forceful nose blowing)
- Arteriosclerosis
- Hypertension
- Tumor (sinus or nasopharynx)
- Thrombocytopenia
- Use of aspirin
- Liver disease
- Rendu–Osler–Weber syndrome (hereditary hemorrhagic telangiectasia)

Adapted from Nguyen, Q. A. (2018). Epistaxis. Retrieved on 5/27/2019 at: www.emedicine.medscape.com/article/863220-overview

Alternatively, a cotton tampon may be used to try to stop the bleeding. Suction may be used to remove excess blood and clots from the field of inspection. The search for the bleeding site should shift from the anteroinferior quadrant to the anterosuperior, then to the posterosuperior, and finally to the posteroinferior area. The field is kept clear by using suction and by shifting the cotton tampon.

If the origin of the bleeding cannot be identified, the nose may be packed with gauze impregnated with petrolatum jelly or antibiotic ointment; a topical anesthetic spray and decongestant agent may be used before the gauze packing is inserted, or a balloon-inflated catheter may be used (Fig. 18-3). Alternatively, a compressed nasal sponge may be used. Once the sponge becomes saturated with blood or is moistened with a small amount of saline, it will expand and produce tamponade to halt the bleeding. The packing may remain in place for 3 to 4 days if necessary to control bleeding (Nguyen, 2018). Antibiotics may be prescribed because of the risk of iatrogenic rhinosinusitis and sepsis.

Nursing Management

The nurse monitors the patient's vital signs, assists in the control of bleeding, and provides tissues and an emesis basin to allow the patient to expectorate any excess blood. It is common for patients to be anxious in response to a nosebleed. Blood loss on clothing and handkerchiefs can be frightening, and the nasal examination and treatment are uncomfortable. Assuring the patient in

a calm, efficient manner that bleeding can be controlled can help reduce anxiety. The nurse continuously assesses the patient's airway and breathing as well as vital signs. On rare occasions, a patient with significant hemorrhage requires IV infusions of crystalloid solutions (normal saline) as well as cardiac and pulse oximetry monitoring.

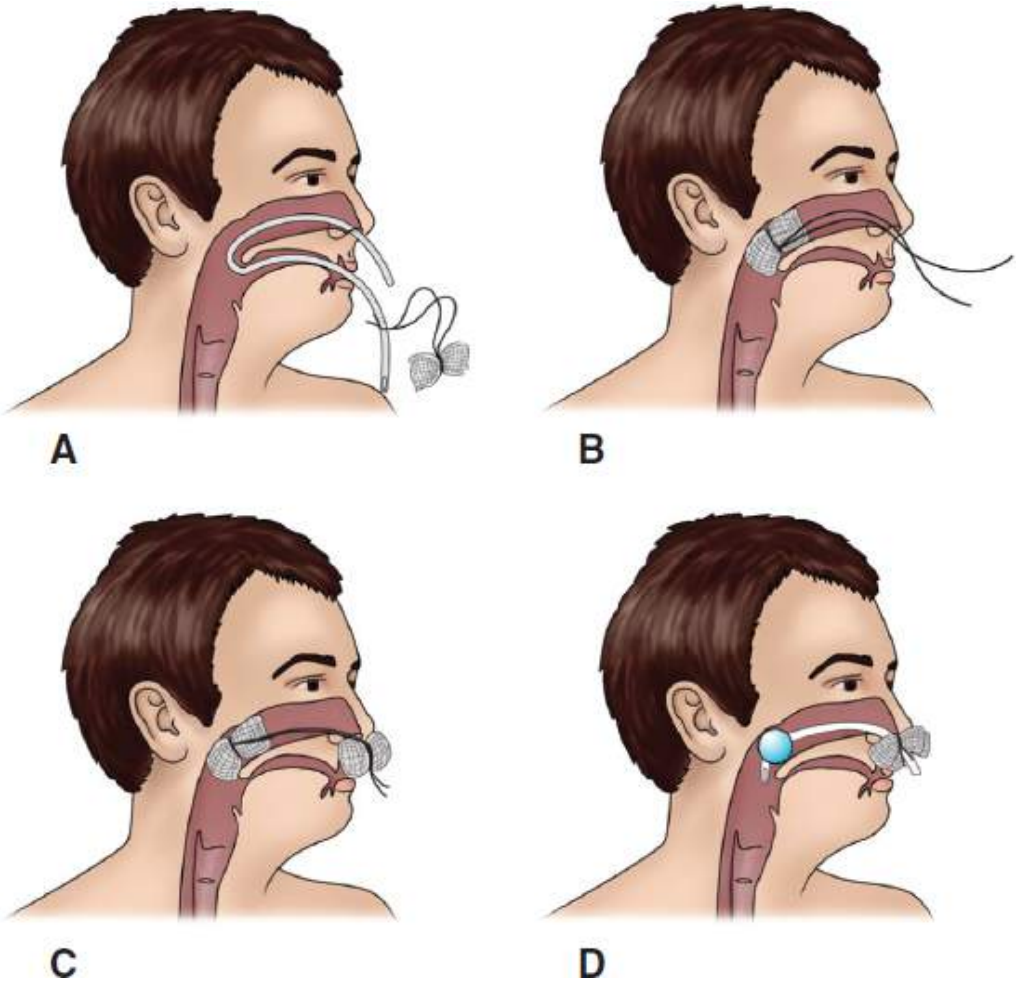

Figure 18-3 • Packing to control bleeding from the posterior nose. **A.** Catheter is inserted and packing is attached. **B.** Packing is drawn into position as the catheter is removed. **C.** Strip is tied over a bolster to hold the packing in place with an anterior pack installed "accordion pleat" style. **D.** Alternative method, using a balloon catheter instead of gauze packing.

Educating Patients About Self-Care

Once the bleeding is controlled, the nurse instructs the patient to avoid vigorous exercise for several days and to avoid hot or spicy foods, tobacco use by smoking, or ENDS use, because this may cause vasodilation and increase the risk of rebleeding. Discharge education includes reviewing ways to prevent

epistaxis: avoiding forceful nose blowing, straining, high altitudes, and nasal trauma (including nose picking). Adequate humidification may prevent drying of the nasal passages. The nurse explains how to apply direct pressure to the nose with the thumb and the index finger for 15 minutes in the case of a recurrent nosebleed. If recurrent bleeding cannot be stopped, the patient is instructed to seek additional medical attention.

Nasal Obstruction

The passage of air through the nostrils is frequently obstructed by a deviation of the nasal septum, hypertrophy of the turbinate bones, or the pressure of nasal polyps. Chronic nasal congestion forces the patient to breathe through the mouth, thus producing dryness of the oral mucosa and associated problems including persistent dry, cracked lips. Patients with chronic nasal congestion often suffer from sleep deprivation due to difficulty maintaining an adequate airway while lying flat and during sleep.

Persistent nasal obstruction also may lead to chronic infection of the nose and result in frequent episodes of nasopharyngitis. Frequently, the infection extends to the nasal sinuses. When rhinosinusitis develops and the drainage from these cavities is obstructed by deformity or swelling within the nose, pain is experienced in the region of the affected sinus.

Medical Management

The treatment of nasal obstruction requires the removal of the obstruction, followed by measures to treat whatever chronic infection exists. In many patients, an underlying allergy also requires treatment. Measures to reduce or alleviate nasal obstruction include nonsurgical as well as surgical techniques. Commonly used medications include nasal corticosteroids (see Table 18-2) as well as oral leukotriene inhibitors, such as montelukast. Treatment with nasal corticosteroids for 1 to 3 months is usually successful for the treatment of small polyps and may even reduce the need for surgical intervention. A short course of oral corticosteroids (6-day course of prednisone) may be beneficial in the treatment of nasal obstruction due to polyps (Papadakis et al., 2018). Additional medications may include antibiotics for the treatment of underlying infection or antihistamines for the management of allergies. Hypertrophied turbinates may be treated by applying an astringent agent to shrink them.

A more aggressive approach in treating nasal obstruction caused by turbinate hypertrophy involves surgical reduction of the hypertrophy. Surgical procedures used to treat obstructive nasal conditions are collectively known as functional rhinoplasty. Technical advances with newer techniques provide a number of options for reconstruction and reshaping of the nose.

Nursing Management

When a surgical procedure is indicated, most often it is performed on an outpatient basis. The nurse explains the procedure to the patient. Postoperatively, the nurse elevates the head of the bed to promote drainage and to alleviate discomfort from edema. Frequent oral hygiene is encouraged to overcome dryness caused by breathing through the mouth. Before discharge from the outpatient or same-day surgical unit, the patient is instructed to avoid blowing the nose with force during the postoperative recovery period. The patient is also instructed about the signs and symptoms of bleeding and infection and when to contact the primary provider. The patient is provided with written postoperative instructions, including emergency phone numbers.

Fractures of the Nose

The location of the nose makes it susceptible to injury. Nasal fracture is the most common facial fracture and the most common fracture in the body (Becker, 2018). Fractures of the nose usually result from a direct assault. Nasal fractures may affect the ascending process of the maxilla and the septum. The torn mucous membrane results in a nosebleed. Complications include hematoma, infection, abscess, and avascular or septic necrosis. However, as a rule, serious consequences usually do not occur.

Clinical Manifestations

The signs and symptoms of a nasal fracture are pain, bleeding from the nose externally and internally into the pharynx, swelling of the soft tissues adjacent to the nose, periorbital ecchymosis, nasal obstruction, and deformity. The patient's nose may have an asymmetric appearance that may not be obvious until the edema subsides.

Assessment and Diagnostic Findings

The nose is examined internally to rule out the possibility that the injury may be complicated by a fracture of the nasal septum and a submucosal septal hematoma. Intranasal examination is performed in all cases to rule out septal hematoma (Papadakis et al., 2018). Because of the swelling and bleeding that occur with a nasal fracture, an accurate diagnosis can be made only after the swelling subsides.

Clear fluid draining from either nostril suggests a fracture of the cribriform plate with leakage of cerebrospinal fluid. Usually, careful inspection or palpation discloses any deviations of the bone or disruptions of the nasal

cartilages. An x-ray may reveal displacement of the fractured bones and may help rule out extension of the fracture into the skull.

Medical Management

A nasal fracture very often produces bleeding from the nasal passage. As a rule, bleeding is controlled with the use of packing. Cold compresses are used to prevent or reduce edema. For the patient who has sustained enough trauma to break the nose or any facial bone, the emergency medical team must consider the possibility of a cervical spine fracture. Therefore, it is essential to ensure a patent airway and to rule out a cervical spine fracture (see Chapter 63). Uncomplicated nasal fractures may be treated initially with antibiotics, analgesic agents, and a decongestant nasal spray.

Treatment of nasal fractures is aimed at restoring nasal function and returning the appearance of the nose to baseline. The patient is referred to a specialist to evaluate the need to realign the bones. Although improved outcomes are obtained when reduction in the fracture is performed during the first 3 hours after the injury, this is often not possible because of the edema. If immediate reduction of the fracture is not possible, it is performed within 3 to 7 days. Timing is important when treating nasal fractures because further delay in treatment may result in problematic bone healing, which ultimately may require surgical intervention that includes rhinoplasty to reshape the external appearance of the nose (Becker, 2018). A septorhinoplasty is performed when the nasal septum needs to be repaired. In patients who develop a septal hematoma, the physician drains the hematoma through a small incision. A septal hematoma that is not drained can lead to permanent deformity of the nose.

Nursing Management

Immediately after the fracture, the nurse applies ice and encourages the patient to keep the head elevated. The nurse instructs the patient to apply ice packs to the nose to decrease swelling. The patient who experiences epistaxis is usually frightened and anxious and needs reassurance. The packing inserted to stop the bleeding may be uncomfortable and unpleasant, and obstruction of the nasal passages by the packing forces the patient to breathe through the mouth. This in turn causes the oral mucous membranes to become dry. Mouth rinses help to moisten the mucous membranes and to reduce the odor and taste of dried blood in the oropharynx and nasopharynx. The use of analgesic agents such as acetaminophen or NSAIDs (e.g., ibuprofen, naproxen) is encouraged. When removing the cotton pledgets, the nurse carefully inspects the mucosa for lacerations or a septal hematoma. The nurse instructs the patient to avoid sports activities for 6 weeks.

Laryngeal Obstruction

Obstruction of the larynx because of edema is a serious condition that may be fatal without swift, decisive intervention. The larynx is a stiff box that will not stretch. It contains a narrow space between the vocal cords (glottis), through which air must pass. Swelling of the laryngeal mucous membranes may close off the opening tightly, leading to life-threatening hypoxia or suffocation. Edema of the glottis occurs rarely in patients with acute laryngitis, occasionally in patients with urticaria, and more frequently in patients with severe inflammation of the throat, as in scarlet fever. It is an occasional cause of death in severe anaphylaxis (angioedema).

TABLE 18-3 Causes of Laryngeal Obstruction

Precipitating Event	Mechanism of Obstruction
History of allergies; exposure to medications, latex, foods (peanuts, tree nuts [e.g., walnuts, pecans]), bee stings	Anaphylaxis
Foreign body	Inhalation/ingestion of meat or other food items, coin, chewing gum, balloon fragments, drug packets (ingested to avoid criminal arrest)
Heavy alcohol consumption; heavy tobacco use	Obstruction from tumor
Family history of airway problems	Suggests angioedema (type I hypersensitivity reaction)
Use of angiotensin-converting enzyme inhibitor	Increased risk of angioedema of the mucous membranes
Recent throat pain or recent fever	Infectious process
History of surgery or previous tracheostomy	Possible subglottic stenosis

Adapted from Reardon, R. F., Mason, P. E., & Clinton, J. E. (2017). Basic airway management and decision-making. In J. D. Roberts (Ed.). *Roberts & Hedges' clinical procedures in emergency medicine* (7th ed.). Philadelphia, PA: Elsevier Saunders.

Hereditary angioedema is also characterized by episodes of life-threatening laryngeal edema. Laryngeal edema in people with hereditary angioedema can occur at any age, although young adults are at greatest risk (Reardon, Mason, & Clinton, 2017). Some causes of laryngeal obstruction appear in Table 18-3.

When foreign bodies are aspirated into the pharynx, the larynx, or the trachea a twofold problem occurs. First, they obstruct the air passages and cause difficulty in breathing, which may lead to asphyxia; later, they may be drawn farther down, entering the bronchi or a bronchial branch and causing symptoms of irritation, such as a croupy cough, expectoration of blood or mucus, or labored breathing.

Clinical Manifestations

The patient's clinical presentation and x-ray findings confirm the diagnosis of laryngeal obstruction. The patient may demonstrate lowered oxygen saturation; however, normal oxygen saturation should not be interpreted as a sign that the obstruction is not significant. The use of accessory muscles to maximize airflow may occur and is often manifested by retractions in the neck or abdomen during inspirations. Patients who demonstrate these symptoms are at an immediate risk of collapse, and respiratory support (i.e., mechanical ventilation or positive-pressure ventilation) is considered.

Assessment and Diagnostic Findings

A thorough history can be very useful in diagnosing and treating the patient with a laryngeal obstruction. However, emergency measures to secure the patient's airway should not be delayed to obtain a history or perform tests. If possible, the nurse obtains a history from the patient or family about heavy alcohol or tobacco consumption, ENDS use, current medications, history of airway problems, recent infections, pain or fever, dental pain or poor dentition, and any previous surgeries, radiation therapy, or trauma.

Medical Management

Medical management is based on the initial evaluation of the patient and the need to ensure a patent airway. If the airway is obstructed by a foreign body and signs of asphyxia are apparent, immediate treatment is necessary using principles from basic and advanced cardiopulmonary resuscitation (CPR). If all efforts are unsuccessful, an immediate tracheotomy is necessary (see Chapter 19 for further discussion). If the obstruction is caused by edema resulting from an allergic reaction, treatment may include immediate administration of subcutaneous epinephrine and a corticosteroid (see Chapter 33). Ice may be applied to the neck in an effort to reduce edema. Continuous pulse oximetry is essential in the patient who has experienced acute upper airway obstruction (Reardon et al., 2017).

Cancer of the Larynx

Cancer of the larynx accounts for approximately half of all head and neck cancers. The American Cancer Society (ACS, 2017) estimates that about 12,410 new cases and 3760 deaths occur annually, with a 5-year relative survival rate that ranges from 32% to 90%, depending on the location of the tumor and its stage at the time of diagnosis (ACS, 2017). Cancer of the larynx

is most common in people older than 65 years and is four times more common in men (ACS, 2017) (Chart 18-6).

Chart 18-6 RISK FACTORS

Laryngeal Cancer

Carcinogens

- Tobacco (smoke, smokeless, e-cigarettes, hookahs, secondhand smoke)
- Heavy alcohol consumption (defined as more than one drink daily)
- Combined effects of alcohol and tobacco
- Asbestos
- Paint fumes
- Wood dust
- Chemicals used in metalworking, petroleum, plastics, and textiles

Other Factors

- Nutritional deficiencies (vitamins)
- Genetic predisposition
- Age (higher incidence after 65 years of age)
- Gender (more common in men)
- Race (more prevalent in African Americans and Whites)
- Weakened immune system

Adapted from American Cancer Society (ACS). (2017). What are the risk factors for laryngeal and hypopharyngeal cancers? Retrieved on 5/27/2019 at: www.cancer.org/Cancer/LaryngealandHypopharyngealCancer/DetailedGuide/laryngeal-and-hypopharyngeal-cancer-risk-factors

Almost all malignant tumors of the larynx arise from the surface epithelium and are classified as squamous cell carcinoma. Approximately 55% of patients with laryngeal cancer present with involved lymph nodes at the time of diagnosis, with bilateral lesions present in 16% of patients (De Vita, Hellman, & Rosenberg, 2018). Recurrence occurs usually within the first 2 to 3 years after diagnosis. The presence of disease after 5 years is often secondary to a new primary malignancy. The incidence of distant metastasis with squamous cell carcinoma of the head and neck (including larynx cancer) is relatively low.

Clinical Manifestations

Hoarseness of more than 2 weeks' duration occurs in the patient with cancer in the glottic area because the tumor impedes the action of the vocal cords during speech. The voice may sound harsh, raspy, and lower in pitch. Affected voice sounds are not always early signs of subglottic or supraglottic cancer, however. The patient may complain of a persistent cough or sore throat and pain and burning in the throat, especially when consuming hot liquids or citrus juices. A lump may be felt in the neck. Later symptoms include dysphagia, dyspnea (difficulty breathing), unilateral nasal obstruction or discharge, persistent hoarseness, persistent ulceration, and foul breath. Cervical lymph adenopathy, unintentional weight loss, a general debilitated state, and pain radiating to the ear may occur with metastasis.

Assessment and Diagnostic Findings

An initial assessment includes a complete history and physical examination of the head and neck. This includes identification of risk factors, family history, and any underlying medical conditions. An indirect laryngoscopy, using a flexible endoscope, is initially performed in the otolaryngologist's office to visually evaluate the pharynx, larynx, and possible tumor. Mobility of the vocal cords is assessed; if normal movement is limited, the growth may affect muscle, other tissue, and even the airway. The lymph nodes of the neck and the thyroid gland are palpated for enlargement.

Diagnostic procedures that may be used include fine-needle aspiration (FNA) biopsy, a barium swallow, endoscopy, CT or MRI scan, and a positron emission tomography (PET) scan (ACS, 2017). FNA biopsy may be done as an initial screening procedure to obtain samples of any enlarged lymph nodes in the neck. A barium swallow may be done if the patient initially presents with a chief complaint of difficulty in swallowing, to outline any structural anomalies of the neck that could pinpoint a tumor. However, if a tumor of the larynx is suspected on an initial examination, a direct laryngoscopic examination is indicated. Laryngoscopy is performed under local or general anesthesia to evaluate all areas of the larynx. In some cases, intraoperative examination obtained by direct microscopic visualization and palpation of the vocal folds may yield a more accurate diagnosis. Samples of the suspicious tissue are obtained for analysis. It is uncommon that human papillomavirus (HPV) is implicated in laryngeal cancers, although it is frequently implicated in oropharyngeal and tonsillar cancers. Whether or not the tumor is positive for HPV does not have an effect on the course of treatment (ACS, 2017).

The classification, including stage of the tumor (i.e., size and histology of the tumor, presence and extent of cervical lymph node involvement) and location of the tumor serve as a basis for treatment. CT scanning and MRI are used to assess regional adenopathy and soft tissues and to stage and determine the extent of a tumor. MRI is also helpful in posttreatment follow-up to detect

a recurrence. PET scanning may also be used to detect recurrence of the laryngeal tumor after treatment.

Medical Management

The goals of treatment of laryngeal cancer include cure; preservation of safe, effective swallowing; preservation of useful voice; and avoidance of permanent tracheostoma (Papadakis et al., 2018). Treatment options include surgery, radiation therapy, and adjuvant chemoradiation therapy. The prognosis depends on the tumor location (i.e., supraglottic, glottis, subglottic), as well as the tumor grade and stage (i.e., using the TNM system; see Chapter 12, Chart 12-3). The treatment plan also depends on whether the cancer is an initial diagnosis or a recurrence. In addition, before treatment begins, a complete dental examination is performed to rule out any oral disease. A consultation with a dental oncologist may be warranted. Any dental problems are resolved, if possible, before surgery and radiotherapy (ACS, 2017).

For patients with early-stage tumors (i.e., stages I and II) and lesions without lymph node involvement, external-beam radiation therapy or conservation surgery (i.e., less invasive surgery, such as vocal cord stripping or cordectomy) may be effective. Other indicated surgical procedures may include transoral endoscopic laser excision or partial **laryngectomy** (i.e., in this instance, removal of part of the larynx) (National Cancer Institute [NCI], 2019). Patients with stage III and IV tumors that are resectable may be advised to have either total laryngectomies with or without postoperative radiation therapy or radiation therapy with concurrent adjuvant chemotherapy (with single-agent cisplatin) and surgical resection aimed at preserving some of the larynx (i.e., organ preservation surgery). Patients with late-stage tumors that extend through cartilage and into soft tissues are generally advised to have total laryngectomies with postoperative radiation therapy (NCI, 2019).

Patients should be educated so that they carefully consider the various side effects and complications associated with the different treatment modalities. The presence of lymph node involvement in the neck can affect the outcome. Supraglottic tumors metastasize early and bilaterally even when there appears to be no lymph node involvement at the time of diagnosis. When the neck lymph nodes are involved, the treatment includes surgery, chemoradiation, or both (Papadakis et al., 2018).

Surgical Management

The overall goals for the patient undergoing surgical treatment include minimizing the effects of surgery on speech, swallowing, and breathing while maximizing the likelihood of a cure of the cancer. Several different curative procedures are available that can offer voice-sparing results while achieving a positive cure rate for the patient who has an early laryngeal carcinoma.

Surgical options include vocal cord stripping, cordectomy, laser surgery, partial laryngectomy, or total laryngectomy (NCI, 2019).

Vocal Cord Stripping

Stripping of the vocal cord is used to treat dysplasia, hyperkeratosis, and leukoplakia and is often curative for these lesions. The procedure involves removal of the mucosa of the edge of the vocal cord, using an operating microscope. Early vocal cord lesions are initially treated with radiation therapy.

Cordectomy

Cordectomy, which is an excision of the vocal cord, is usually performed via transoral laser. This procedure is used for lesions limited to the middle third of the vocal cord. The resulting voice quality is related to the extent of tissue removed.

Laser Surgery

Laser microsurgery is well known to have several advantages for the treatment of early glottic cancers. Treatment and recovery are shorter, with fewer side effects, and treatment may be less costly than for other forms of therapy. Microelectrodes are useful for surgical resection of smaller laryngeal carcinomas. The carbon dioxide (CO_2) laser can be used for the treatment of many laryngeal tumors, with the exception of large vascular tumors. When compared with the results of other treatments for early laryngeal cancer, laser microsurgery is considered to be the method of choice based on patient outcomes (NCI, 2019).

Partial Laryngectomy

A partial laryngectomy (laryngofissure–thyrotomy) is often used for patients in the early stages of cancer in the glottic area when only one vocal cord is involved. The surgery is associated with a very high cure rate. It may also be performed for recurrence when high-dose radiation has failed. A portion of the larynx is removed, along with one vocal cord and the tumor; all other structures remain. The airway remains intact, and the patient is expected to have no difficulty swallowing. The voice quality may change, or the patient may sound hoarse.

Total Laryngectomy

Complete removal of the larynx (total laryngectomy) can provide a cure in most advanced laryngeal cancers, when the tumor extends beyond the vocal cords, or for cancer that recurs or persists after radiation therapy. In a total laryngectomy, the laryngeal structures are removed, including the hyoid bone,

epiglottis, cricoid cartilage, and two or three rings of the trachea. The tongue, pharyngeal walls, and most of the trachea are preserved. A total laryngectomy results in permanent loss of the voice and a change in the airway, requiring a permanent tracheostomy (Fig. 18-4). Occasionally, patients continue to have a laryngectomy tube in the stoma. Laryngectomy tubes are similar in appearance to tracheostomy tubes; however, a laryngectomy tube can be distinguished from a tracheostomy tube because the patient is unable to speak or breathe when the laryngectomy tube is occluded. Patients who have a total laryngectomy require alternatives to normal speech; these may include a prosthetic device, such as a Blom–Singer valve, to speak without aspirating (see later discussion).

Surgery is more difficult when the lesion involves the midline structures or both vocal cords. With or without neck dissection, a total laryngectomy requires a permanent tracheal stoma because the larynx that provides the protective sphincter is no longer present. The tracheal stoma prevents the aspiration of food and fluid into the lower respiratory tract. The patient has no voice but has normal swallowing. A total laryngectomy changes the manner in which airflow is used for breathing and speaking, as depicted in Figure 18-4. The patient has significant loss of the natural voice and the need to breathe through a stoma (an opening) created in the lower neck. Complications that may occur include a salivary leak, wound infection from the development of a pharyngocutaneous fistula, stomal stenosis, and dysphagia secondary to esophageal stricture. In some cases, the patient may be a candidate for a near-total laryngectomy. In this situation, the patient would be a candidate for chemoradiation therapy regimens postoperatively. Voice preservation can be achieved in most cases and tends to be associated with overall improved quality of life (Adil, 2018). Advances in surgical techniques for treating laryngeal cancer may minimize the cosmetic and functional deficits previously seen with total laryngectomy. Some microlaryngeal surgery can be performed endoscopically.

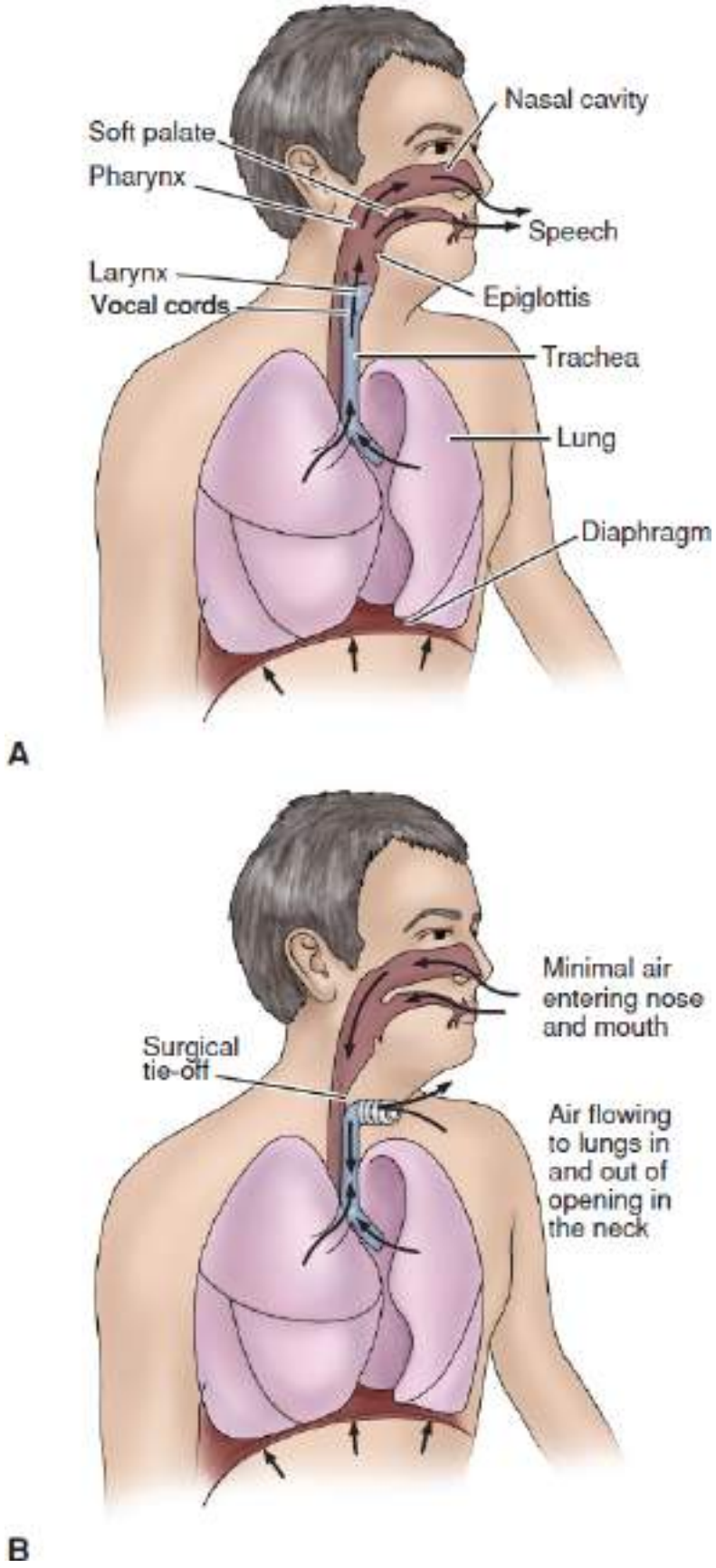

Figure 18-4 • Total laryngectomy produces a change in airflow for breathing and speaking. **A.** Normal airflow. **B.** Airflow after total

laryngectomy.

Radiation Therapy

The goal of radiation therapy is to eradicate the cancer and preserve the function of the larynx. The decision to use radiation therapy is based on several factors, including the staging of the tumor and the patient's overall health status, lifestyle (including occupation), and personal preference. Excellent results have been achieved with radiation therapy in patients with early-stage glottic tumors when only one vocal cord is involved and there is normal mobility of the cord (i.e., with phonation), as well as in small supraglottic lesions. One of the benefits of radiation therapy is that patients retain a near-normal voice. A few may develop chondritis (inflammation of the cartilage) or stenosis; a small number may later require laryngectomy.

Radiation therapy may also be used preoperatively to reduce the tumor size. Radiation therapy is combined with surgery in advanced laryngeal cancer as adjunctive therapy to surgery or chemotherapy and as a palliative measure.

Complications from radiation therapy are a result of external radiation to the head and neck area, which may also include the parotid gland, which is responsible for mucus production. Symptoms may include acute mucositis, ulceration of the mucous membranes, pain, **xerostomia** (dry mouth), loss of taste, dysphasia, fatigue, and skin reactions. Later complications may include laryngeal necrosis, edema, and fibrosis (see Chapter 12).

Speech Therapy

The patient who undergoes a laryngectomy and the patient's family face potentially complex challenges, including significant changes in the ability to communicate. To minimize anxiety and frustration on the part of the patient and family, the loss or alteration of speech is discussed with them. To plan postoperative communication strategies and speech therapy, the speech therapist or pathologist conducts a preoperative evaluation (ACS, 2017). During this time, the nurse discusses with the patient and family the methods of communication that will be available in the immediate postoperative period. These include writing, lip speaking and reading, communication or word boards, or smartphones or other electronic devices. A system of communication is established with the patient, family, nurse, and primary provider and is implemented consistently after surgery.

In addition, a long-term postoperative communication plan for **alaryngeal communication** (modes of speaking not involving the normal larynx) is developed. The three most common techniques of alaryngeal communication are esophageal speech, artificial larynx (electric larynx), and tracheoesophageal puncture. Training in these techniques begins once medical clearance is obtained from the primary provider.

Esophageal Speech

The patient needs the ability to compress air into the esophagus and expel it, setting off a vibration of the pharyngeal esophageal segment for esophageal speech. The technique can be taught once the patient begins oral feedings, approximately 1 week after surgery. First, the patient learns to belch and is reminded to do so an hour after eating. Then, the technique is practiced repeatedly. Later, this conscious belching action is transformed into simple explosions of air from the esophagus for speech purposes. The speech therapist continues to work with the patient to make speech intelligible and as close to normal as possible. Because it takes a long time to become proficient, the success rate is low (ACS, 2017).

Artificial Larynx

If esophageal speech is not successful, or until the patient masters the technique, an electric larynx may be used for communication. This battery-powered apparatus projects sound into the oral cavity. When the mouth forms words (articulation), the sounds from the electric larynx become audible words. The voice that is produced sounds mechanical, and some words may be difficult to understand. The advantage is that the patient is able to communicate with relative ease while working to become proficient at either esophageal or tracheoesophageal puncture speech.

Tracheoesophageal Puncture

The third technique of alaryngeal speech is tracheoesophageal puncture (Fig. 18-5). This technique for voice restoration is simple and has few complications. It is associated with high phonation success, good phonation quality, and steady long-term results. This technique is the most widely used because the speech associated with it most resembles normal speech (the sound produced is a combination of esophageal speech and voice), and it is easily achieved either during the initial surgery to treat the tumor or at a later date (ACS, 2017). A valve is placed in the tracheal stoma to divert air into the esophagus and out the mouth. Once the puncture is surgically created and has healed, a voice prosthesis (Blom–Singer) is fitted over the puncture site. A speech therapist teaches the patient how to produce sounds. Moving the tongue and lips to form the sound into words produces speech as before. To prevent airway obstruction, the prosthesis is removed and cleaned when mucus builds up.

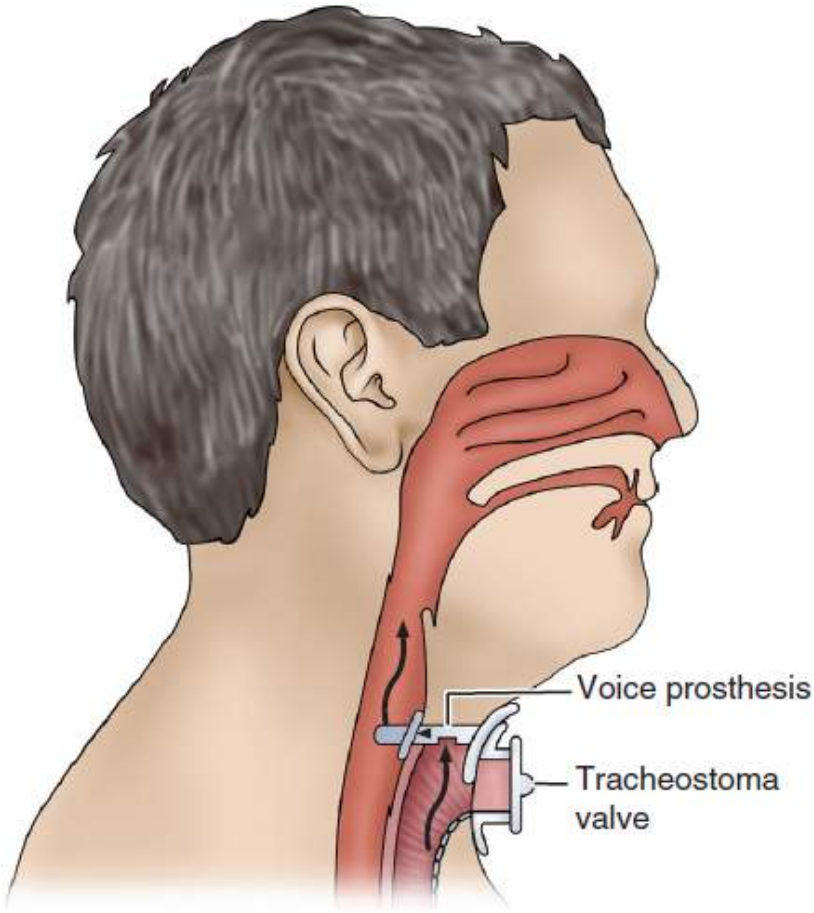

Figure 18-5 • Schematic representation of tracheoesophageal puncture speech. Air travels from the lung through a puncture in the posterior wall of the trachea into the esophagus and out the mouth. A voice prosthesis is fitted over the puncture site.

NURSING PROCESS

The Patient Undergoing Laryngectomy

Assessment

The nurse obtains a health history and assesses the patient's physical, psychosocial, and spiritual domains. The health history focuses on the following symptoms: hoarseness, sore throat, dyspnea, dysphagia, and pain or burning in the throat. The physical assessment includes a thorough head and neck examination with an emphasis on the patient's airway. In addition, the neck and thyroid are palpated for swelling, nodularity, or adenopathy.

The nurse also assesses the patient's general state of nutrition, including height and weight and body mass index and reviews laboratory values that assist in determining the patient's nutritional status (albumin, protein, glucose, and electrolyte levels). If treatment includes surgery, the nurse must know the nature of the surgery to plan appropriate care. If the patient is expected to have no voice as a result of the surgical procedure, a preoperative evaluation by the speech therapist is essential. The patient's ability to hear, see, read, and write is assessed. Visual impairment and functional illiteracy may create additional problems with communication and may require creative approaches to ensure that the patient is able to communicate any needs. Because alcohol abuse is a risk factor for cancer of the larynx, the patient's pattern of alcohol intake must be assessed. Patients who are accustomed to daily consumption of alcohol are at the risk for delirium tremens (alcohol withdrawal syndrome) when alcohol intake is stopped suddenly. It is also not uncommon that patients are active smokers at the time of diagnosis; assessment of readiness for smoking cessation should be done, and nicotine replacements prescribed to avoid nicotine withdrawal, as indicated (NCI, 2019) (see Chapter 23: Promoting Cessation of Tobacco Use).

In addition, the nurse assesses the psychological status of the patient and family. The fear of a diagnosis of cancer is compounded by the possibility of permanent voice loss and, in some cases, some degree of disfigurement. The nurse evaluates the patient's and family's knowledge of the planned surgical procedure and expected postoperative course and assesses their coping methods and support systems. The nurse assesses the patient's spirituality needs based on the patient's individual preferences, beliefs, and culture.

Diagnosis

NURSING DIAGNOSES

Based on the assessment data, major nursing diagnoses may include the following:

- Lack of knowledge about the surgical procedure and postoperative course
- Anxiety associated with the diagnosis of cancer and impending surgery
- Impaired airway clearance associated with excess mucus production secondary to surgical alterations in the airway
- Impaired verbal communication associated with anatomic deficit secondary to removal of the larynx and to edema
- Impaired nutritional intake associated with inability to ingest food secondary to swallowing difficulties
- Disturbed body image and risk for chronic low self-esteem secondary to major neck surgery, change in appearance, and altered structure and function
- Impaired ability to manage regime associated with pain, weakness, fatigue, musculoskeletal impairment related to surgical procedure and postoperative course

Collaborative Problems/Potential Complications

Based on the assessment data, potential complications may include the following:

- Respiratory distress (hypoxia, airway obstruction, tracheal edema)
- Hemorrhage, infection, and wound breakdown
- Aspiration
- Tracheostomal stenosis

Planning and Goals

The major goals for the patient may include attainment of an adequate level of knowledge, reduction in anxiety, maintenance of a patent airway (patient is able to handle own secretions), effective use of alternative means of communication, attainment of optimal levels of nutrition and hydration, improvement in body image and self-esteem, improved self-care management, and absence of complications.

Nursing Interventions

Providing Preoperative Patient Education

The diagnosis of laryngeal cancer often produces misconceptions and fears. Many people assume that loss of speech and disfigurement are inevitable with this condition. Once the primary provider explains the diagnosis and discusses treatment options with the patient and family, the nurse clarifies any misconceptions by identifying the location of the larynx, its function, the nature of the planned surgical procedure, and its effect on speech. Further, the patient's ability to sing, laugh, and whistle will be lost.

Informational materials (written and audiovisual) about the surgery are given to the patient and family for review and reinforcement. If a complete laryngectomy is planned, the patient must understand that the natural voice will be lost, but that special training can provide a means for communicating. The patient needs to know that until training is started, communication will be possible by using the call light, by writing, or by using a communication device. The interdisciplinary team conducts an initial assessment of the patient and family. In addition to the nurse and the primary provider, the team might include an advanced practice nurse (e.g., nurse practitioner), speech therapist, respiratory therapist, social worker, dietitian, and home health nurse. The services of a spiritual advisor are made available to the patient and family, as appropriate.

The nurse also reviews equipment and treatments for postoperative care with the patient and family, educates the patient about important coughing and deep breathing exercises, and helps the patient perform return demonstrations. The nurse clarifies the patient's role in the postoperative and rehabilitation periods. The family's needs must also be addressed because family members are often responsible for complex care of the patient in the home.

Reducing Anxiety

Because surgery of the larynx is performed most often for a malignant tumor, the patient may have many questions: Will the surgeon be able to remove all of the tumor? Is it cancer? Will I die? Will I choke? Will I suffocate? Will I ever speak again? What will I look like? Because of these and other questions, the psychological preparation of the patient is as important as the physical preparation.

Any patient undergoing surgery may have many fears. In laryngeal surgery, these fears may relate to the diagnosis of cancer and the possibility of permanent loss of the voice and disfigurement. The nurse provides the patient and family with opportunities to ask questions, verbalize feelings, and discuss perceptions. The nurse should address any questions and misconceptions the patient and family have. During the preoperative or postoperative period, a visit from someone who has had a laryngectomy may reassure the patient that people are available to assist and that rehabilitation is possible.

In the immediate postoperative period, the nurse attempts to build trust and reduce the patient's anxiety. Active listening provides an environment that promotes open communication and allows the patient to verbalize feelings. Clear instructions and explanations are given to the patient and family in a calm, reassuring manner. The nurse listens attentively, encourages the patient, and identifies and reduces environmental stressors. The nurse seeks to learn from the patient what activities promote feelings of comfort and assists the patient in such activities (e.g., listening to music,

reading). Relaxation techniques such as guided imagery and meditation are often helpful. During episodes of severe anxiety, the nurse remains with the patient and includes them in decision making.

Maintaining a Patent Airway

The nurse helps maintain a patent airway by positioning the patient in the semi-Fowler or Fowler position after recovery from anesthesia. This position decreases surgical edema and promotes lung expansion. Observing the patient for restlessness, labored breathing, apprehension, and increased pulse rate helps identify possible respiratory or circulatory problems. The nurse assesses the patient's lung sounds and reports changes that may indicate impending complications. Medications that depress respiration, particularly opioids, should be used cautiously. However, adequate use of analgesic medications is essential for pain relief because postoperative pain can result in shallow breathing and an ineffective cough (see Chapter 9 for discussion of pain management). The nurse encourages the patient to turn, cough, and take deep breaths. If necessary, suctioning may be performed to remove secretions, but disruption of suture lines must be avoided. The nurse also encourages and assists the patient with early ambulation to prevent atelectasis, pneumonia, and venous thromboemboli formation (e.g., pulmonary embolism and deep vein thrombosis). Pulse oximetry is used to monitor the patient's oxygen saturation level.

If a total laryngectomy was performed, a laryngectomy tube will most likely be in place. In some instances a laryngectomy tube is not used; in others it is used temporarily; and in many it is used permanently. The laryngectomy tube, which is shorter than a tracheostomy tube but has a larger diameter, is the patient's only airway. The care of this tube is similar to that for a tracheostomy tube (see Chapter 19). The nurse changes the inner cannula (if present) every 8 h if it is disposable. Although nondisposable tubes are used infrequently, if one is used, the nurse cleans the inner cannula every 8 h or more often as needed. If a tracheostomy tube without an inner cannula is used, humidification and suctioning of this tube are essential to prevent formation of mucus plugs. If a T-shaped laryngectomy tube is used, both sides of the T-tube should be suctioned to prevent obstruction due to copious secretions. The nurse should also use secure tracheostomy ties to prevent tube dislodgement. The nurse cleans the stoma daily with soap and water or another prescribed solution and a soft cloth or gauze, taking care to prevent water and soap or solution from entering the stoma. If a non–oil-based antibiotic ointment is prescribed, it is applied around the stoma and suture line. If crusting appears around the stoma, the crusts are removed with sterile tweezers and additional ointment is applied.

Wound drains, inserted during surgery, may be in place to assist in removal of fluid and air from the surgical site. Suction also may be used,

but cautiously, to avoid trauma to the surgical site and incision. The nurse observes, measures, and records drainage. When drainage is less than 30 mL/day for 2 consecutive days, the surgeon usually removes the drains.

Frequently, the patient coughs up large amounts of mucus through this opening. Because air passes directly into the trachea without being warmed and moistened by the upper respiratory mucosa, the tracheobronchial tree compensates by secreting excessive amounts of mucus. Therefore, the patient has frequent coughing episodes and may develop a brassy-sounding, mucus-producing cough. The nurse reassures the patient that these problems will diminish in time as the tracheobronchial mucosa adapts to the altered physiology.

After the patient coughs, the tracheostomy opening must be wiped clean and clear of mucus. A simple gauze dressing, washcloth, or even paper towel (because of its size and absorbency) worn below the tracheostomy may serve as a barrier to protect the clothing from the copious mucus that the patient may initially expel.

One of the most important factors in decreasing cough, mucus production, and crusting around the stoma is adequate humidification of the environment. Mechanical humidifiers and aerosol generators (nebulizers) increase the humidity and are important for the patient's comfort. The laryngectomy tube may be removed when the stoma is well healed, within 3 to 6 wk after surgery. The nurse educates the patient about how to clean and change the tube and remove secretions.

Promoting Alternative Communication Methods

Establishing an effective means of communication is usually the ultimate goal in the rehabilitation of the laryngectomy patient. To understand and anticipate the patient's postoperative needs, the nurse works with the patient, speech therapist, and family to encourage the use of alternative communication methods. These means of communication are established preoperatively and must be used consistently by all personnel who come in contact with the patient postoperatively. The patient is now unable to use an intercom system. A call bell or hand bell must be placed within easy reach of the patient. In the immediate postoperative period, a handheld communication device like a Magic Slate, electronic tablet, notebook, or smartphone can be used. If the patient cannot write, a picture–word–phrase board or hand signals can be used. The nurse documents which hand is the patient's dominant hand (e.g., used for writing) so that the opposite arm can be used for IV infusions. (To ensure the patient's privacy, the nurse shreds notes used for communication.)

Writing everything or communicating through gestures can be very time-consuming and frustrating. The patient must be given adequate time to communicate their needs. The patient may become impatient and angry when not understood.

Promoting Adequate Nutrition and Hydration

Postoperatively, the patient may not be permitted to eat or drink for at least 7 d (Suslu, 2016). Alternative sources of nutrition and hydration include IV fluids, enteral feedings through a nasogastric or gastrostomy tube, and parenteral nutrition (see Chapters 39 and 41).

When the patient is ready to start oral feedings, a swallow study (a video fluoroscopy radiology procedure) may be conducted to evaluate the patient's risk of aspiration. Once the patient is cleared for oral feedings, the nurse explains that thick liquids will be used first because they are easy to swallow. Different swallowing maneuvers are attempted with various food consistencies. Once the patient is cleared for food intake, the nurse stays with the patient during initial oral feedings and keeps a suction setup at the bedside for needed suctioning. The nurse instructs the patient to avoid sweet foods, which increase salivation and suppress the appetite. Solid foods are introduced as tolerated. The patient is instructed to rinse the mouth with warm water or mouthwash after oral feedings and to brush the teeth frequently.

Because taste and smell are so closely related, taste sensations are altered for a while after surgery because inhaled air passes directly into the trachea, bypassing the nose and the olfactory end organs. In time, however, the patient usually accommodates to this change and olfactory sensation adapts, often with return of interest in eating. The nurse observes the patient for any difficulty in swallowing, particularly when eating resumes, and reports its occurrence to the primary provider.

The patient's weight and laboratory data are monitored to ensure that nutritional and fluid intake are adequate. In addition, skin turgor and vital signs are assessed for signs of decreased fluid volume.

Promoting Positive Body Image and Self-Esteem

Disfiguring surgery and an altered communication pattern are threats to a patient's body image and self-esteem. The reaction of family members and friends is a major concern for the patient. The nurse encourages the patient to express feelings about the changes brought about by surgery, particularly feelings related to fear, anger, depression, and isolation. Encouraging the use of previous effective coping strategies may be helpful. Referral to a support group, such as the International Association of Laryngectomees (IAL) and WebWhispers, and to resources available through the American Cancer Society may help the patient and family deal with the changes in their lives. Information about these support groups can be found in the Resources section at the end of the chapter.

Promoting Effective Health Management

A positive approach along with promotion of effective health management is important when caring for the patient. The patient should begin

participating in effective health management activities as soon as possible. The nurse assesses the patient's readiness for decision making and encourages the patient to participate actively in performing care. Positive reinforcement is provided when the patient makes an effort in managing health effectively. The nurse needs to be a good listener and a support to the family, especially when explaining the tubes, dressings, and drains that are in place postoperatively.

Monitoring and Managing Potential Complications

The potential complications after laryngectomy include respiratory distress and hypoxia, hemorrhage, infection, wound breakdown, aspiration, and tracheostomal stenosis.

Respiratory Distress and Hypoxia. The nurse monitors the patient for signs and symptoms of respiratory distress and hypoxia, particularly restlessness, irritation, agitation, confusion, tachypnea, the use of accessory muscles, and decreased oxygen saturation on pulse oximetry (SpO_2). Any change in respiratory status requires immediate intervention. Hypoxia may cause restlessness and an initial rise in blood pressure; this is followed by hypotension and somnolence. Cyanosis is a late sign of hypoxia. Obstruction needs to be ruled out immediately by suctioning and by having the patient cough and breathe deeply. Hypoxia and airway obstruction, if not treated immediately, are life-threatening.

Other nursing measures include repositioning of the patient to ensure an open airway and administering oxygen as prescribed. Oxygen is used with caution in patients with chronic obstructive pulmonary disease. The nurse should always be prepared for possible intubation and mechanical ventilation and must be knowledgeable about the hospital's emergency code protocols and skilled in the use of emergency equipment. The nurse must remain with the patient at all times during respiratory distress and initiate a call to the rapid response team as necessary.

Hemorrhage. Bleeding from the drains at the surgical site or with tracheal suctioning may signal the occurrence of hemorrhage. The nurse promptly notifies the surgeon of any active bleeding, which can occur at a variety of sites, including the surgical site, drains, and trachea. Rupture of the carotid artery is especially dangerous. Should this occur, the nurse must apply direct pressure over the artery, summon assistance, and provide emotional support to the patient until the vessel is ligated. The nurse monitors vital signs for changes, particularly increased pulse rate, decreased blood pressure, and rapid deep respirations. Cold, clammy, pale skin may indicate active bleeding. IV fluids and blood components may be given and other measures implemented to prevent or treat hemorrhagic shock. (Management of the patient with shock is discussed in detail in Chapter 11.)

Infection. The nurse monitors the patient for signs of postoperative infection. These include an increase in temperature and pulse, a change in the type of wound drainage, and increased areas of redness or tenderness at the surgical site. Other signs include purulent drainage, odor, and increased wound drainage. The nurse monitors the patient's white blood cell (WBC) count; a rise in WBCs may indicate the body's effort to combat infection. In older adult patients, infection can be present without an increase in the patient's WBC count; therefore, the nurse must monitor the patient for more subtle signs, such as lethargy, weakness, and decreased appetite. WBCs are suppressed in the patient with decreased immune function (e.g., patients receiving chemotherapy or radiation therapy); this predisposes the patient to a severe infection and sepsis. Antimicrobial (antibiotic) medications must be given as scheduled. All suspicious drainage is cultured, and the patient may be placed on the appropriate infection prevention precautions. Strategies are implemented to minimize the exposure of the patient to microorganisms and their spread to others. The nurse reports any significant change in the patient's status to the surgeon.

Wound Breakdown. Wound breakdown caused by infection, poor wound healing, development of a fistula, radiation therapy, or tumor growth can create a life-threatening emergency. The carotid artery, which is close to the stoma, may rupture from erosion if the wound does not heal properly. The nurse observes the stoma area for wound breakdown, hematoma, and bleeding and reports their occurrence to the surgeon. If wound breakdown occurs, the patient must be monitored carefully and identified as at high risk for carotid hemorrhage.

Aspiration. The patient who has undergone a laryngectomy is at the risk for aspiration and aspiration pneumonia due to depressed cough, the sedating effects of anesthetic and analgesic medications, alteration in the airway, impaired swallowing, and the administration of tube feedings. The nurse assesses for the presence of nausea and administers antiemetic medications, as prescribed. The nurse keeps a suction setup available in the hospital and instructs the family to do so at home for use if needed. Patients receiving tube feedings are positioned with the head of the bed at 30 degrees or higher during feedings and for 30 to 45 min after tube feedings. Patients receiving oral feedings are positioned with the head of the bed in an upright position for 30 to 45 min after feedings. For patients with a nasogastric or gastrostomy tube, the placement of the tube and residual gastric volume must be checked before each feeding. High amounts of residual volume (greater than 50% of previous intake) indicate delayed gastric emptying; this can lead to reflux and aspiration (Papadakis et al., 2018). Signs or symptoms of aspiration are reported to the primary provider immediately.

Tracheostomal Stenosis. Tracheostomal stenosis is an abnormal narrowing of the trachea or the tracheostomy stoma. Infection at the stoma site, excessive traction on the tracheostomy tube by the connecting tubing, and persistent high tracheostomy cuff pressure are risk factors for tracheostomal stenosis. The incidence of this condition varies widely, and it is often preventable. The nurse assesses the patient's stoma for signs and symptoms of infection and reports any evidence of this to the primary provider immediately. Tracheostomy care is performed routinely. The nurse assesses the connecting tubing (e.g., ventilation tubing) and secures the tubing to avoid excessive traction on the patient's tracheostomy. The nurse ensures that the tracheostomy cuff is deflated (for a patient with a cuffed tube) except for short periods, such as when the patient is eating or taking medications.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care. The nurse has an important role in the recovery and rehabilitation of the patient who has had a laryngectomy. To facilitate the patient's ability to manage self-care, discharge instruction begins as soon as the patient is able to participate. Nursing care and patient education in the hospital, outpatient setting, and rehabilitation or long-term care facility must take into consideration the many emotions, physical changes, and lifestyle changes experienced by the patient. In preparing the patient to go home, the nurse assesses the patient's readiness to learn and the level of knowledge about self-care management. The nurse also reassures the patient and family that most self-care management strategies can be mastered. The patient needs to learn a variety of self-care behaviors, including tracheostomy and stoma care, wound care, and oral hygiene. The nurse also instructs the patient about the need for adequate dietary intake, safe hygiene, and recreational activities.

Tracheostomy and Stoma Care. The nurse provides specific instructions to the patient and family about what to expect with a tracheostomy and its management. The nurse instructs the patient and caregiver how to perform suctioning and emergency measures and tracheostomy and stoma care. The nurse stresses the importance of humidification at home and instructs the family to obtain and set up a humidification system before the patient returns home.

For the procedural guidelines for care of the patient with a tracheostomy tube, go to thepoint.lww.com/Brunner15e.

Hygiene and Safety Measures. The nurse instructs the patient and family about safety precautions that are needed because of the changes in structure and function resulting from the surgery. Special precautions are needed in the shower to prevent water from entering the stoma. Wearing a loose-fitting plastic bib over the tracheostomy or simply holding a hand over the opening is effective. Swimming is not recommended because a person with a laryngectomy can drown without submerging their face. Barbers and beauticians need to be alerted so that hair sprays, loose hair, and powder do not get near the stoma, because they can block or irritate the trachea and possibly cause infection. These self-care points are summarized in Chart 18-7.

The nurse educates the patient and caregiver about the signs and symptoms of infection and identifies indications that require contacting the primary provider after discharge. A discussion regarding cleanliness and infection control behaviors is essential. The nurse educates the patient and family to use hand hygiene before and after caring for the tracheostomy, to use tissues to remove mucus, and to dispose of soiled dressings and equipment properly. If the patient's surgery included cervical lymph node dissection, the nurse instructs the patient about how to perform exercises to strengthen the shoulder and neck muscles. A referral to a physical therapist might be helpful.

Recreation and exercise are important for the patient's well-being and quality of life, and all but very strenuous exercise can be enjoyed safely. Avoidance of strenuous exercise and fatigue is important because the patient will have more difficulty speaking when tired, which can be discouraging. Additional safety points to address include the need for the patient to wear or carry medical identification, such as a bracelet or card, to alert medical personnel to the special requirements for resuscitation should this need arise. If resuscitation is needed, direct mouth-to-stoma ventilation should be performed. For home emergency situations, prerecorded emergency messages for police, the fire department, or other rescue services can be kept near the phone or programmed into smartphones or other electronic devices to be used quickly.

Chart 18-7 **HOME CARE CHECKLIST**

At the completion of education, the patient and/or caregiver will be able to:

- Name the procedure that was performed and identify any permanent changes in anatomic structure or function as well as changes in ADLs, IADLs, communication, roles, relationships, and spirituality.
- State the name, dose, side effects, frequency, and schedule for all medications.
- Identify interventions and strategies (e.g., durable medical equipment, oxygen, nebulizer, humidifier) used in adapting to any permanent changes in structure or function.
- Describe ongoing postoperative therapeutic regimen, including stoma care, diet, and activities to perform (e.g., shoulder and neck exercises if a node dissection was performed) and to limit or avoid (e.g., swimming and contact sports).
  - Demonstrate tracheostomy care and tracheal suctioning to clear the airway and handle secretions.
  - Explain the rationale for maintaining adequate humidification with a humidifier or nebulizer.
  - Demonstrate how to clean the skin around the stoma and how to use ointments and tweezers to remove encrustations.
  - State the rationale for wearing a loose-fitting protective cloth at the stoma and covering the stoma when showering or bathing.
  - Discuss the need to avoid sprays, powders, particulates, and cold air from air-conditioning and the environment to prevent irritation of the airway.
  - Demonstrate safe technique in changing the laryngectomy/tracheostomy tube.
  - Identify fluid and caloric needs.
  - Describe mouth care and discuss its importance.
  - Identify the signs and symptoms of wound infection and state what to do about them.
  - Describe safety or emergency measures to implement in case of breathing difficulty or bleeding.
  - State the rationale for wearing or carrying special medical identification and ways to obtain help in an emergency.
  - Demonstrate alternative communication methods.
- Relate how to reach primary provider with questions or to report complications.
- State time and date of follow-up appointments.

- Obtain an annual influenza vaccine, and discuss vaccination against pneumonia with the primary provider.
- State understanding of community resources, support groups, and referrals (if any).
- Identify the need for health promotion (e.g., weight reduction, smoking cessation, and stress management), disease prevention, and screening activities.

Resources

In student resources for Chapter 19 at thepoint.lww.com/Brunner15e, see Procedural Guidelines: Care of the Patient with a Tracheostomy Tube and Procedural Guidelines: Performing Tracheal Suction.

ADL, activities of daily living; IADL, independent activities of daily living.

The nurse instructs and encourages the patient to perform oral care frequently to prevent halitosis and infection. If the patient is receiving radiation therapy, synthetic saliva may be required because of decreased saliva production. Patients receiving radiation therapy frequently report dry mouth, change in taste, lack of appetite, and mouth sores (Cullen, Baumler, Farrington, et al., 2018) (see the Nursing Research Profile in Chart 18-8). The nurse instructs the patient to drink water or sugar-free liquids throughout the day and to use a humidifier at home. Brushing the teeth or dentures and rinsing the mouth several times a day will assist in maintaining proper oral hygiene.

Continuing and Transitional Care. Referral for home, community-based, or transitional care is an important aspect of postoperative care for the patient who has had a laryngectomy and will assist the patient and family in the discharge home. The nurse assesses the patient's general health status and the ability of the patient and family to care for the stoma and tracheostomy. The surgical incisions, nutritional and respiratory status, and adequacy of pain management are also assessed. The nurse assesses for signs and symptoms of complications and the patient's and family's knowledge of signs and symptoms to be reported to the physician. During the home visit, the nurse identifies and addresses other learning needs and concerns of the patient and family, such as adaptation to physical, lifestyle, and functional changes, as well as the patient's progress with learning and using new communication strategies. The nurse assesses the patient's psychological status, reinforces previous instructions, and provides reassurance and support to the patient and family caregivers as needed.

The person who has had a laryngectomy should have regular physical examinations and seek advice concerning any problems related to recovery and rehabilitation. The nurse reminds the patient to participate in health promotion activities and health screening and about the importance of

keeping scheduled appointments with the physician, speech therapist, and other health care providers.

Evaluation

Expected patient outcomes may include the following:

1. Demonstrates an adequate level of knowledge, verbalizing an understanding of the surgical procedure and performing self-care adequately

Chart 18-8 NURSING RESEARCH PROFILE

Mitigating the Effects of Radiation Therapy on the Oral Mucosa of Patients with Head and Neck Cancers

Cullen, L., Baumler, S., Farrington, M., et al. (2018). Oral care for head and neck cancer symptom management. *American Journal of Nursing, 118*(1), 24–34.

Purpose

Patients diagnosed with laryngeal and oropharyngeal cancer (head and neck cancer [HNC]) commonly receive radiation therapy on an outpatient basis. These patients often develop mucositis, which causes symptoms that include pain, difficulty swallowing, dry mouth, change in taste, lack of appetite, and mouth sores. An evidence-based practice intervention at a radiation oncology center in a large academic medical center in the Midwestern United States was designed to reduce the severity of oral mucositis in adults receiving radiation therapy for HNC.

Design

Study participants included adults with HNC who were receiving outpatient radiation therapy with or without concurrent chemotherapy. Twenty participants were recruited to the usual care group. The usual care group received extensive oral care preparation prior to radiation treatment. This included a visit with an oncologic dentist for a professional dental evaluation, fluoride treatments, the provision of oral care supplies, and tooth extraction if needed. Radiation treatment then proceeded as usual for 6 to 8 wk. These participants served as historical controls for the intervention group.

The 85 participants who were then recruited into the intervention group received the same care as those in the usual care group plus targeted education, a comprehensive oral care kit, and information on how to use the kit. The targeted education included a brochure from the U.S. Department of Health and Human Services, *Head and Neck Radiation Treatment and Your Mouth*, and a one-page additional insert, which was developed by the team. Nurses were integral throughout the study process in educating patients about the intervention.

Both clinicians and participants were surveyed at various intervals. Clinicians' (i.e., nurses, physicians, and radiation therapists) knowledge of oral care and correct use of oral care products, perceptions and attitudes about oral care, and behaviors and practices related to the documentation of patients' oral health and education were assessed. Participant feedback was obtained before radiation treatment, during weeks 4 to 5 of treatment, and 1 mo after treatment. The participants' questionnaires included sections that surveyed oral care practices (the frequency of care and products used), perceptions about oral care (feeling well prepared and the usefulness of oral care products), and oral mucositis symptoms.

Findings

The percentage of clinicians with correct responses to knowledge assessment items improved from 71% preimplementation to 80% postimplementation. The clinicians' mean scores on questions capturing their perceptions were higher postimplementation than preimplementation.

Feedback provided by patients during radiation treatment on weeks 4 to 5 demonstrated improvement in oral hygiene behaviors. More patients in the intervention group reported brushing at least daily, using Biotene toothpaste, performing oral rinses at least twice a day, and using lanolin lip balm, compared with those in the usual care group. Patients in the intervention group showed higher adherence with the targeted education and oral care kit intervention which led to a reduction of symptoms at weeks 4 to 5 of radiation treatment, when symptoms are expected to peak. The intervention group reported less severity than the usual care patients regarding the following symptoms: mouth and throat soreness, difficulty swallowing, difficulty eating, and difficulty talking. Furthermore, the intervention group reported less difficulty with xerostomia 1 mo after radiation was completed.

Nursing Implications

Mucositis is a frequent and distressing complication of radiation therapy in the treatment of patients with HNC. Nurses are key members of the treatment team and play many roles in caring for these patients, from assessing patients' symptoms to educating them on ways to reduce these symptoms. Findings from this study show that the distribution of standardized oral care kits and related educational materials can offer an effective way to meet patients' needs and reduce oral mucositis severity in adults treated with radiation therapy for HNC. The success of the project also highlights the key role nurses play in cancer symptom management, before radiation therapy begins, throughout the course of treatment, and in the months afterward.

2. Demonstrates less anxiety
    a. Expresses a sense of hope
    b. Is aware of available community organizations and agencies that provide patient education and support groups
    c. Participates in support group for people with a laryngectomy
3. Maintains a clear airway and handles own secretions; also demonstrates practical, safe, and correct technique for cleaning and changing the tracheostomy or laryngectomy tube
4. Acquires effective communication techniques
    a. Uses assistive devices and strategies for communication (Magic Slate, call bell, picture board, sign language, speech reading, handheld electronic devices, smartphones)
    b. Follows the recommendations of the speech therapist

c. Demonstrates ability to communicate with new communication strategy
d. Reports availability of prerecorded messages to summon emergency assistance by telephone

5. Maintains adequate nutrition and adequate fluid intake
6. Exhibits improved body image, self-esteem, and self-concept
   a. Expresses feelings and concerns
   b. Manages health effectively
   c. Accepts information about support group
7. Adheres to rehabilitation and home care program
   a. Practices recommended speech therapy
   b. Demonstrates proper methods for caring for stoma and laryngectomy or tracheostomy tube (if present)
   c. Verbalizes understanding of symptoms that require medical attention
   d. States safety measures to take in emergencies
   e. Performs oral hygiene as prescribed
8. Absence of complications
   a. Demonstrates a patent airway
   b. No bleeding from surgical site and minimal bleeding from drains; vital signs (blood pressure, temperature, pulse, respiratory rate) are normal
   c. No redness, tenderness, or purulent drainage at surgical site
   d. No wound breakdown
   e. Clear breath sounds; oxygen saturation level within acceptable range; chest x-ray clear
   f. No indications of infection, stenosis, or obstruction of tracheal stoma

CRITICAL THINKING EXERCISES

1 pq A 19-year-old college student presents to the student health center where you work as a staff nurse with complaints of a "stuffed up head," severe headache, green mucous when blowing her nose, and "teeth achiness." She reports a fever of 100.8 for the past 2 days. What further questions do you have regarding her symptoms? What is your priority focus for your physical examination? What diagnostic tests and treatments may you anticipate?

2 ebp You are attending a wedding shower when the bride's grandmother starts bleeding from her nose. You find out from her granddaughter that she has been receiving intravenous pembrolizumab for advanced lung cancer and had her last treatment 5 days ago. What is your priority focus for your nursing assessment? What types of interventions are indicated for epistaxis? What additional concerns do you have for this patient related to her immunotherapy regimen? Would you consider transport to an urgent care center or ED? Why or why not? What is the strength of the evidence that might guide your recommendations for follow-up for this older adult woman?

3 ipc You are working in a family practice clinic and are triaging a 58-year-old male who is complaining of weight loss, difficulty swallowing, sore throat, and hoarseness for the past month. He is worried about having cancer. What risk factors would you screen for in this patient? What type of referral do you expect to be made for this patient? Who else might need to be involved in his care?

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19 Management of Patients with Chest and Lower Respiratory Tract Disorders

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Identify patients at risk for atelectasis and the nursing interventions related to its prevention and management.
2. Compare the various pulmonary infections with regard to causes, clinical manifestations, nursing management, complications, and prevention.
3. Identify the nursing care of a patient with an endotracheal tube, with mechanical ventilation, or with a tracheostomy.
4. Relate the therapeutic management of acute respiratory distress syndrome to the underlying pathophysiology of the syndrome.
5. Describe preventive measures appropriate for controlling and eliminating occupational lung disease.
6. Discuss the modes of therapy and related nursing management of patients with lung cancer.
7. Use the nursing process as a framework for care of the patient with pneumonia, receiving mechanical ventilation, or with a thoracotomy.
8. Describe the complications of chest trauma and their clinical manifestations and nursing management.
9. Explain the principles of chest drainage and the nursing responsibilities related to the care of the patient with a chest drainage system.

NURSING CONCEPTS

Infection
Oxygenation

GLOSSARY

acute lung injury: an umbrella term for hypoxemic respiratory failure; equivalent to mild acute respiratory distress syndrome (ARDS)

acute respiratory distress syndrome (ARDS): nonspecific pulmonary response to a variety of pulmonary and nonpulmonary insults to the lung; characterized by interstitial infiltrates, alveolar hemorrhage, atelectasis, refractory hypoxemia, and, with the exception of some patients with coronavirus disease 2019 (COVID-19) and ARDS, decreased compliance

airway pressure release ventilation (APRV): mode of mechanical ventilation that allows unrestricted, spontaneous breaths throughout the ventilatory cycle; on inspiration the patient receives a preset level of continuous positive airway pressure, and pressure is periodically released to aid expiration

aspiration: inhalation of either oropharyngeal or gastric contents into the lower airways

atelectasis: collapse or airless condition of the alveoli caused by hypoventilation, obstruction to the airways, or compression

bilevel positive airway pressure (BiPAP): noninvasive spontaneous breath mode of mechanical ventilation that allows for the separate control of inspiratory and expiratory pressures; given via a mask

central cyanosis: bluish discoloration of the skin or mucous membranes due to hemoglobin carrying reduced amounts of oxygen

chest drainage system: the use of a chest tube and closed drainage system to re-expand the lung and to remove excess air, fluid, or blood

consolidation: lung tissue that has become more solid in nature due to collapse of alveoli or infectious process (pneumonia)

continuous mandatory (volume or pressure) ventilation (CMV): also referred to as assist–control (A/C) ventilation; mode of mechanical ventilation in which the patient's breathing pattern may trigger the ventilator to deliver a preset tidal volume or set pressure; in the absence of spontaneous breathing, the machine delivers a controlled breath at a preset minimum rate and tidal volume or set pressure

continuous positive airway pressure (CPAP): positive pressure applied throughout the respiratory cycle to a spontaneously breathing patient to promote alveolar and airway stability and increase functional residual capacity; may be given with endotracheal or tracheostomy tube or by mask

cor pulmonale: "heart of the lungs"; enlargement of the right ventricle from hypertrophy or dilation or as a secondary response to disorders that affect the lungs

empyema: accumulation of purulent material in the pleural space

endotracheal intubation: insertion of a breathing tube (type of artificial airway) through the nose or mouth into the trachea

fraction of inspired oxygen (FiO_2): concentration of oxygen delivered (e.g., 1.0 = 100% oxygen)

hemoptysis: the coughing up of blood from the lower respiratory tract

hemothorax: partial or complete collapse of the lung due to blood accumulating in the pleural space; may occur after surgery or trauma

hypoxemia: decrease in oxygen tension in the arterial blood

hypoxia: decrease in oxygen supply to the tissues and cells

incentive spirometry: method of deep breathing that provides visual feedback to help the patient inhale deeply and slowly and achieve maximum lung inflation

induration: an abnormally hard lesion or reaction, as in a positive tuberculin skin test

intermittent mandatory (volume or pressure) ventilation (IMV): mode of mechanical ventilation that provides a combination of mechanically assisted breaths at a preset volume or pressure and rate and spontaneous breaths

mechanical ventilator: a positive- or negative-pressure breathing device that supports ventilation and oxygenation

orthopnea: shortness of breath when reclining or in the supine position

pleural effusion: abnormal accumulation of fluid in the pleural space

pleural friction rub: localized grating or creaking sound caused by the rubbing together of inflamed parietal and visceral pleurae

pleural space: the area between the parietal and visceral pleurae; a potential space

pneumothorax: partial or complete collapse of the lung due to positive pressure in the pleural space

positive end-expiratory pressure (PEEP): positive pressure maintained at the end of exhalation (instead of a normal zero pressure) to increase functional residual capacity and open collapsed alveoli

pressure support ventilation (PSV): mode of mechanical ventilation in which preset positive pressure is delivered with spontaneous breaths to decrease work of breathing

proportional assist ventilation (PAV): mode of mechanical ventilation that provides partial ventilatory support in proportion to the patient's inspiratory efforts; decreases the work of breathing

purulent: consisting of, containing, or discharging pus

respiratory weaning: process of gradual, systematic withdrawal or removal of ventilator, breathing tube, and oxygen

restrictive lung disease: disease of the lung that causes a decrease in lung volumes

synchronized intermittent mandatory ventilation (SIMV): mode of mechanical ventilation in which the ventilator allows the patient to breathe spontaneously while providing a preset number of breaths to ensure adequate ventilation; ventilated breaths are synchronized with spontaneous breathing

tension pneumothorax: pneumothorax characterized by increasing positive pressure in the pleural space with each breath; this is an emergency situation, and the positive pressure needs to be decompressed or released immediately

thoracentesis: insertion of a needle or catheter into the pleural space to remove fluid that has accumulated and decrease pressure on the lung tissue; may also be used diagnostically to identify potential causes of a pleural effusion

thoracotomy: surgical opening into the chest cavity

tidal volume: volume of air inspired and expired with each breath

tracheostomy tube: indwelling tube inserted directly into the trachea to assist with ventilation

tracheotomy: surgical opening into the trachea

transbronchial: through the bronchial wall, as in a transbronchial lung biopsy

ventilation–perfusion (V./Q.): refers to the ratio between ventilation and perfusion in the lung; matching of ventilation to perfusion optimizes gas exchange

Disorders affecting the chest and lower respiratory tract range from acute to chronic conditions. Many of these disorders are serious and often life-threatening. Patients with chest and lower respiratory tract disorders require care from nurses with astute assessment and clinical management skills as well as knowledge of evidence-based practice. Nurses must also understand the impact of the particular disorder on the patient's quality of life and ability to carry out activities of daily living. Patient and family education is an important nursing intervention in the management of all chest and lower respiratory tract disorders.

INFLAMMATORY AND INFECTIOUS PULMONARY DISORDERS

Inflammatory pulmonary disorders may include relatively common disorders such as atelectasis, as well as uncommon disorders such as aspiration and

sarcoidosis. Infectious pulmonary disorders are responsible for much morbidity and mortality, and include diseases such as pneumonia and tuberculosis, as well as lung abscesses.

Atelectasis

Atelectasis refers to closure or collapse of alveoli and often is described in relation to chest x-ray findings and clinical signs and symptoms. Atelectasis is one of the most commonly encountered abnormalities seen on a chest x-ray (Stark, 2019). Atelectasis may be acute or chronic and may cover a broad range of pathophysiologic changes, from microatelectasis (which is not detectable on chest x-ray) to macroatelectasis with loss of segmental, lobar, or overall lung volume. The most commonly described is acute atelectasis, which occurs most often in the postoperative setting usually following thoracic and upper abdominal procedures or in people who are immobilized and have a shallow, monotonous breathing pattern (Conde & Adams, 2018; Smetana, 2018). Excess secretions or mucus plugs may also cause obstruction of airflow and result in atelectasis in an area of the lung. Atelectasis also is observed in patients with a chronic airway obstruction that impedes or blocks the flow of air to an area of the lung (e.g., obstructive atelectasis in the patient with lung cancer that is invading or compressing the airways). This type of atelectasis is more insidious and slower in onset (Conde & Adams, 2018; Stark, 2019).

Pathophysiology

Atelectasis may be described as either nonobstructive or obstructive. Nonobstructive atelectasis occurs in adults as a result of reduced ventilation. Obstructive atelectasis results from any blockage that impedes the passage of air to and from the alveoli, reducing alveolar ventilation (Stark, 2019). Obstructive atelectasis is the most common type and results from reabsorption of gas (trapped alveolar air is absorbed into the bloodstream); no additional air can enter into the alveoli because of the blockage. As a result, the affected portion of the lung becomes airless and the alveoli collapse. Causes of atelectasis include foreign body, tumor or growth in an airway, altered breathing patterns, retained secretions, pain, alterations in small airway function, prolonged supine positioning, increased abdominal pressure, reduced lung volumes due to musculoskeletal or neurologic disorders, restrictive defects, and specific surgical procedures (e.g., upper abdominal, thoracic, or open heart surgery) (Conde & Adams, 2018).

Patients are at high risk for atelectasis postoperatively because of several factors. A monotonous, low tidal breathing pattern may cause small airway closure and alveolar collapse. This can result from the effects of anesthesia or

analgesic agents, supine positioning, splinting of the chest wall because of pain, or abdominal distention. Secretion retention, airway obstruction, and an impaired cough reflex may also occur, or patients may be reluctant to cough because of pain (Conde & Adams, 2018). Figure 19-1 shows the mechanisms and consequences of acute atelectasis in postoperative patients.

Atelectasis resulting from bronchial obstruction by secretions may also occur in patients with impaired cough mechanisms (e.g., musculoskeletal or neurologic disorders) as well as in those who are debilitated and confined to bed. In addition, atelectasis may develop because of excessive pressure on the lung tissue (i.e., compressive atelectasis), which restricts normal lung expansion on inspiration (Stark, 2019). Such pressure can be produced by a **pleural effusion** (fluid accumulating within the pleural space), a **pneumothorax** (air in the pleural space), or a **hemothorax** (blood in the pleural space). The **pleural space** is the area between the parietal and the visceral pleurae, and is normally a potential rather than an actual space. Pressure may also be produced by a pericardial effusion (pericardium distended with fluid), tumor growth within the thorax, or an elevated diaphragm.

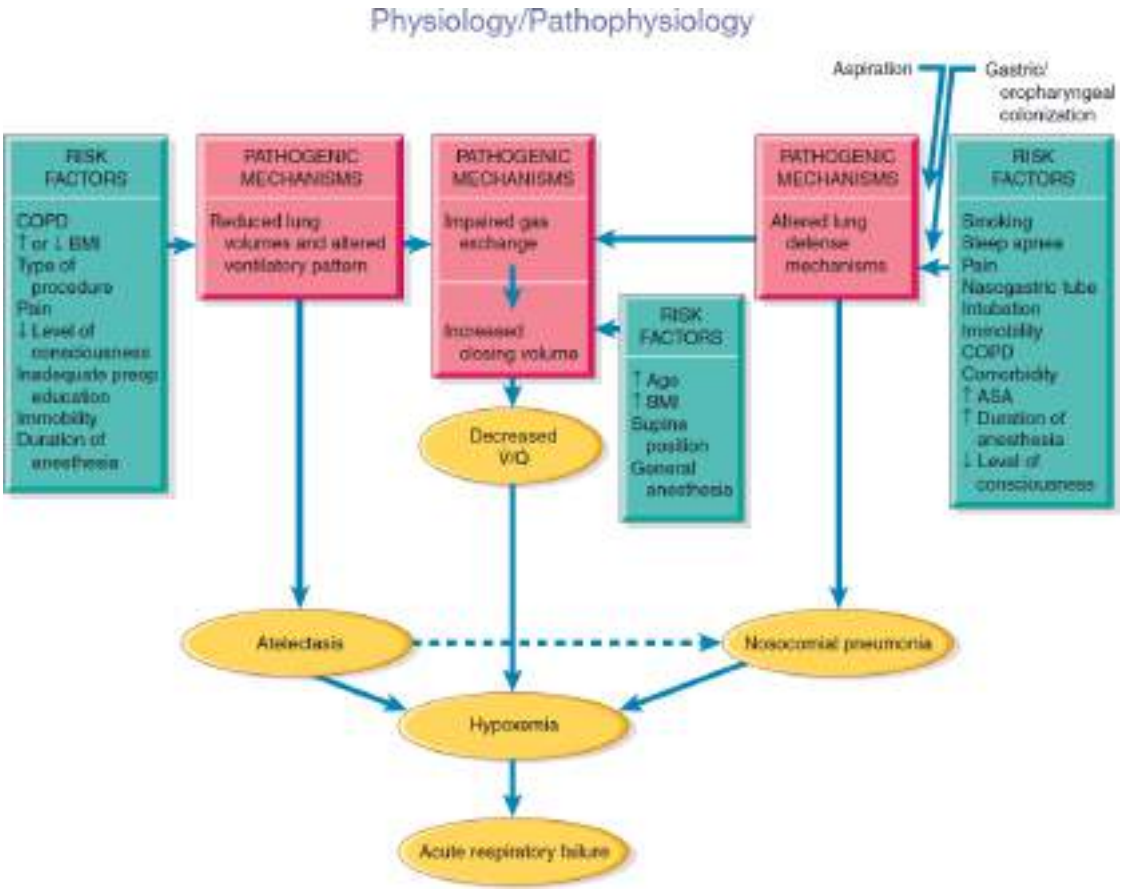

Figure 19-1 • Relationship of risk factors, pathogenic mechanisms, and consequences of acute atelectasis in the postoperative patient. ASA, acetylsalicylic acid; BMI, body mass index; COPD, chronic obstructive pulmonary disease; V./Q., ventilation–perfusion ratio.

Clinical Manifestations

The development of atelectasis usually is insidious. Signs and symptoms include increasing dyspnea (shortness of breath), cough, and sputum production.

In acute atelectasis involving a large amount of lung tissue (lobar atelectasis), marked respiratory distress may be observed. In addition to the previously mentioned signs and symptoms, tachycardia, tachypnea, pleural pain, and **central cyanosis** (a bluish skin hue that is a late sign of hypoxemia) may be anticipated. Patients characteristically have difficulty breathing in the supine position and are anxious.

In chronic atelectasis, signs and symptoms are similar to those of acute atelectasis. The chronic nature of the alveolar collapse predisposes patients to infection distal to the obstruction. Therefore, the signs and symptoms of a pulmonary infection also may be present.

Assessment and Diagnostic Findings

When clinically significant atelectasis develops, it is generally characterized by increased work of breathing and **hypoxemia** (i.e., a decrease in oxygen tension in the arterial blood). Decreased breath sounds and crackles are heard over the affected area. A chest x-ray may suggest a diagnosis of atelectasis before clinical symptoms appear; the x-ray may reveal patchy infiltrates or consolidated areas. Depending on the degree of hypoxemia, pulse oximetry (SpO_2) may demonstrate a low saturation of hemoglobin with oxygen (less than 90%) or a lower-than-normal partial pressure of arterial oxygen (PaO_2).

Quality and Safety Nursing Alert

Tachypnea, dyspnea, and mild-to-moderate hypoxemia are hallmarks of the severity of atelectasis.

Prevention

Nursing measures to prevent atelectasis include frequent turning, early mobilization, and strategies to expand the lungs and to manage secretions. Voluntary deep-breathing maneuvers (at least every 2 hours) assist in preventing and treating atelectasis. The performance of these maneuvers requires the patient to be alert and cooperative. Patient education and reinforcement are key elements to the success of these interventions. The use of incentive spirometry or voluntary deep breathing enhances lung expansion, decreases the potential for airway closure, and may generate a cough. **Incentive spirometry** is a method of deep breathing that provides visual feedback to encourage the patient to inhale slowly and deeply to maximize lung inflation and prevent or reduce atelectasis. The purpose of an incentive spirometer is to ensure that the volume of air inhaled is increased gradually as the patient takes deeper and deeper breaths.

Incentive spirometers are available in two types: volume or flow. In the volume type, the tidal volume is set using the manufacturer's instructions. The patient takes a deep breath through the mouthpiece, pauses at peak lung inflation, and then relaxes and exhales. Taking several normal breaths before attempting another with the incentive spirometer helps avoid fatigue. The volume is periodically increased as tolerated.

In the flow type, the volume is not preset. The spirometer contains a number of movable balls that are pushed up by the force of the breath and held suspended in the air while the patient inhales. The amount of air inhaled and the flow of the air are estimated by how long and how high the balls are suspended (see Chart 19-1).

Secretion management techniques include directed cough, suctioning, aerosol nebulizer treatments followed by chest physiotherapy (CPT; see Figs. 20-6 and 20-7 and further discussion of CPT principles in Chapter 20), and bronchoscopy. In some settings, a pressurized metered-dose inhaler (pMDI) is used to dispense a bronchodilator rather than an aerosolized, small-volume nebulizer (SVN) (see Chapter 20 for further discussion of pMDIs and SVNs). Chart 19-2 summarizes measures used to prevent atelectasis.

Chart 19-1 **PATIENT EDUCATION**

Performing Incentive Spirometry

The inspired air helps inflate the lungs. The ball or weight in the spirometer rises in response to the intensity of the intake of air. The higher the ball rises, the deeper the breath.

The nurse instructs the patient to:

- Assume a semi-Fowler position or an upright position before initiating therapy.
- Use diaphragmatic breathing.
- Place the mouthpiece of the spirometer firmly in the mouth, breathe air in (inspire) slowly through the mouth, and hold the breath at the end of inspiration for about 3 seconds to maintain the ball/indicator between the lines. Exhale slowly through the mouthpiece.
- Cough during and after each session. Splint the incision when coughing postoperatively.
- Perform the procedure approximately 10 times in succession, repeating the 10 breaths with the spirometer each hour during waking hours.

Chart 19-2

Preventing Atelectasis

- Change patient's position frequently, especially from supine to upright position, to promote ventilation and prevent secretions from accumulating.
- Encourage early mobilization from bed to chair followed by early ambulation.
- Encourage appropriate deep breathing and coughing to mobilize secretions and prevent them from accumulating.
- Educate/reinforce appropriate technique for incentive spirometry.
- Administer prescribed opioids and sedatives judiciously to prevent respiratory depression.
- Perform postural drainage and chest percussion, if indicated.
- Institute suctioning to remove tracheobronchial secretions, if indicated.

Management

The goal of the treatment is to improve ventilation and remove secretions. Strategies to prevent atelectasis, which include frequent turning, early ambulation, lung volume expansion maneuvers (e.g., deep-breathing exercises and incentive spirometry), and coughing, also serve as the first-line measures to minimize or treat atelectasis by improving ventilation. Multidisciplinary, evidence-based standardized intervention programs that incorporate ICOUGH℠ (see Chart 19-3) can prevent atelectasis (Moore, Conway, Thomas, et al., 2017; Smetana, 2018).

In patients who do not respond to first-line measures or who cannot perform deep-breathing exercises, other treatments such as **positive end-expiratory pressure** (**PEEP**; a simple mask and one-way valve system that provides varying amounts of expiratory resistance, usually 10 to 15 cm H_2O), continuous positive airway breathing, or bronchoscopy may be used. Before initiating more complex, costly, and labor-intensive therapies, the nurse should ask several questions:

- Has the patient been given an adequate trial of deep-breathing exercises?

Chart 19-3

ICOUGH[SM] Program

- **I**ncentive spirometry
- **C**oughing and deep breathing
- **O**ral care (brushing teeth and using mouthwash twice a day)
- **U**nderstanding (patient and staff education)
- **G**etting out of bed at least three times daily
- **H**ead-of-bed elevation

Adapted from Boston University School of Medicine. (2019). ICOUGHSM. Retrieved on 8/22/2019 at: www.bumc.bu.edu/surgery/quality-safety/i-cough

- Has the patient received adequate education, supervision, and coaching to carry out the deep-breathing exercises?
- Have other factors been evaluated that may impair ventilation or prevent a good patient effort (e.g., lack of turning, mobilization; excessive pain; excessive sedation)?

If the cause of atelectasis is bronchial obstruction from secretions, the secretions must be removed by coughing or suctioning to allow air to reenter that portion of the lung. CPT and postural drainage may also be used to mobilize secretions. SVN treatments with a bronchodilator may be used to assist patients in the expectoration of secretions. If respiratory care measures fail to remove the obstruction, a bronchoscopy is performed. Although bronchoscopy is an excellent measure to acutely remove secretions and increase ventilation, it is imperative for the nurse to assist the patient with maintaining the patency of the airways after bronchoscopy, using the traditional techniques of deep breathing, coughing, and suctioning. Severe or massive atelectasis may lead to acute respiratory failure, especially in patients with underlying lung disease. Endotracheal (ET) intubation and mechanical ventilation may be necessary.

If the cause of atelectasis is compression of lung tissue, the goal is to decrease the compression. With a large pleural effusion that is compressing lung tissue and causing alveolar collapse, treatment may include **thoracentesis** (removal of the fluid by needle aspiration) or insertion of a chest tube. The measures to increase lung expansion described previously also are used.

Management of chronic atelectasis focuses on removing the cause of the obstruction of the airways or the compression of the lung tissue. For example, bronchoscopy may be used to open an airway obstructed by lung cancer or a nonmalignant lesion, and the procedure may involve cryotherapy or laser therapy. If the atelectasis is a result of obstruction caused by lung cancer, an airway stent or radiation therapy to shrink a tumor may be used to open the airways and provide ventilation to the collapsed area. However, reopening the

airways and reaerating the area of the lung may not be possible in patients who have experienced chronic, long-term collapse. In some cases, surgical management may be indicated.

Acute Tracheobronchitis

Acute tracheobronchitis, an acute inflammation of the mucous membranes of the trachea and the bronchial tree, often follows infection of the upper respiratory tract usually as a result of a viral infection (see Chapter 18). Patients with viral infections have decreased resistance and can readily develop a secondary bacterial infection. Adequate treatment of upper respiratory tract infection is one of the major factors in the prevention of acute tracheobronchitis.

Pathophysiology

In acute tracheobronchitis, the inflamed mucosa of the bronchi produces mucopurulent sputum, often in response to infection by *Streptococcus pneumoniae, Haemophilus influenzae,* or *Mycoplasma pneumoniae.* A fungal infection (e.g., *Aspergillus*) may also cause tracheobronchitis. A sputum culture is essential to identify the specific causative organism. In addition to infection, inhalation of physical and chemical irritants, gases, or other air contaminants can also cause acute bronchial irritation (File, 2019a).

Clinical Manifestations

Initially, the patient has a dry, irritating cough and expectorates a scanty amount of mucoid sputum. The patient may report sternal soreness from coughing and have fever or chills, night sweats, headache, and general malaise. As the infection progresses, the patient may be short of breath, have noisy inspiration and expiration (inspiratory stridor and expiratory wheeze), and produce **purulent** (pus-filled) sputum. In severe tracheobronchitis, blood-streaked secretions may be expectorated as a result of the irritation of the mucosa of the airways.

Medical Management

Antibiotic treatment for an infection may be indicated depending on the symptoms, sputum purulence, and results of the sputum culture and sensitivity. Antihistamines usually are not prescribed, because they can cause excessive drying and make secretions more difficult to expectorate. Fluid intake is increased to thin viscous and tenacious secretions. Copious, purulent

secretions that cannot be cleared by coughing place patients at risk for increasing airway obstruction and the development of more severe lower respiratory tract infections, such as pneumonia. Suctioning and bronchoscopy may be needed to remove secretions. Rarely, ET intubation may be necessary in cases of acute tracheobronchitis leading to acute respiratory failure, such as in patients who are severely debilitated or who have coexisting diseases that impair the respiratory system.

In most cases, treatment of tracheobronchitis is largely symptomatic. Increasing the vapor pressure (moisture content) in the air reduces airway irritation. Cool vapor therapy or steam inhalations may help relieve laryngeal and tracheal irritation. Moist heat to the chest may relieve the soreness and pain, and mild analgesics may be prescribed.

Nursing Management

Acute tracheobronchitis is usually treated in the home setting. A primary nursing function is to encourage bronchial hygiene, such as increased fluid intake and directed coughing to remove secretions. The nurse encourages and assists the patient to sit up frequently to cough effectively and to prevent retention of mucopurulent sputum. If the patient is taking antibiotics for an underlying bacterial infection, the need to complete the full course of antibiotics prescribed is emphasized. Fatigue is a consequence of tracheobronchitis; therefore, the nurse cautions the patient against overexertion, which can induce a relapse or exacerbation of the infection. The patient is advised to rest (File, 2019a).

Pneumonia

Pneumonia is an inflammation of the lung parenchyma caused by various microorganisms, including bacteria, mycobacteria, fungi, and viruses. *Pneumonitis* is a more general term that describes an inflammatory process in the lung tissue that may predispose or place the patient at risk for microbial invasion. Pneumonia and influenza are the most common causes of death from infectious diseases in the United States. Pneumonia and influenza accounted for 55,672 deaths in the United States in 2017 (Centers for Disease Control and Prevention [CDC], 2017a). Together, these diseases were the eighth leading cause of death in the United States in 2017, accounting for 5.9% of all deaths (CDC, 2017a).

Chart 19-4

Classifications and Definitions of Pneumonias

- *Community-acquired pneumonia (CAP):* Pneumonia occurring in the community or ≤48 hours after hospital admission or institutionalization of patients who do not meet the criteria for health care–associated pneumonia (HCAP)
- *Health care–associated pneumonia (HCAP):* Pneumonia occurring in a nonhospitalized patient with extensive health care contact with one or more of the following:
  - Hospitalization for ≥2 days in an acute care facility within 90 days of infection
  - Residence in a nursing home or long-term care facility
  - Antibiotic therapy, chemotherapy, or wound care within 30 days of current infection
  - Hemodialysis treatment at a hospital or clinic
  - Home infusion therapy or home wound care
  - Family member with infection due to multidrug-resistant bacteria
- *Hospital-acquired pneumonia (HAP):* Pneumonia occurring ≥48 hours after hospital admission that did not appear to be incubating at the time of admission
- *Ventilator-associated pneumonia (VAP):* A type of HAP that develops ≥48 hours after endotracheal tube intubation

Adapted from Klompas, M., File, T. M., & Bond, S. (2019). Treatment of hospital-acquired, ventilator-associated and healthcare-associated pneumonia in adults. *UpToDate.* Retrieved on 8/22/2019 at: www.uptodate.com/contents/treatment-of-hospital-acquired-ventilator-associated-and-healthcare-associated-pneumonia-in-adults

Classification

Pneumonia can be classified into four types: community-acquired pneumonia (CAP), health care–associated pneumonia (HCAP), hospital-acquired pneumonia (HAP), and ventilator-associated pneumonia (VAP) (American Thoracic Society & Infectious Diseases Society of America, 2005; Klompas, 2019a). HCAP was conceived as a specific category in order to identify patients at increased risk for multidrug-resistant organisms (MDRO) versus community-acquired organisms (Klompas, 2019a). Chart 19-4 describes the different classifications and definitions of pneumonias. Other subcategories of HCAPs are those in the immunocompromised host and aspiration pneumonia. There is overlap in how specific pneumonias are classified, because they may occur in differing settings. Risk factors associated for specific pathogens are shown in Chart 19-5.

Community-Acquired Pneumonia

CAP, a common infectious disease, occurs either in the community setting or within the first 48 hours after hospitalization or institutionalization. The need for hospitalization for CAP depends on the severity of the pneumonia. The causative pathogens for CAP by site of care are shown in Table 19-1. The specific etiologic pathogen is identified in about 50% of cases. The rate of CAP increases with age, with 2000 per 100,000 adults 65 years of age and older hospitalized with CAP each year (Ramirez, 2019).

Chart 19-5 RISK FACTORS

Pneumonia Based upon Pathogen Type

Risk Factors for Infection with Penicillin-Resistant and Drug-Resistant Pneumococci

- Age >65 years
- Alcoholism
- Beta-lactam therapy (e.g., cephalosporins) in past 3 months
- Immunosuppressive disorders
- Multiple medical comorbidities
- Exposure to a child in a day care facility

Risk Factors for Infection with Enteric Gram-Negative Bacteria

- Residency in a long-term care facility
- Underlying cardiopulmonary disease
- Multiple medical comorbidities
- Recent antibiotic therapy

Risk Factors for Infection with *Pseudomonas aeruginosa*

- Structural lung disease (e.g., bronchiectasis)
- Corticosteroid therapy
- Broad-spectrum antibiotic therapy (>7 days in the past month)
- Malnutrition

Adapted from Ramirez, J. A. (2019). Overview of community acquired pneumonia in adults. *UpToDate*. Retrieved on 9/23/2019 at: www.uptodate.com/contents/overview-of-community-acquired-pneumonia-in-adults

S. pneumoniae (pneumococcus) is the most common bacterial cause of CAP in people younger than 60 years without comorbidity and in those 60 years and older with comorbidity (Baer, 2019; Ramirez, 2019). *S. pneumoniae,* a gram-positive organism that resides naturally in the upper respiratory tract, colonizes

the upper respiratory tract and can cause disseminated invasive infections, pneumonia and other lower respiratory tract infections, and upper respiratory tract infections such as otitis media and rhinosinusitis. It may occur as a lobar or bronchopneumonic form in patients of any age and may follow a recent respiratory illness.

TABLE 19-1 Community-Acquired Pneumonia Microbial Causes by Site of Care[a]

Outpatients	Hospitalized Patients	
	Non-ICU	ICU
Streptococcus pneumoniae	*S. pneumoniae*	*S. pneumoniae*
Mycoplasma pneumoniae	*M. pneumoniae*	*Staphylococcus aureus*
Haemophilus influenzae	*Chlamydophila pneumoniae*	*Legionella*
C. pneumoniae	*H. influenzae*	Gram-negative bacilli
Respiratory viruses	*Legionella*	*H. influenzae*

ICU, intensive care unit.

[a]Listed in descending order of frequency at each site.

Adapted from Klompas, M. (2019b). Treatment of hospital-acquired and ventilator-associated pneumonia in adults. *UpToDate*. Last updated: July 10, 2019. Retrieved on 9/23/2019 at: www.uptodate.com/contents/treatment-of-hospital-acquired-and-ventilator-associated-pneumonia-in-adults/print

H. influenzae causes a type of CAP that frequently affects older adults and those with comorbid illnesses (e.g., chronic obstructive pulmonary disease [COPD], alcoholism, diabetes). The presentation is indistinguishable from that of other forms of bacterial CAP and may be subacute, with cough or low-grade fever for weeks before diagnosis.

Mycoplasma pneumonia is caused by *M. pneumoniae.* Mycoplasma pneumonia is spread by infected respiratory droplets through person-to-person contact. Patients can be tested for mycoplasma antibodies. The inflammatory infiltrate is primarily interstitial rather than alveolar. It spreads throughout the entire respiratory tract, including the bronchioles, and has the characteristics of a bronchopneumonia. Earache and bullous myringitis are common. Impaired ventilation and diffusion may occur.

Viruses are the most common cause of pneumonia in infants and children. Until the advent of the coronavirus disease 2019 (COVID-19) pandemic, viruses were relatively uncommon causes of CAP in adults (see later discussion). Pre-COVID-19, cytomegalovirus was the most commonly implicated viral pathogen in adults with compromised immune systems, followed by herpes simplex virus, adenovirus, and respiratory syncytial virus. The acute stage of a viral respiratory infection occurs within the ciliated cells of the airways, followed by infiltration of the tracheobronchial tree. With

pneumonia, the inflammatory process extends into the alveolar area, resulting in edema and exudation. The clinical signs and symptoms of a viral pneumonia are often difficult to distinguish from those of a bacterial pneumonia.

Health Care–Associated Pneumonia

An important distinction of HCAP is that the causative pathogens are often MDROs because of prior contact with a health care environment. Consequently, identifying this type of pneumonia in areas such as the emergency department is crucial. Because HCAP is often difficult to treat, initial antibiotic treatment must not be delayed. Initial antibiotic treatment of HCAP is often different from that for CAP due to the possibility of MDROs (Ramirez, 2019).

Hospital-Acquired Pneumonia

HAP develops 48 hours or more after hospitalization and does not appear to be incubating at the time of admission. VAP can be considered a subtype of HAP, as the only differentiating factor is the presence of an ET tube (see later discussion of VAP). Certain factors may predispose patients to HAP because of impaired host defenses (e.g., severe acute or chronic illness), a variety of comorbid conditions, supine positioning and aspiration, coma, malnutrition, prolonged hospitalization, hypotension, metabolic disorders. Hospitalized patients are also exposed to potential bacteria from other sources (e.g., respiratory therapy devices and equipment, transmission of pathogens by the hands of health care personnel). Numerous intervention-related factors also may play a role in the development of HAP (e.g., therapeutic agents leading to central nervous system depression with decreased ventilation, impaired removal of secretions, or potential aspiration; prolonged or complicated thoracoabdominal procedures, which may impair mucociliary function and cellular host defenses; ET intubation [VAP]; prolonged or inappropriate use of antibiotics; the use of nasogastric tubes). In addition, patients with compromised immune systems are at particular risk. HAP is associated with a high mortality rate, in part because of the virulence of the organisms, the resistance to antibiotics, and the patient's underlying disorder. It is the most common cause of death among all patients with hospital-acquired infections, with mortality rates up to 33% (Cunha, 2018; Klompas, 2019a).

The common organisms responsible for HAP include the *Enterobacter* species, *Escherichia coli, H. influenzae, Klebsiella pneumoniae*, *Pseudomonas aeruginosa, Acinetobacter* species, methicillin-sensitive or methicillin-resistant *Staphylococcus aureus* (MRSA), and *S. pneumoniae.* Most patients with HAP are colonized by multiple organisms. Pseudomonal pneumonia occurs in patients who are debilitated, those with altered mental status, and those with prolonged intubation or with tracheostomy. Staphylococcal

pneumonia can occur through inhalation of the organism or spread through the hematogenous route. It is often accompanied by sepsis and positive blood cultures. Its mortality rate is high. Specific strains of staphylococci are resistant to many available antimicrobial agents; notable exceptions include vancomycin and linezolid (Klompas, 2019b). Overuse and misuse of antimicrobial agents are major risk factors for the emergence of these resistant pathogens. Because MRSA is highly virulent, steps must be taken to prevent its spread. Patients with MRSA are isolated in a private room, and contact precautions (gown, gloves, and antibacterial soap or alcohol-based hand rub) are used. The number of people in contact with affected patients is minimized, and appropriate precautions must be taken when transporting these patients within or between facilities.

The usual presentation of HAP is a new pulmonary infiltrate on chest x-ray combined with evidence of infection such as fever, respiratory symptoms, purulent sputum, or leukocytosis. Pneumonias from *Klebsiella* or other gram-negative organisms are characterized by the destruction of lung structure and alveolar walls, **consolidation** (tissue that solidifies as a result of collapsed alveoli or infectious process such as pneumonia), and sepsis. Older adult patients and those with alcoholism, chronic lung disease, or diabetes are at increased risk (Klompas, 2019a). Development of a cough or increased cough and sputum production are common presentations, along with low-grade fever and general malaise. In patients who are debilitated or dehydrated, sputum production may be minimal or absent. Pleural effusion, high fever, and tachycardia are common.

Ventilator-Associated Pneumonia

As noted previously, VAP can be thought of as a subtype of HAP; however, in such cases, the patient has been endotracheally intubated and has received mechanical ventilatory support for at least 48 hours (see later discussions on ET intubation and mechanical ventilation). VAP is a complication in as many as 27% of patient who require mechanical ventilation (Gamache, 2019). The incidence of VAP increases with the duration of mechanical ventilation and the mortality rate is variable, depending upon the complexity of the underlying illness. The etiologic bacteriologic agents associated with VAP typically differ based on the timing of the occurrence of the infection relative to the start of mechanical ventilation. VAP occurring within 96 hours of the onset of mechanical ventilation is usually due to antibiotic-sensitive bacteria that colonize the patient prior to hospital admission, whereas VAP developing after 96 hours of ventilatory support is more often associated with MDROs. Prevention remains the key to reducing the burden of VAP (Klompas, File, & Bond, 2019; Timsit, Esaied, Neuville, et al., 2017). See Chart 19-6 for an overview of bundled interventions aimed at preventing VAP.

Chart 19-6

Collaborative Practice Interventions to Prevent Ventilator-Associated Pneumonia

Current best practices can include the implementation of specific evidence-based bundle interventions that, when used together (i.e., as a "bundle"), improve patient outcomes. This chart outlines specific parameters for the ventilator-bundled collaborative interventions that have been found to reduce ventilator-associated pneumonia (VAP).

What are the five key elements of the VAP bundle?

- Elevation of the head of the bed (30° to 45°)
- Daily "sedation vacations" and assessment of readiness to extubate (see below)
- Peptic ulcer disease prophylaxis
- Deep venous thrombosis (DVT) prophylaxis (see below)
- Daily oral care with chlorhexidine (0.12% oral rinses)

What is meant by daily "sedation vacations," and how does this tie into assessing readiness to extubate?

- Protocols should be developed so that sedative doses are purposely decreased at a time of the day when it is possible to assess the patient's neurologic readiness for extubation.
- Vigilance must be employed during the time that sedative doses are lower to ensure that the patient does not self-extubate.

What effect does DVT prophylaxis have on preventing VAP?

- The exact relationship is unclear. However, when appropriate, evidence-based methods to ensure DVT prophylaxis are applied (see Chapter 26); then the rates of VAP also drop.

Adapted from Institute for Healthcare Improvement. (2012). How-to guide: Prevent ventilator-associated pneumonia. Cambridge, MA: Institute for Healthcare Improvements. Retrieved on 3/6/2020 at: www.ihi.org/resources/Pages/Tools/HowtoGuidePreventVAP.aspx

Pneumonia in the Immunocompromised Host

Due to advances in immunosuppressive therapy, prevalence of MDROs, and improvements in diagnostic studies, there is an increased incidence of pneumonia in patients who are immunocompromised. Common causative organisms include *Pneumocystis* pneumonia (PCP), fungal pneumonias, and *Mycobacterium tuberculosis.* The organism that causes PCP is now known as *Pneumocystis jiroveci* instead of *Pneumocystis carinii.* The acronym PCP still applies because it can be read "***P****neumo****c****ystis* **p**neumonia."

Pneumonia in the immunocompromised host can occur with the use of corticosteroids or other immunosuppressive agents, chemotherapy, nutritional

depletion, the use of broad-spectrum antimicrobial agents, acquired immune deficiency syndrome (AIDS), genetic immune disorders, and long-term advanced life support technology (mechanical ventilation). It is seen with increasing frequency because affected patients constitute a growing portion of the population; however, pneumonias that typically occur in people who are immunocompromised may also occur in those who are immunocompetent. Pneumonia carries a higher morbidity and mortality rate in patients who are immunocompromised than in those who are immunocompetent (Zhao & Shin, 2019). Patients with compromised immune systems commonly develop pneumonia from organisms of low virulence. In addition, increasing numbers of patients with impaired defenses develop HAP from gram-negative bacilli (*Klebsiella, Pseudomonas, E. coli,* Enterobacteriaceae, *Proteus, Serratia*) (Zhao & Shin, 2019).

Whether patients are immunocompromised or immunocompetent, the clinical presentation of pneumonia is similar. PCP has a subtle onset, with progressive dyspnea, fever, and a nonproductive cough.

Aspiration Pneumonia

Aspiration pneumonia refers to the pulmonary consequences resulting from entry of endogenous or exogenous substances into the lower airway. The most common form of aspiration pneumonia is bacterial infection from aspiration of bacteria that normally reside in the upper airways. Aspiration pneumonia may occur in the community or hospital setting. Common pathogens are anaerobes, *S. aureus, Streptococcus* species, and gram-negative bacilli (Bartlett, 2019a). Substances other than bacteria may be aspirated into the lung, such as gastric contents, exogenous chemical contents, or irritating gases. This type of aspiration or ingestion may impair the lung defenses, cause inflammatory changes, and lead to bacterial growth and a resulting pneumonia (see later discussion of aspiration).

Pathophysiology

Normally, the upper airway prevents potentially infectious particles from reaching the sterile lower respiratory tract. Pneumonia arises from normal flora present in patients whose resistance has been altered or from aspiration of flora present in the oropharynx; patients often have an acute or chronic underlying disease that impairs host defenses. Pneumonia may also result from bloodborne organisms that enter the pulmonary circulation and are trapped in the pulmonary capillary bed.

Pneumonia affects both ventilation and diffusion. An inflammatory reaction can occur in the alveoli, producing an exudate that interferes with the diffusion of oxygen and carbon dioxide. White blood cells, mostly neutrophils, also migrate into the alveoli and fill the normally air-filled spaces. Areas of the

lung are not adequately ventilated because of secretions and mucosal edema that cause partial occlusion of the bronchi or alveoli, with a resultant decrease in alveolar oxygen tension. Bronchospasm may also occur in patients with reactive airway disease. Because of hypoventilation, a **ventilation–perfusion** (V./Q.) mismatch occurs in the affected area of the lung. V./Q. refers to the ratio between ventilation and perfusion in the lung, which is normally approximately 4 to 5, or 0.8; matching of ventilation to perfusion optimizes gas exchange. Venous blood entering the pulmonary circulation passes through the underventilated area and travels to the left side of the heart poorly oxygenated. The mixing of oxygenated and unoxygenated or poorly oxygenated blood eventually results in arterial hypoxemia.

If a substantial portion of one or more lobes is involved, the disease is referred to as lobar pneumonia. The term *bronchopneumonia* is used to describe pneumonia that is distributed in a patchy fashion, having originated in one or more localized areas within the bronchi and extending to the adjacent surrounding lung parenchyma. Bronchopneumonia is more common than lobar pneumonia (see Fig. 19-2).

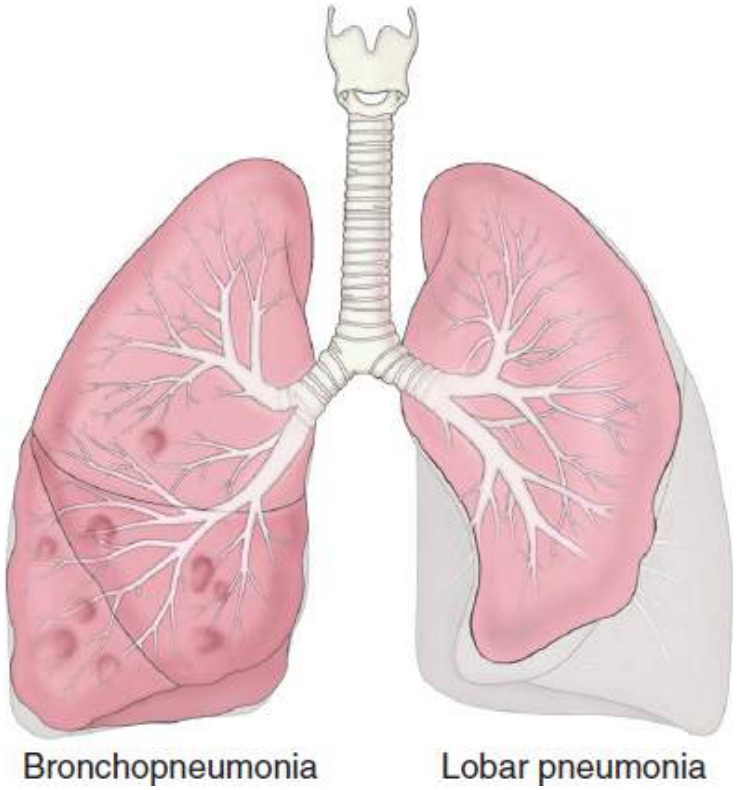

Figure 19-2 • Distribution of lung involvement in bronchial and lobar pneumonia. In bronchopneumonia (*left*), patchy areas of consolidation occur. In lobar pneumonia (*right*), an entire lobe is consolidated.

Risk Factors

Being knowledgeable about the factors and circumstances that commonly predispose people to pneumonia helps identify patients at high risk for the disease (Bartlett, 2019a). Table 19-2 describes risk factors for pneumonia; additional risk factors are travel or exposure to certain environments and residence in a long-term care facility. Increasing numbers of patients who have compromised defenses against infections are susceptible to pneumonia. Some types of pneumonia, such as those caused by viral infections, occur in previously healthy people, often after a viral illness.

Pneumonia occurs in patients with certain underlying disorders such as heart failure, diabetes, alcoholism, COPD, and AIDS (Klompas, 2019a). Certain diseases also have been associated with specific pathogens. For example, staphylococcal pneumonia has been noted after epidemics of influenza, and patients with COPD are at increased risk for development of pneumonia caused by pneumococci or *H. influenzae.* In addition, cystic fibrosis is associated with respiratory infection caused by pseudomonal and staphylococcal organisms, and PCP has been associated with AIDS. Pneumonias occurring in hospitalized patients often involve organisms not usually found in CAP, including enteric gram-negative bacilli and *S. aureus.*

TABLE 19-2 Risk Factors and Preventive Measures for Pneumonia

Risk Factor	Preventive Measure
Conditions that produce mucus or bronchial obstruction and interfere with normal lung drainage (e.g., cancer, cigarette smoking, chronic obstructive pulmonary disease)	Promote coughing and expectoration of secretions. Encourage smoking cessation
Patients who are immunosuppressed or neutropenic (low neutrophil count)	Initiate special precautions against infection
Smoking (cigarette smoke disrupts both mucociliary and macrophage activity)	Encourage smoking cessation
Prolonged immobility and shallow breathing pattern	Reposition frequently and promote lung expansion exercises and coughing. Initiate suctioning and chest physical therapy if indicated
Depressed cough reflex (due to medications, a debilitated state, or weak respiratory muscles); aspiration of foreign material into the lungs during a period of unconsciousness (head injury, anesthesia, depressed level of consciousness), or abnormal swallowing mechanism	Reposition frequently to prevent aspiration and administer medications judiciously, particularly those that increase risk for aspiration. Perform suctioning and chest physical therapy if indicated
Nothing-by-mouth (NPO) status; placement of nasogastric, orogastric, or endotracheal tube	Promote frequent oral hygiene. Minimize risk for aspiration by checking placement of tube and proper positioning of patient
Supine positioning in patients unable to protect their airway	Elevate head of bed at least 30 degrees
Antibiotic therapy (in people who are very ill, the oropharynx is likely to be colonized by gram-negative bacteria)	Monitor patients receiving antibiotic therapy for signs and symptoms of pneumonia
Alcohol intoxication (because alcohol suppresses the body's reflexes, may be associated with aspiration, and decreases white cell mobilization and tracheobronchial ciliary motion)	Encourage reduced or moderate alcohol intake (in case of alcohol stupor, position patient to prevent aspiration)
General anesthetic, sedative, or opioid preparations that promote respiratory depression, which causes a shallow breathing pattern and predisposes to the pooling of bronchial secretions and potential development of pneumonia	Observe the respiratory rate and depth during recovery from general anesthesia and before giving medications. If respiratory depression is apparent, withhold the medication and contact the primary provider
Advanced age, because of possible depressed cough and glottic reflexes and nutritional depletion	Promote frequent turning, early ambulation and mobilization, effective coughing, breathing exercises, and nutritious diet

Respiratory therapy with improperly cleaned equipment	Make sure that respiratory equipment is cleaned properly; participate in continuous quality improvement monitoring with the respiratory care department
Transmission of organisms from health care providers	Use strict hand hygiene and gloves. Implement health care provider education

Adapted from Ramirez, J. A. (2019). Overview of community acquired pneumonia in adults. *UpToDate*. Retrieved on 9/23/2019 at: www.uptodate.com/contents/overview-of-community-acquired-pneumonia-in-adults

Clinical Manifestations

Pneumonia varies in its signs and symptoms depending on the type, causal organism, and presence of underlying disease. However, it is not possible to diagnose a specific form or classification of pneumonia by clinical manifestations alone. The patient with streptococcal (pneumococcal) pneumonia usually has a sudden onset of chills, rapidly rising fever (38.5° to 40.5°C [101° to 105°F]), and pleuritic chest pain that is aggravated by deep breathing and coughing. The patient is severely ill, with marked tachypnea (25 to 45 breaths/min), accompanied by other signs of respiratory distress (e.g., shortness of breath and the use of accessory muscles in respiration) (Weinberger, Cockrill, & Mandel, 2019). A relative bradycardia (a pulse–temperature deficit in which the pulse is slower than that expected for a given temperature) may suggest viral infection, mycoplasma infection, or infection with a *Legionella* organism.

Some patients exhibit an upper respiratory tract infection (nasal congestion, sore throat), and the onset of symptoms of pneumonia is gradual and nonspecific. The predominant symptoms may be headache, low-grade fever, pleuritic pain, myalgia, rash, and pharyngitis. After a few days, mucoid or mucopurulent sputum is expectorated. In severe pneumonia, the cheeks are flushed and the lips and nail beds demonstrate central cyanosis (a late sign of hypoxemia).

The patient may exhibit **orthopnea** (shortness of breath when reclining or in the supine position), preferring to be propped up or sitting in bed leaning forward (orthopneic position) in an effort to achieve adequate gas exchange without coughing or breathing deeply. Appetite is poor, and the patient is diaphoretic and tires easily. Sputum is often purulent; however, this is not a reliable indicator of the etiologic agent. Rusty, blood-tinged sputum may be expectorated with streptococcal (pneumococcal), staphylococcal, and *Klebsiella* pneumonia.

Signs and symptoms of pneumonia may also depend on a patient's underlying condition. Different signs occur in patients with conditions such as

cancer, and in those who are undergoing treatment with immunosuppressant medications, which decrease the resistance to infection. Such patients have fever, crackles, and physical findings that indicate consolidation of lung tissue, including increased tactile fremitus (vocal vibration detected on palpation), percussion dullness, bronchial breath sounds, egophony (when auscultated, the spoken "E" becomes a loud, nasal-sounding "A"), and whispered pectoriloquy (whispered sounds are easily auscultated through the chest wall). These changes occur because sound is transmitted better through solid or dense tissue (consolidation) than through normal air-filled tissue; these sounds are described in Chapter 17.

Purulent sputum or slight changes in respiratory symptoms may be the only sign of pneumonia in patients with COPD. Determining whether an increase in symptoms is an exacerbation of the underlying disease process or an additional infectious process may be difficult.

Assessment and Diagnostic Findings

The diagnosis of pneumonia is made by history (particularly of a recent respiratory tract infection), physical examination, chest x-ray, blood culture (bloodstream invasion [bacteremia] occurs frequently), and sputum examination. The sputum sample is obtained by having patients rinse the mouth with water to minimize contamination by normal oral flora, breathe deeply several times, cough deeply, and expectorate the raised sputum into a sterile container.

More invasive procedures may be used to collect specimens. Sputum may be obtained by nasotracheal or orotracheal suctioning with a sputum trap or by fiberoptic bronchoscopy (see Chapter 17). Bronchoscopy is often used in patients with acute severe infection, in patients with chronic or refractory infection, in patients with compromised immune systems when a diagnosis cannot be made from an expectorated or induced specimen, and in patients who are mechanically ventilated. Bronchoscopic techniques may include a protected brush specimen or bronchoalveolar lavage.

Unfolding Patient Stories: Kenneth Bronson • Part 1

Kenneth Bronson, a 27-year-old man, has a history of fatigue, high fever, and a productive cough for a week and arrives in the emergency department with difficulty breathing. A chest x-ray reveals a right lower lobe pneumonia. What are the clinical manifestations and assessment findings associated with a right lower lobe pneumonia that the nurse should investigate when evaluating the patient? (Kenneth Bronson's story continues in Chapter 22.)

Care for Kenneth and other patients in a realistic virtual environment: vSim (**thepoint.lww.com/vSimMedicalSurgical**). Practice documenting these patients' care in DocuCare (**thepoint.lww.com/DocuCareEHR**).

Prevention

Pneumococcal vaccination reduces the incidence of pneumonia, hospitalizations for cardiac conditions, and deaths in the older adult population. There are two types of pneumococcal vaccine recommended for adults: a pneumococcal conjugate vaccine (PCV13) and a pneumococcal polysaccharide vaccine (PPSV23) (CDC, 2017c).

PCV13 protects against 13 types of pneumococcal bacteria. PCV13 is recommended for all adults 65 years of age or older as well as adults 19 years or older with conditions that weaken the immune system, such as HIV infection, organ transplantation, leukemia, lymphoma, chronic kidney disease, and asplenism, or with cerebrospinal fluid leak or with cochlear implants (CDC, 2017b). PPSV23 is a newer vaccine and protects against 23 types of pneumococcal bacteria. It is recommended for all adults 65 years of age or older and for those adults 19 through 64 years of age who smoke cigarettes or who have chronic heart, lung, or liver disease, or alcoholism (CDC, 2017b). Most patients who have previously received PCV13 should receive PPSV23. In particular, all adults 65 years of age or older who previously received the PCV13 should receive the PPSV23 vaccine. For immunocompetent adults age 65 or older who have not received PCV13, a dose of PCV13 should be given followed by PPSV23 at least 1 year later. These two vaccines should not be co-administered (CDC, 2017b). As pneumococcal vaccination guidelines may change from year to year, it is important to consult the CDC web site for the most current recommendations. Other preventive measures are summarized in Table 19-2.

Medical Management

Medical management of patients with pneumonia includes prescribing appropriate antibiotics for bacterial pneumonias; assisting the patient to get adequate rest and hydration; and managing complications if they occur. In some patients, supplemental oxygenation may be prescribed.

Pharmacologic Therapy

The treatment of pneumonia includes administration of the appropriate antibiotic as determined by the results of a culture and sensitivity. However, the causative organism is not identified in half of CAP cases when therapy is initiated (File, 2019b). Guidelines are used to guide antibiotic choice; however, the resistance patterns, prevalence of causative organisms, patient risk factors, treatment setting (inpatient vs. outpatient), and costs and availability of newer antibiotic agents must all be considered. See Table 19-3 for the treatment of patients with pneumonia due to specific pathogens.

Inpatients should be switched from intravenous (IV) to oral therapy when they are hemodynamically stable, are improving clinically, are able to take medications/fluids by mouth, and have a normally functioning gastrointestinal tract. As soon as patients are clinically stable, have no medical problems, and have a safe environment for continued care, they should be discharged from the hospital. Clinical stability is defined as temperature less than or equal to 37.8°C (100°F), heart rate less than or equal to 100 bpm, respiratory rate less than or equal to 24 breaths/min, systolic blood pressure greater than or equal to 90 mm Hg, and oxygen saturation greater than or equal to 90%, with ability to maintain oral intake and normal (baseline) mental status.

TABLE 19-3 Commonly Encountered Pneumonias

Type (Causal Organism)	Epidemiology	Clinical Features	Treatment	Complications/ Comments
Community-Acquired Pneumonia				
Streptococcal pneumonia (*Streptococcus pneumoniae*)	Most prevalent in winter months More frequent occurrence in African Americans Incidence greatest in older adults and in patients with COPD, heart failure, alcoholism, asplenia, diabetes, and after influenza Leading infectious cause of illness worldwide among young children, people with underlying chronic health conditions, and older adults Mortality rate (in hospitalized adults with invasive disease): 14%	Abrupt onset, toxic appearance, pleuritic chest pain; usually involves ≥1 lobes Lobar infiltrate common on chest x-ray or bronchopneumonia pattern	Severity determines type of antibiotic and route (IV vs. oral) PCN sensitive: PCN, amoxicillin, ceftriaxone, cefotaxime, cefpodoxime, cefprozil or a macrolide PCN resistant: levofloxacin, moxifloxacin, vancomycin, or linezolid	Shock, pleural effusion, superinfections, pericarditis, and otitis media
Haemophilus influenzae (*Haemophilus influenzae*)	Incidence greatest in patients with alcoholism, older adults, patients in long-term care facilities and nursing homes, patients with diabetes or COPD, and children <5 yrs of age Accounts for 5–20% of community-acquired pneumonias Mortality rate: 30%	Frequently insidious onset associated with upper respiratory tract infection 2–6 wks before onset of illness; fever, chills, productive cough; usually involves ≥1 lobes Sepsis is common. Infiltrate, occasional bronchopneumonia pattern on chest x-ray	Severity determines type of antibiotic and route (IV vs. oral) doxycycline, third-generation cephalosporin (ceftriaxone) or a fluoroquinolone	Lung abscess, pleural effusion, meningitis, arthritis, pericarditis, epiglottitis
Legionnaires disease (*Legionella pneumophila*)	Highest occurrence in summer and fall May cause disease sporadically or as part of an epidemic Incidence greatest in middle-aged and older men, people who smoke, patients with chronic diseases, those receiving immunosuppressive therapy, and those in close proximity to excavation sites Accounts for 15% of community-acquired pneumonias Mortality rate: 15–50%	Flulike symptoms; high fevers, mental confusion, headache, pleuritic pain, myalgias, dyspnea, productive cough, hemoptysis, leukocytosis Bronchopneumonia, unilateral or bilateral disease, lobar consolidation	Severity determines type of antibiotic and route (IV vs. oral) Azithromycin, moxifloxacin, or a fluoroquinolone	Hypotension, shock, and acute kidney injury
Mycoplasma pneumoniae (*Mycoplasma pneumoniae*)	Increase in fall and winter Responsible for epidemics of respiratory illness Most common type of atypical pneumonia Accounts for 20% of community-acquired pneumonias; more common in children and young adults Mortality rate: <0.1%	Onset is usually insidious. Patients not usually as ill as in other pneumonias. Sore throat, nasal congestion, ear pain, headache, low-grade fever, pleuritic pain, myalgias, diarrhea, erythematous rash, pharyngitis. Interstitial infiltrates on chest x-ray	Severity determines type of antibiotic and route (IV vs. oral) Macrolides, combination drugs (macrolide plus ampicillin and sulbactam) or tetracyclines (doxycycline)	Aseptic meningitis, meningoencephalitis, transverse myelitis, cranial nerve palsies, pericarditis, myocarditis
Viral pneumonia (influenza virus types A, B adenovirus, parainfluenza, cytomegalovirus, coronavirus, varicella-zoster)	Incidence greatest in winter months Epidemics occur every 2–3 yrs. Most common causative organisms in adults; other organisms in children (e.g., cytomegalovirus and respiratory syncytial virus) Accounts for 20% of community-acquired pneumonias	Patchy infiltrate, small pleural effusion on chest x-ray In most patients, influenza begins as an acute upper respiratory infection; others have bronchitis, pleurisy, and so on, and still others develop gastrointestinal symptoms	Treated symptomatically; treat in high-risk patients; oseltamivir or zanamivir (+ other agents depending upon dominant strain [type of virus]) Does not respond to treatment with currently available antimicrobials	Superimposed bacterial infection, bronchopneumonia

Chlamydial pneumonia (*Chlamydophila pneumoniae*)	Reported mainly in college students, military recruits, and older adults May be a common cause of community-acquired pneumonia or observed in combination with other pathogens Mortality rate is low because the majority of cases are relatively mild. Older adults with coexistent infections, comorbidities, and reinfections may require hospitalization	Hoarseness, fever, chills, pharyngitis, rhinitis, nonproductive cough, myalgias, arthralgias Single infiltrate on chest x-ray; pleural effusion possible	Macrolide or doxycycline	Reinfection and acute respiratory failure
Hospital-Acquired and Health Care–Associated Pneumonias				
Pseudomonas pneumonia (*Pseudomonas aeruginosa*)	Incidence greatest in those with preexisting lung disease, cancer (particularly leukemia); those with homograft transplants; burns; people who are debilitated; and patients receiving antimicrobial therapy and treatments such as tracheostomy, suctioning, and in postoperative settings. Almost always of nosocomial origin Accounts for 15% of hospital-acquired pneumonias Mortality rate: 40–60%	Diffuse consolidation on chest x-ray; toxic appearance: fever, chills, productive cough, relative bradycardia, leukocytosis	Sensitivity tests guide choice and severity determines type of antibiotic and route (IV vs. oral): ceftazidime, ciprofloxacin, cefepime, aztreonam, imipenem/cilastatin, meropenem, piperacillin, +/– an aminoglycoside	Lung cavitation; has capacity to invade blood vessels, causing hemorrhage and lung infection; usually requires hospitalization
Staphylococcal pneumonia (*Staphylococcus aureus*)	Incidence greatest in immunocompromised patients, IV drug users, and as a complication of epidemic influenza Commonly nosocomial in origin Accounts for 10–30% of hospital-acquired pneumonias Mortality rate: 25–60% MRSA may also cause community-based infection	Severe hypoxemia, cyanosis, necrotizing infection. Sepsis is common	Severity determines type of antibiotic and route (IV vs. oral) MSSA: oxacillin or nafcillin MRSA or PCN allergy: vancomycin or linezolid	Pleural effusion/pneumothorax, lung abscess, empyema, meningitis, endocarditis Frequently requires hospitalization. Treatment must be vigorous and prolonged because disease tends to destroy lung tissue
Klebsiella pneumonia (*Klebsiella pneumoniae* [Friedländer's bacillus—encapsulated gram-negative aerobic bacillus])	Incidence greatest in older adults; patients with alcoholism; patients with chronic disease, such as diabetes, heart failure, COPD; patients in chronic care facilities and nursing homes Accounts for 2–5% of community-acquired and 10–30% of hospital-acquired pneumonias Mortality rate: 40–50%	Tissue necrosis occurs rapidly. Toxic appearance: fever, cough, sputum production, bronchopneumonia, lung abscess. Lobar consolidation, bronchopneumonia pattern on chest x-ray	Severity determines type of antibiotic and route (IV vs. oral) Hospital acquired: cefepime, ceftazidime, imipenem, meropenem, or piperacillin/tazobactam plus an aminoglycoside or a fluoroquinolone; Community acquired: a levofloxacin plus ciprofloxacin or nitrofurantoin or nitrofurantoin macrocrystals	Multiple lung abscesses with cyst formation, empyema, pericarditis, pleural effusion; may be fulminating, progressing to fatal outcome
Pneumonia in the Immunocompromised Host				
Pneumocystis pneumonia (*Pneumocystis jirovecii*)	Incidence greatest in patients with AIDS and patients receiving immunosuppressive therapy for cancer, organ transplantation, and other disorders Frequently seen with cytomegalovirus infection Mortality rate 15–20% in hospitalized patients and fatal if not treated	Pulmonary infiltrates on chest x-ray; nonproductive cough, fever, dyspnea	Severity determines type of antibiotic and route (IV vs. oral) Trimethoprim/sulfamethoxazole	Respiratory failure

Fungal pneumonia (*Aspergillus fumigatus*)	Incidence greatest in patients who are immunocompromised or neutropenic Mortality rate: 15–20%	Cough, hemoptysis, infiltrates, fungus ball on chest x-ray	Severity determines type of antibiotic and route (IV vs. oral) Voriconazole, for invasive disease; amphotericin B or liposomal amphotericin B or caspofungin Lobectomy for fungus ball	Dissemination to brain, myocardium, and thyroid gland
Tuberculosis (*Mycobacterium tuberculosis*)	Incidence increased in indigent, immigrant, and prison populations; people with AIDS; and people who are homeless Mortality rate: <1% (depending on comorbidity)	Weight loss, fever, night sweats, cough, sputum production, hemoptysis, nonspecific infiltrate (lower lobe), hilar node enlargement, pleural effusion on chest x-ray	Isoniazid + rifampin + ethambutol + pyrazinamide (see section on TB and Table 10-4)	Reinfection and acute respiratory infection
Pneumonia from Aspiration				
Anaerobic bacteria (*S. pneumoniae*, *H. influenzae*, *S. aureus*)	Risk: reduced consciousness, dysphagia, disorders of upper GI tract, mechanical disruption of glottic closure (endotracheal tube, tracheostomy, nasogastric feeding)	Abrupt onset of dyspnea, low-grade fever, cough, predisposing condition for aspiration	Severity determines type of antibiotic and route (IV vs. oral) Clindamycin +/– a fluoroquinolone	Identification of potential aspirate is important for treatment

AIDS, acquired immune deficiency syndrome; COPD, chronic obstructive pulmonary disease; GI, gastrointestinal; IV, intravenous; MRSA, methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-sensitive *Staphylococcus aureus*; PCN, penicillin; TB, tuberculosis

Adapted from Gilbert, D. N., Chambers, H. F., Eliopoulos, G. M., et al. (2018). *The Sanford guide to antimicrobial therapy 2018* (48th ed.). Sperryville, VA: Antimicrobial Therapy, Inc.

In suspected HAP, treatment is usually initiated with a broad-spectrum IV antibiotic and may be monotherapy or combination therapy. For patients with no known multidrug resistance, monotherapy with ceftriaxone, ampicillin/sulbactam, levofloxacin, or ertapenem is used. With known multidrug resistance, a three-drug combination therapy may be used; this drug regimen may include an antipseudomonal cephalosporin or ceftazidime or antipseudomonal carbapenem or piperacillin/tazobactam plus antipseudomonal fluoroquinolone or aminoglycoside plus linezolid or vancomycin. The patient's status must be assessed 72 hours after the initiation of therapy, and antibiotics should be discontinued or modified based on the culture results. Of concern is the rampant rise in respiratory pathogens that are resistant to available antibiotics. Examples include vancomycin-resistant enterococcus (VRE), MRSA, and drug-resistant *S. pneumoniae*. Providers tend to prescribe antibiotics aggressively in the presence of suspected infection. Mechanisms to monitor and minimize the inappropriate use of antibiotics are in place. In response to antibiotic resistant organisms, the CDC recommends all acute care hospitals participate in an antibiotic stewardship program (CDC, 2019b). Antibiotic stewardship refers to a set of coordinated strategies to improve the use of antimicrobial medications with the goal of enhancing patient health outcomes, reducing resistance to antibiotics, and decreasing unnecessary costs (CDC, 2019a; Nathwani, Varghese, Stephens, et al., 2019). Education of clinicians about the use of evidence-based guidelines in the treatment of respiratory infection is important, and some institutions have implemented algorithms to assist clinicians in choosing the appropriate antibiotics. Monitoring and surveillance of susceptibility patterns for pathogens are also important.

Other Therapeutic Regimens

Antibiotics are ineffective in viral upper respiratory tract infections and pneumonias, and their use may be associated with adverse effects. Antibiotics are indicated with a viral respiratory infection *only* if a secondary bacterial pneumonia, bronchitis, or rhinosinusitis is present. With the exception of the use of antimicrobial therapy, treatment of viral pneumonia is generally the same as that for bacterial pneumonia; however, different treatments have been used for the patient who develops pneumonia as a result of infection with the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virion implicated in COVID-19 (Kim & Gandhi, 2020) (see later discussion).

Treatment of viral pneumonia is primarily supportive. Hydration is a necessary part of therapy, because fever and tachypnea may result in insensible fluid losses. Antipyretic agents may be used to treat headache and fever; antitussive medications may be used for the associated cough. Warm, moist inhalations are helpful in relieving bronchial irritation. Antihistamines may provide benefit with reduced sneezing and rhinorrhea. Nasal decongestants may also be used to treat symptoms and improve sleep; however, excessive use can cause rebound nasal congestion. Bed rest is prescribed until the infection shows signs of clearing. If hospitalized, the patient is observed carefully until the clinical condition improves.

If hypoxemia develops, oxygen is administered. Pulse oximetry or arterial blood gas analysis is used to determine the need for oxygen and to evaluate the effectiveness of the therapy. Arterial blood gases may be used to obtain a baseline measure of the patient's oxygenation and acid–base status; however, pulse oximetry is used to continuously monitor the patient's oxygen saturation and response to therapy. More aggressive respiratory support measures include administration of high concentrations of oxygen (**fraction of inspired oxygen [FiO_2]**, or the concentration of oxygen that is delivered), ET intubation, and mechanical ventilation. Different modes of mechanical ventilation may be required. Modes of mechanical ventilation are discussed later in this chapter.

Gerontologic Considerations

Pneumonia in older adult patients may occur as a primary diagnosis or as a complication of a chronic disease. Pulmonary infections in older adults frequently are difficult to treat and result in a higher mortality rate than in younger people (Ramirez, 2019). General deterioration, weakness, abdominal symptoms, anorexia, confusion, tachycardia, and tachypnea may signal the onset of pneumonia. The diagnosis of pneumonia may be missed because the classic symptoms of cough, chest pain, sputum production, and fever may be absent or masked in older adult patients. In addition, the presence of some signs may be misleading. Abnormal breath sounds, for example, may be caused by microatelectasis that occurs as a result of decreased mobility, decreased lung volumes, or other respiratory function changes. Chest x-rays

may be needed to differentiate chronic heart failure, which is often seen in older adults, from pneumonia as the cause of clinical signs and symptoms.

Supportive treatment includes hydration (with caution and with frequent assessment because of the risk of fluid overload in older adults); supplemental oxygen therapy; and assistance with deep breathing, coughing, frequent position changes, and early ambulation. All of these are particularly important in the care of older adult patients with pneumonia. To reduce or prevent serious complications of pneumonia in older adults, vaccination against pneumococcal and influenza infections is recommended.

COVID-19 Considerations

SARS-CoV-2 is a community-acquired coronavirus whose primary pathologic evolution occurs within the respiratory system. Viral transmission is presumed to occur through direct person-to-person contact via respiratory droplets, although it is hypothesized that fomite transmission (i.e., transmission from inanimate surfaces that carry the virus) might be possible (Cascella, Rajnik, Cuomo, et al., 2020; Kim & Gandhi, 2020). SARS-CoV-2 enters host cells through ACE2 cellular surface receptors where it replicates; these ACE2 receptors are particularly abundant in type II alveolar and vascular endothelial cells within the pulmonary vascular circuit (see Chapter 27, Fig. 27-2 for an illustration of viral transmission and replication; see Chapter 66 for a discussion of risks of SAR-CoV-2).

At the time of this writing, although it is believed that some patients infected with SARS-CoV-2 may remain asymptomatic, others exhibit signs and symptoms consistent with a type of viral upper respiratory tract infection that may lead to viral pneumonia. Clinical manifestations consistent with mild COVID-19 may include fever, nonproductive cough, sore throat, fatigue, myalgias (muscle aches), nasal congestion, nausea, vomiting, diarrhea, anosmia (loss of smell), and ageusia (loss of taste) (Cascella et al., 2020; CDC, 2020). Data derived from epidemiologic studies in China, where the COVID-19 pandemic originated, suggest that approximately 81% of patients with COVID-19 have mild illness, with either mild viral pneumonia or no pneumonia (Wu & McGoogan, 2020).

Ideally, the diagnosis of COVID-19 is confirmed by patient self-administered bilateral nasal swabbing for viral antigen or nucleic acid. Self-swabbing minimizes risk of person-to-person transmission of respiratory droplets. The act of patient self-swabbing ideally should be observed by a health care provider to assure it is performed properly (CDC, 2020).

Most patients with known or suspected mild COVID-19 may be managed on an outpatient basis within their homes, which conserves hospital resources and diminishes likelihood of exposure to others, including health care workers

(Kim & Gandhi, 2020). At the present time, no specific medications are prescribed to either treat COVID-19 or mitigate its effects in patients with mild disease who are managed at home. The therapeutic regimens that patients with mild COVID-19 are advised to follow mirror those for other viral respiratory illnesses. Patients are advised to rest, hydrate, take antipyretic agents (e.g., acetaminophen) and monitor their symptoms. However, given the virulence of SARS-CoV-2, these patients must be capable of maintaining self-quarantine/isolation at home until all of the following criteria are met (CDC, 2020):

- At least 72 hours have transpired since the patient had a fever and the patient has not taken any antipyretic agents during that timeframe;
- The patient reports an improvement in any respiratory manifestations of COVID-19; and
- At least 10 days have elapsed since the patient first noted clinical manifestations suggestive of COVID-19.

Clinicians and others in contact with patients with suspected or known COVID-19 should observe infection control and prevention measures and utilize appropriate personal protective equipment (PPE; CDC, 2020) (see Chapter 66 for further discussion).

Patients with moderate COVID-19 should be hospitalized so that they may be closely observed on an ongoing basis, because many of these patients may rapidly deteriorate to severe COVID-19 and respiratory failure. These patients have clear evidence of viral pneumonia that may be diagnosed based upon clinical examination, chest x-ray or CT scan findings but have SpO_2 levels >93% on room air, suggesting adequate oxygenation (Cascella et al., 2020; National Institutes of Health COVID-19 Treatment Guidelines Panel [NIH], 2020). These patients may or may not have dyspnea. Laboratory tests upon admission include a CBC with differential, a complete metabolic panel, creatine kinase (CK), lactate dehydrogenase (LDH), C-reactive protein (CRP), ferritin, and D-dimer. Notable findings may include leukopenia (low white blood cell count), lymphopenia (low lymphocyte count), and elevated CK, LDH, CRP, ferritin, and D-dimer levels (Cascella et al., 2020).

It appears at the present time that few patients with COVID-19 have a superinfection with bacterial pathogens (i.e., concomitant bacterial pneumonia); therefore, antibiotic agents are not routinely prescribed for the patient hospitalized to manage moderate COVID-19 pneumonia. However, if it is believed that the patient has a bacterial pneumonia or sepsis, then antibiotic agents indicated to treat CAP are prescribed (Kim & Gandhi, 2020; NIH, 2020) (see previous discussion). Most patients are prescribed anticoagulant agents as prophylaxis, as they have a higher risk of venous thromboembolism (VTE) (see Chapter 26 for further discussion of VTE). The typical agents

prescribed are low-molecular-weight heparins (e.g., enoxaparin, dalteparin), administered twice daily (Kim & Gandhi, 2020).

Currently, there is insufficient evidence to support prescribing any antiviral or immunomodulating agents to manage patients with moderate COVID-19 pneumonia (NIH, 2020). If a patient must be prescribed an inhaled medication (e.g., to manage a preexisting chronic respiratory disease), then to the extent possible, that medication should be administered by a pMDI rather than an SVN, to minimize the likelihood of aerosolizing the patient's respiratory droplets into the ambient air. Ideally, patients hospitalized with moderate COVID-19 pneumonia should be placed in airborne infection isolation rooms, with limitations enforced so that clinicians enter only as necessary, wearing appropriate PPE (NIH, 2020) (see Chapter 66 for further discussion). For instance, the nurse caring for the patient might arrange activities so that assessments are performed and medications are administered at the same time (see Chart 19-7).

The patient with severe COVID-19 pneumonia has SpO_2 ≤93% on room air with tachypnea and requires supplemental oxygen, perhaps with ET intubation and mechanical ventilation (see later discussions on ET intubation and mechanical ventilation). Chest x-ray findings typically show diffuse, bilateral, "ground-glass" opacities (Cascella et al., 2020). Some patients have severe dyspnea, while others report no dyspnea and have been referred to as the *happy hypoxemics* by Caputo, Strayer, and Levitan (2020). Reportedly, many patients deteriorate rapidly and without clear prodromal clinical indicators from moderate to severe disease (Cascella et al., 2020).

Chart 19-7 **ETHICAL DILEMMA**

Is It Ever Ethical to Refuse to Care for a Patient?

Case Scenario

You are a staff nurse in a medical intensive care unit (MICU). Within the past week, there has been a significantly increased incidence of patients infected with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in two counties that border the county where your hospital is located. Your nurse manager holds an emergency mandatory staff meeting, and informs all staff present that preparations are being made for the hospital to receive and treat a large volume of patients with coronavirus disease 2019 (COVID-19). The MICU where you work has been designated to exclusively treat these patients who are critically ill, while the surgical ICU (SICU) in the hospital will admit all patients who are critically ill but do not have COVID-19. The MICU nurse manager describes hospital administration's plans to manage the distribution and rationing of personal protective equipment (PPE) for MICU staff and identifies new policies that have been emergently put in place to guide their usage, conservation, and disposal. H.S., a MICU staff nurse who works with you, turns to you and says "I am not going to take care of patients with COVID-19! They can find another safer place for me to work in this hospital or I will quit. I did not sign up to be a nurse here to risk my life."

Discussion

Nurses who work in MICUs confront risks to their health on a continuing basis by being in contact with patients who have infectious diseases. Prior to the COVID-19 pandemic, most of these health risks to nurses were minimal. Most pathogens that caused infectious diseases in patients in MICUs could be effectively treated pharmacologically (e.g., with antibiotics) in people with healthy immune systems. Many patients in MICUs who were critically ill with these infectious diseases had comorbid disorders that hampered their immune responses; however, a healthy nurse who became exposed to the pathogen would likely not become infected. Yet if the nurse did become ill, the nurse could have expected an expedient recovery to health after treatment was instituted. The personal risk to the nurse changes dramatically during pandemics, when the nurse is confronted with a novel aggressive contagious pathogen that can cause life-threatening illness in the previously healthy person, without the benefit of clearly effective evidence-based treatment strategies.

Analysis

- Identify the ethical principles that are in conflict in this case (see Chapter 1, Chart 1-7). Should the principle of beneficence have preeminence during pandemics? Can the desire to do the greatest good for the greatest number of people ever be given greater moral credence than ensuring that individual rights are preserved?

- Assume that H.S. is a healthy 24-year-old woman without any known risk factors for COVID-19. Now assume she is 62 years old, with diabetes and hypertension, and that her 88-year-old mother resides with her. Do these factors make a difference in whether or not you would support her desire to not care for patients with COVID-19?
- Do you and H.S. have a professional obligation to care for patients with COVID-19 who are critically ill? Do you have the right to refuse to care for these patients? How might your viewpoint change, depending upon the availability or lack of availability of appropriate PPE? How would you evaluate the new policies put in place that guide the usage, conservation, and disposal of PPE in the MICU? What resources are available for you to evaluate the soundness of this policy, to ensure that you, H.S., and your MICU colleagues are not placed at undue risk? Identify professional resources that might help you to resolve this dilemma.

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Resources

See Chapter 1, Chart 1-10 for Steps of an Ethical Analysis and Ethics Resources.

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Although patients with severe COVID-19 pneumonia were nearly universally managed with ET intubation and mechanical ventilation during the first weeks of the pandemic, case fatality rates were reportedly much higher than anticipated (Caputo et al., 2020). That observation, along with actual or anticipated shortages of mechanical ventilators, led some providers to try managing patients with other strategies, including trials of placing nonintubated hospitalized patients with COVID-19 in the prone position at periodic intervals, along with administering high flow oxygen therapy. Although not universally effective, data from preliminary research suggest that periodic prone positioning with high flow oxygen therapy can prevent eventual ET intubation in some patients with severe COVID-19 pneumonia (Caputo et al., 2020).

At the present time, there are no immunomodulating agents that are recommended to treat severe COVID-19 pneumonia, although interleukin-6 (IL-6) antagonists (e.g., tocizilumab) are currently under investigation. IL-6 is believed to be a key cytokine responsible for propagating the haywire inflammatory response called cytokine release syndrome (CRS) or the "cytokine storm" that occurs in some patients with severe COVID-19 (NIH, 2020) (see Chapter 12 for further discussion of CRS). Another therapy that is under investigation and approved for emergency use is using convalescent plasma, which transfuses antibodies from patients recovered from COVID-19 into patients with severe disease (Kim & Gandhi, 2020).

It is recommended that the antiviral agent remdesivir be prescribed to treat patients with severe COVID-19 pneumonia as it has demonstrated promising results in clinical trials, notably improved recovery times and overall outcomes (Beigel, Tomashek, Dodd, et al., 2020; NIH, 2020; Wang, Zhang, Du, et al., 2020). Among patients with severe COVID-19 pneumonia, a frequent and serious complication is acute respiratory distress syndrome (ARDS), which is commonly managed with ET intubation and mechanical ventilation (see later discussion). Among patients with COVID-19 and ARDS, the mortality rate is reported at 50% (Anesi, 2020).

Complications

Shock and Respiratory Failure

Severe complications of pneumonia include hypotension and septic shock and respiratory failure (especially with gram-negative bacterial disease or with SARS-CoV-2 infection in older adult patients). These complications are encountered chiefly in patients who have received no specific treatment or inadequate or delayed treatment or in patients at risk for severe COVID-19. These complications are also encountered when the infecting organism is resistant to therapy, when a comorbid disease complicates the pneumonia, or when the patient is immune compromised. (See Chapter 11 for further discussion of management of the patient with septic shock.)

Pleural Effusion

A pleural effusion is an accumulation of pleural fluid in the pleural space (space between the parietal and visceral pleurae of the lung). A parapneumonic effusion is any pleural effusion associated with bacterial pneumonia, lung abscess, or bronchiectasis. After the pleural effusion is detected on a chest x-ray, a thoracentesis may be performed to remove the fluid, which is sent to the laboratory for analysis. There are three stages of parapneumonic pleural effusions based on pathogenesis: uncomplicated, complicated, and thoracic

empyema. An **empyema** occurs when thick, purulent fluid accumulates within the pleural space, often with fibrin development and a loculated (walled-off) area where the infection is located (see later discussion). A chest tube may be inserted to treat pleural infection by establishing proper drainage of the empyema. Sterilization of the empyema cavity requires 4 to 6 weeks of antibiotics, and sometimes surgical management is required.

NURSING PROCESS

The Patient with Bacterial Pneumonia

Assessment

Nursing assessment is critical in detecting pneumonia. Fever, chills, or night sweats in a patient who also has respiratory symptoms should alert the nurse to the possibility of bacterial pneumonia. Respiratory assessment further identifies the clinical manifestations of pneumonia: pleuritic-type pain, fatigue, tachypnea, the use of accessory muscles for breathing, bradycardia or relative bradycardia, coughing, and purulent sputum. The nurse monitors the patient for the following: changes in temperature and pulse; amount, odor, and color of secretions; frequency and severity of cough; degree of tachypnea or shortness of breath; changes in physical assessment findings (primarily assessed by inspecting and auscultating the chest); and changes in the chest x-ray findings.

In addition, it is important to assess older adult patients for unusual behavior, altered mental status, dehydration, excessive fatigue, and concomitant heart failure.

Diagnosis

Nursing Diagnoses

Based on the assessment data, major nursing diagnoses may include the following:

- Impaired airway clearance associated with copious tracheobronchial secretions
- Fatigue and activity intolerance associated with impaired respiratory function
- Risk for hypovolaemia associated with fever and a rapid respiratory rate
- Impaired nutritional status
- Lack of knowledge about the treatment regimen and preventive measures

Collaborative Problems/Potential Complications

Based on the assessment data, collaborative problems or potential complications that may occur include the following:

- Continuing symptoms after initiation of therapy
- Sepsis and septic shock
- Respiratory failure
- Atelectasis
- Pleural effusion

- Delirium

Planning and Goals

The major goals may include improved airway patency, increased activity, maintenance of proper fluid volume, maintenance of adequate nutrition, an understanding of the treatment protocol and preventive measures, and absence of complications.

Nursing Interventions

Improving Airway Patency

Removing secretions is important because retained secretions interfere with gas exchange and may slow recovery. The nurse encourages hydration (2 to 3 L/day), because adequate hydration thins and loosens pulmonary secretions. Humidification may be used to loosen secretions and improve ventilation. A high-humidity facemask (using either compressed air or oxygen) delivers warm, humidified air to the tracheobronchial tree, helps liquefy secretions, and relieves tracheobronchial irritation. Coughing can be initiated either voluntarily or by reflex. Lung expansion maneuvers, such as deep breathing with an incentive spirometer, may induce a cough. To improve airway patency, the nurse encourages the patient to perform an effective, directed cough, which includes correct positioning, a deep inspiratory maneuver, glottic closure, contraction of the expiratory muscles against the closed glottis, sudden glottic opening, and an explosive expiration. In some cases, the nurse may assist the patient by placing both hands on the lower rib cage (either anterior or posterior) to focus the patient on a slow deep breath, and then manually assisting the patient by applying constant, external pressure during the expiratory phase.

CPT is important in loosening and mobilizing secretions (see Figs. 20-6 and 20-7 and further discussion in Chapter 20). Indications for CPT include sputum retention not responsive to spontaneous or directed cough, a history of pulmonary problems previously treated with chest physiotherapy, continued evidence of retained secretions (decreased or abnormal breath sounds, change in vital signs), abnormal chest x-ray findings consistent with atelectasis or infiltrates, and deterioration in oxygenation. The patient is placed in the proper position to drain the involved lung segments, then the chest is percussed and vibrated either manually or with a mechanical percussor. The nurse may consult the respiratory therapist for volume expansion protocols and secretion management protocols that help direct the respiratory care of the patient and match the patient's needs with appropriate treatment schedules.

After each position change, the nurse encourages the patient to breathe deeply and cough. If the patient is too weak to cough effectively, the nurse may need to remove the mucus by nasotracheal suctioning. It may take time for secretions to mobilize and move into the central airways for

expectoration. Therefore, it is important for the nurse to monitor the patient for cough and sputum production after the completion of CPT.

The nurse also administers and titrates oxygen therapy as prescribed or via protocols. The effectiveness of oxygen therapy is monitored by improvement in clinical signs and symptoms, patient comfort, and adequate oxygenation values as measured by pulse oximetry or arterial blood gas analysis.

Promoting Rest and Conserving Energy

The nurse encourages the patient who is debilitated to rest and avoid overexertion and possible exacerbation of symptoms. The patient should assume a comfortable position to promote rest and breathing (e.g., semi-Fowler position) and should change positions frequently to enhance secretion clearance and pulmonary ventilation and perfusion. Outpatients must be instructed to avoid overexertion and to engage in only moderate activity during the initial phases of treatment.

Promoting Fluid Intake

The respiratory rate of patients with pneumonia increases because of the increased workload imposed by labored breathing and fever. An increased respiratory rate leads to an increase in insensible fluid loss during exhalation and can lead to dehydration. Therefore, unless contraindicated, increased fluid intake (at least 2 L/day) is encouraged. Hydration must be achieved more slowly and with careful monitoring in patients with preexisting conditions such as heart failure (see Chapter 25).

Maintaining Nutrition

Many patients with shortness of breath and fatigue have a decreased appetite and consume only fluids. Fluids with electrolytes (commercially available drinks, such as Gatorade) may help provide fluid, calories, and electrolytes. Other nutritionally enriched drinks such as oral nutritional supplements may be used to supplement calories. Small, frequent meals may be advisable. In addition, IV fluids and nutrients may be given if necessary.

Promoting Patients' Knowledge

The patient and family are educated about the cause of pneumonia, management of symptoms, signs and symptoms that should be reported to the primary provider or nurse, and the need for follow-up. The patient also needs information about factors (both patient risk factors and external factors) that may have contributed to the development of pneumonia and strategies to promote recovery and prevent recurrence. If the patient is hospitalized, they are instructed about the purpose and importance of management strategies that have been implemented and about the importance of adhering to them during and after the hospital stay.

Explanations should be given simply and in language that the patient can understand. If possible, written instructions and information should be provided, and alternative formats should be provided for patients with hearing or vision loss, if necessary. Because of the severity of symptoms, the patient may require that instructions and explanations be repeated several times.

Monitoring and Managing Potential Complications

Continuing Symptoms After Initiation of Therapy. The patient is observed for response to antibiotic therapy; patients usually begin to respond to treatment within 24 to 48 hours after antibiotic therapy is initiated. If the patient started taking antibiotics before evaluation by culture and sensitivity of the causative organisms, antibiotics may need to be changed once the results are available. The patient is monitored for changes in physical status (deterioration of condition or resolution of symptoms) and for persistent recurrent fever, which may be a result of medication allergy (signaled possibly by a rash); medication resistance or slow response (greater than 48 hours) of the susceptible organism to therapy; pleural effusion; or pneumonia caused by an unusual organism, such as *P. jiroveci* or *Aspergillus fumigatus*. Failure of the pneumonia to resolve or persistence of symptoms despite changes on the chest x-ray raises the suspicion of other underlying disorders, such as lung cancer. As described previously, lung cancers may invade or compress airways, causing an obstructive atelectasis that may lead to pneumonia.

In addition to monitoring for continuing symptoms of pneumonia, the nurse also monitors for other complications, such as septic shock and multiple organ dysfunction syndrome (MODS) and atelectasis, which may develop during the first few days of antibiotic treatment.

Shock and Respiratory Failure. The nurse assesses for signs and symptoms of septic shock and respiratory failure by evaluating the patient's vital signs, pulse oximetry values, and hemodynamic monitoring parameters. The nurse reports signs of deteriorating patient status and assists in administering IV fluids and medications prescribed to combat shock. Intubation and mechanical ventilation may be required if respiratory failure occurs. (Sepsis and septic shock are described in detail in Chapter 11, and care of the patient receiving mechanical ventilation is described later in this chapter.)

Pleural Effusion. If pleural effusion develops and thoracentesis is performed to remove fluid, the nurse assists in the procedure and explains it to the patient. After thoracentesis, the nurse monitors the patient for pneumothorax or recurrence of pleural effusion. If a chest tube needs to be inserted, the nurse monitors the patient's respiratory status (see discussion on chest tubes later in this chapter).

For the procedural guidelines for assisting the patient undergoing a thoracentesis, go to thepoint.lww.com/Brunner15e.

Delirium. A patient with pneumonia is assessed for delirium and other more subtle changes in cognitive status; this is especially true in the older adult. The Confusion Assessment Method (CAM) is a commonly used screening tool (see Chapter 8, Chart 8-7). Confusion, suggestive of delirium, and other changes in cognitive status resulting from pneumonia are poor prognostic signs (File, 2019b). Delirium may be related to hypoxemia, fever, dehydration, sleep deprivation, or developing sepsis. The patient's underlying comorbid conditions may also play a part in the development of confusion. Addressing and correcting underlying factors as well as ensuring patient safety are important nursing interventions.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care. Depending on the severity of the pneumonia, treatment may occur in the hospital or in the outpatient setting. Patient education is crucial regardless of the setting, and the proper administration of antibiotics is important. In some instances, the patient may be treated initially with IV antibiotics as an inpatient and then discharged to continue the IV antibiotics at home. A seamless system of care must be maintained for the patient from hospital to home; this includes communication between the nurses caring for the patient in both settings.

If oral antibiotics are prescribed, the nurse educates the patient about their proper administration and potential side effects. The patient should be educated about symptoms that require contacting the primary provider: difficulty breathing, worsening cough, recurrent/increasing fever, and medication intolerance.

After the fever subsides, the patient may gradually increase activities. Fatigue and weakness may be prolonged after pneumonia, especially in older adults. The nurse encourages breathing exercises to promote secretion clearance and volume expansion. A patient who is being treated as an outpatient should be contacted by the health care team or instructed to contact the primary provider 24 to 48 hours after starting therapy. The patient is also instructed to return to the clinic or primary provider's office for a follow-up chest x-ray and physical examination. Often, improvement in chest x-ray findings lags behind improvement in clinical signs and symptoms.

The nurse encourages the patient who smokes to stop smoking. Smoking inhibits tracheobronchial ciliary action, which is the first line of defense of the lower respiratory tract. Smoking also irritates the mucous cells of the bronchi and inhibits the function of alveolar macrophage (scavenger) cells. The patient is instructed to avoid stress, fatigue, sudden changes in temperature, and excessive alcohol intake, all of which lower resistance to pneumonia. The nurse reviews with the patient the principles of adequate nutrition and rest, because one episode of pneumonia may make a patient susceptible to recurring respiratory tract infections.

Continuing and Transitional Care. Patients who are severely debilitated or who cannot care for themselves may require referral for home, transitional, or community-based care. During home visits, the nurse assesses the patient's physical status, monitors for complications, assesses the home environment, and reinforces previous education. The patient's adherence to the therapeutic regimen is evaluated (i.e., taking medications as prescribed; performing breathing exercises; consuming adequate fluid and dietary intake; and avoiding smoking, alcohol, and excessive activity). The nurse stresses to the patient and family the importance of monitoring for complications or exacerbation of the pneumonia. The patient is encouraged to obtain an influenza vaccination at the prescribed times, because influenza increases susceptibility to secondary bacterial pneumonia, especially that caused by staphylococci, *H. influenzae,* and *S. pneumoniae.* The patient also is urged to receive the pneumococcal vaccine(s) according to CDC recommendations (see previous discussion).

Evaluation

Expected patient outcomes may include the following:

1. Demonstrates improved airway patency, as evidenced by adequate oxygenation by pulse oximetry or arterial blood gas analysis, normal temperature, normal breath sounds, and effective coughing
2. Rests and conserves energy by limiting activities and remaining in bed while symptomatic and then slowly increasing activities
3. Maintains adequate hydration, as evidenced by an adequate fluid intake and urine output and normal skin turgor
4. Consumes adequate dietary intake, as evidenced by maintenance or increase in body weight without excess fluid gain
5. Verbalizes increased knowledge about management strategies
6. Adheres to management strategies
7. Exhibits no complications
    a. Exhibits acceptable vital signs, pulse oximetry, and arterial blood gas measurements
    b. Reports productive cough that diminishes over time

c. Has absence of signs or symptoms of sepsis, septic shock, respiratory failure, or pleural effusion
d. Remains oriented and aware of surroundings

8. Maintains or increases weight
9. Adheres to treatment protocol and prevention strategies

Aspiration

Aspiration is inhalation of foreign material (e.g., oropharyngeal or stomach contents) into the lungs. It is a serious complication that can cause pneumonia and result in the following clinical picture: tachycardia, dyspnea, central cyanosis, hypertension, hypotension, and potentially death. It can occur when the protective airway reflexes are decreased or absent due to a variety of factors (see Chart 19-8). Studies suggest that aspiration pneumonia accounts for 5% to 15% of CAP (Gamache, 2019).

Pathophysiology

The primary factors responsible for death and complications after aspiration are the volume and character of the aspirated contents. Aspiration pneumonia develops after inhalation of colonized oral or pharyngeal material. The pathologic process involves an acute inflammatory response to bacteria and bacterial products. Most commonly, the causative organisms in community-acquired aspiration pneumonia may include *S. aureus*, *S. pneumoniae*, *H. influenzae*, and *Enterobacter* species (Gamache, 2019).

Chart 19-8 RISK FACTORS

Aspiration

- Seizure activity
- Brain injury
- Decreased level of consciousness from trauma, drug or alcohol intoxication, excessive sedation, or general anesthesia
- Flat body positioning
- Stroke
- Swallowing disorders
- Cardiac arrest

Adapted from American Association of Critical-Care Nurses. (2017b). AACN practice alert: Prevention of aspiration in adults. *Critical Care Nurse*, *37*(3), 88; Bartlett, J. (2019a). Aspiration pneumonia in adults. *UpToDate*. Retrieved on 9/23/2019 at: www.uptodate.com/contents/aspiration-pneumonia-in-adults

A full stomach contains solid particles of food. If these are aspirated, the problem then becomes one of mechanical blockage of the airways and secondary infection. During periods of fasting, the stomach contains acidic gastric juice, which, if aspirated, can be very destructive to the alveoli and capillaries. Fecal contamination (more likely seen in intestinal obstruction) increases the likelihood of death, because the endotoxins produced by intestinal organisms may be absorbed systemically, or the thick proteinaceous material found in the intestinal contents may obstruct the airway, leading to atelectasis and secondary bacterial invasion.

Esophageal conditions may also be associated with aspiration pneumonia. These include dysphagia, esophageal strictures, neoplasm or diverticula, tracheoesophageal fistula, and gastroesophageal reflux disease.

Prevention

The risk of aspiration is indirectly related to the level of consciousness of the patient. Aspiration of small amounts of material from the buccal (oral) cavity is not uncommon, particularly during sleep; however, disease as a result of aspiration does not occur in healthy people because the material is cleared by the mucociliary tree and the macrophages. Witnessed aspiration of large volumes occurs occasionally; however, small-volume clinically silent aspiration is more common. Prevention is the primary goal when caring for patients at risk for aspiration (American Association of Critical Care Nurses [AACN], 2017b).

Quality and Safety Nursing Alert

When a nonfunctioning nasogastric tube allows the gastric contents to accumulate in the stomach, a condition known as silent aspiration may result. Silent aspiration often occurs unobserved and may be more common than suspected. If untreated, massive inhalation of gastric contents develops in a period of several hours.

Compensating for Absent Reflexes

Aspiration may occur if the patient cannot adequately coordinate protective glottic, laryngeal, and cough reflexes. This hazard is increased if the patient has a distended abdomen, is supine, has the upper extremities immobilized in any manner, receives local anesthetic agents to the oropharyngeal or laryngeal area for diagnostic procedures, has been sedated, or has had long-term intubation. Clinical interventions are key to preventing aspiration (see Chart 19-9).

For patients with known swallowing dysfunction or those recently extubated following prolonged ET intubation, a swallowing screen is necessary. Patients deemed at risk are then assessed by a speech therapist. Besides positioning the patient semirecumbent or upright prior to eating, other helpful techniques may include suggesting a soft diet and encouraging the patient to take small bites. The patient should be instructed to keep the chin tucked and the head turned with repeated swallowing. Straws should not be used.

Chart 19-9

Clinical Practices That Prevent Aspiration

- Maintain head-of-bed elevation at an angle of 30 to 45 degrees, unless contraindicated
- Use sedatives as sparingly as possible
- Before initiating enteral tube feeding, confirm the tip location
- For patients receiving tube feedings, assess placement of the feeding tube at 4-hour intervals, assess for gastrointestinal residuals (<150 mL before next feeding) to the feedings at 4-hour intervals
- For patients receiving tube feedings, avoid bolus feedings in those at risk for aspiration
- Consult with primary provider about obtaining a swallowing evaluation before oral feedings are started for patients who were recently extubated but were previously intubated for >2 days
- Maintain endotracheal cuff pressures at an appropriate level, and ensure that secretions are cleared from above the cuff before it is deflated.

American Association of Critical Care Nurses (AACN). (2017b). AACN practice alert: Prevention of aspiration in adults. *Critical Care Nurse*, *37*(3), 88.

When vomiting, people can normally protect their airway by sitting up or turning on the side and coordinating breathing, coughing, gag, and glottic reflexes. If these reflexes are active, an oral airway should not be inserted. If an airway is in place, it should be pulled out the moment the patient gags so as not to stimulate the pharyngeal gag reflex and promote vomiting and aspiration. Suctioning of oral secretions with a catheter should be performed with minimal pharyngeal stimulation.

For patients with an ET tube and feeding tube, the ET cuff pressure should be maintained at greater than 20 cm H_2O (but less than 30 cm H_2O to minimize injury) to prevent leakage of secretions from around the cuff into the lower respiratory tract. In addition, hypopharyngeal suctioning is recommended before the cuff is deflated (AACN, 2017a).

Assessing Feeding Tube Placement

Tube feedings must be given only when it is certain that the feeding tube is positioned correctly in the stomach. Many patients receive enteral feeding directly into the duodenum through a small-bore flexible feeding tube or surgically implanted tube. (See Chapter 39 for discussion of enteral tube feedings.)

Identifying Delayed Stomach Emptying

A full stomach can cause aspiration because of increased intragastric or extragastric pressure. The following may delay emptying of the stomach: intestinal obstruction; increased gastric secretions in gastroesophageal reflex disease; increased gastric secretions during anxiety, stress, or pain; and abdominal distention due to paralytic ileus, ascites, peritonitis, the use of opioids or sedatives, severe illness, or vaginal delivery. (See Chapter 39 for discussion of management of patients receiving gastric tube feedings.)

Managing Effects of Prolonged Intubation

Prolonged ET intubation or tracheostomy (see later discussions) can depress the laryngeal and glottic reflexes because of disuse. Patients with prolonged tracheostomies are encouraged to phonate and exercise their laryngeal muscles. For patients who have had long-term intubation or tracheostomies, it may be helpful to have a speech therapist experienced in swallowing disorders work with the patient to address swallowing problems, as noted previously.

Pulmonary Tuberculosis

Tuberculosis (TB) is an infectious disease that primarily affects the lung parenchyma. It also may be transmitted to other parts of the body, including the meninges, kidneys, bones, and lymph nodes. The primary infectious agent, *M. tuberculosis,* is an acid-fast aerobic rod that grows slowly and is sensitive to heat and ultraviolet light. *Mycobacterium bovis* and *Mycobacterium avium* have rarely been associated with the development of a TB infection.

TB is a worldwide public health problem that is closely associated with poverty, malnutrition, overcrowding, substandard housing, and inadequate health care. Mortality and morbidity rates continue to rise; *M. tuberculosis* infects an estimated one third of the world's population and remains the leading cause of death from infectious disease in the world. In 2017, 10 million people were sick with TB throughout the world, and there were 1.3 million TB-related deaths (CDC, 2018b).

In the United States, 9105 cases of TB were reported in 2017, which is a 2.3% decrease from 2016 (CDC, 2018b). Factors that prevent elimination of TB in the United States include the prevalence of TB among foreign-born residents, delays in detecting and reporting cases of TB, the lack of protection of contacts of people with infectious cases of TB, the presence of a substantial number of people with latent TB, and barriers to supporting clinical and public health expertise in this disease (CDC, 2018b).

Transmission and Risk Factors

TB spreads from person to person by airborne transmission. An infected person releases droplet nuclei (usually particles 1 to 5 mcm in diameter) through talking, coughing, sneezing, laughing, or singing. Larger droplets settle; smaller droplets remain suspended in the air and are inhaled by a susceptible person. Chart 19-10 lists risk factors for TB. Chart 19-11 summarizes the CDC's recommendations for the prevention of TB transmission in health care settings.

Pathophysiology

TB begins when a susceptible person inhales mycobacteria and becomes infected. The bacteria are transmitted through the airways to the alveoli, where they are deposited and begin to multiply. The bacilli also are transported via the lymph system and bloodstream to other parts of the body (kidneys, bones, cerebral cortex) and other areas of the lungs (upper lobes). The body's immune system responds by initiating an inflammatory reaction. Phagocytes (neutrophils and macrophages) engulf many of the bacteria, and TB-specific lymphocytes lyse (destroy) the bacilli and normal tissue. This tissue reaction results in the accumulation of exudate in the alveoli, causing bronchopneumonia. The initial infection usually occurs 2 to 10 weeks after exposure.

Granulomas, new tissue masses of live and dead bacilli, are surrounded by macrophages, which form a protective wall. They are then transformed to a fibrous tissue mass, the central portion of which is called a *Ghon tubercle.* The material (bacteria and macrophages) becomes necrotic, forming a cheesy mass. This mass may become calcified and form a collagenous scar. At this point, the bacteria become dormant, and there is no further progression of active disease.

Chart 19-10 **RISK FACTORS**

Tuberculosis

- Close contact with someone who has active TB. Inhalation of airborne nuclei from a person who is infected is proportional to the amount of time spent in the same air space, the proximity of the person, and the degree of ventilation.
- Immunocompromised status (e.g., those with HIV infection, cancer, transplanted organs, and prolonged high-dose corticosteroid therapy).
- Substance use disorder (individuals who use IV/injection drug or abuse alcohol).
- Any person without adequate health care (those experiencing homelessness; those who are impoverished; and racial–ethnic minorities, particularly children <15 years and young adults between ages 15 and 44 years).
- Preexisting medical conditions or special treatment (e.g., diabetes, chronic kidney disease, malnourishment, select malignancies, hemodialysis, transplanted organ, gastrectomy, and jejunoileal bypass).
- Immigration from or recent travel to countries with a high prevalence of TB (southeastern Asia, Africa, Latin America, Caribbean).
- Institutionalization (e.g., long-term care facilities, psychiatric institutions, prisons).
- Living in overcrowded, substandard housing.
- Being a health care worker performing high-risk activities: administration of aerosolized pentamidine and other medications, sputum induction procedures, bronchoscopy, suctioning, coughing procedures, caring for patients who are immune suppressed, home care with the high-risk population, and administering anesthesia and related procedures (e.g., intubation, suctioning).

TB, tuberculosis.

Adapted from Centers for Disease Control and Prevention (CDC). (2018b). *TB fact sheets-infection control and prevention*; *TB in specific populations*. Retrieved on 9/26/2019 at: www.cdc.gov/tb/statistics/default.htm

After initial exposure and infection, active disease may develop because of a compromised or inadequate immune system response. Active disease also may occur with reinfection and activation of dormant bacteria. In this case, the *Ghon tubercle* ulcerates, releasing the cheesy material into the bronchi. The bacteria then become airborne, resulting in the further spread of the disease. Then, the ulcerated tubercle heals and forms scar tissue. This causes the infected lung to become more inflamed, resulting in the further development of bronchopneumonia and tubercle formation.

Unless this process is arrested, it spreads slowly downward to the hilum of the lungs and later extends to adjacent lobes. The process may be prolonged and is characterized by long remissions when the disease is arrested, followed

by periods of renewed activity. Approximately 10% of people who are initially infected develop active disease (Pozniak, 2019). Some people develop reactivation TB (also called *adult-type progressive TB*). The reactivation of a dormant focus occurring during the primary infection is the cause.

Chart 19-11

Centers for Disease Control and Prevention Recommendations for Preventing Transmission of Tuberculosis in Health Care Settings

1. Early identification and treatment of people with active TB
   a. Maintain a high index of suspicion for TB to identify cases rapidly.
   b. Promptly initiate effective multidrug anti-TB therapy based on clinical and drug-resistance surveillance data.
2. Prevention of spread of infectious droplet nuclei by source control methods and by reduction of microbial contamination of indoor air
   a. Initiate AFB isolation precautions immediately for all patients who are suspected or confirmed to have active TB and who may be infectious. AFB isolation precautions include the use of a private room with negative pressure in relation to surrounding areas and a minimum of six air exchanges per hour. Air from the room should be exhausted directly to the outside. The use of ultraviolet lamps or high-efficiency particulate air filters to supplement ventilation may be considered.
   b. People entering the AFB isolation room should use disposable particulate respirators that fit snugly around the face.
   c. Continue AFB isolation precautions until there is clinical evidence of reduced infectiousness (i.e., cough has substantially decreased and the number of organisms on sequential sputum smears is decreasing). If drug resistance is suspected or confirmed, continue AFB precautions until the sputum smear is negative for AFB.
   d. Use special precautions during cough-inducing procedures.
3. Surveillance for TB transmission
   a. Maintain surveillance for TB infection among health care workers (HCWs) by routine, periodic tuberculin skin testing. Recommend appropriate preventive therapy for HCWs when indicated.
   b. Maintain surveillance for TB cases among patients and HCWs.
   c. Promptly initiate contact investigation procedures among HCWs, patients, and visitors exposed to a patient with infectious TB who is untreated, or ineffectively treated, and for whom appropriate AFB procedures are not in place. Recommend appropriate therapy or preventive therapy for contacts with disease or TB infection without current disease. Therapeutic regimens should be chosen based on the clinical history and local drug-resistance surveillance data.

AFB, acid-fast bacilli; TB, tuberculosis.

Adapted from Centers for Disease Control and Prevention (CDC). (2018b). *TB fact sheets-infection control and prevention*; *TB in specific populations*. Retrieved on 9/26/2019 at: www.cdc.gov/tb/statistics/default.htm

Clinical Manifestations

The signs and symptoms of pulmonary TB are insidious. Most patients have a low-grade fever, cough, night sweats, fatigue, and weight loss. The cough may

be nonproductive, or mucopurulent sputum may be expectorated. **Hemoptysis** (i.e., coughing up blood) also may occur. Both the systemic and the pulmonary symptoms are chronic and may have been present for weeks to months. Older adult patients usually present with less pronounced symptoms than younger patients. Extrapulmonary disease occurs in up to 20% of cases in the United States (Bernardo, 2019). In patients infected with HIV, extrapulmonary disease is more prevalent.

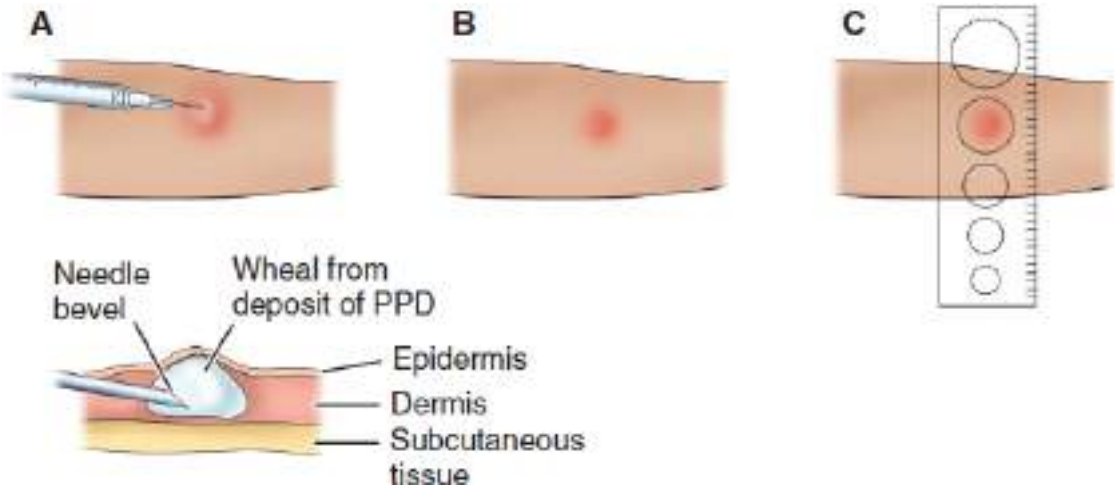


Figure 19-3 • The Mantoux test for tuberculosis. **A.** Correct technique for inserting the needle involves depositing the purified protein derivative (PPD) subcutaneously with the needle bevel facing upward. **B.** The reaction to the Mantoux test usually consists of a wheal, a hivelike, firm welt. **C.** To determine the extent of the reaction, the wheal is measured using a commercially prepared gauge. Interpretation of the Mantoux test is discussed in the text.

Assessment and Diagnostic Findings

Once a patient presents with a positive skin test, blood test, or sputum culture for acid-fast bacilli (AFB; see later discussion on these), additional assessments must be done. These tests include a complete history, physical examination, tuberculin skin test, chest x-ray, and drug susceptibility testing.

Clinical manifestations of fever, anorexia, weight loss, night sweats, fatigue, cough, and sputum production prompt a more thorough assessment of respiratory function—for example, assessing the lungs for consolidation by evaluating breath sounds (diminished, bronchial sounds; crackles), fremitus, and egophony. If the patient is infected with TB, the chest x-ray usually reveals lesions in the upper lobes. For all patients, the initial *M. tuberculosis* isolate should be tested for drug resistance. Drug susceptibility patterns should be repeated at 3 months for patients who do not respond to therapy (Sterling, 2019).

Tuberculin Skin Test

The Mantoux method is used to determine whether a person has been infected with the TB bacillus and is used widely in screening for latent *M. tuberculosis* infection. The Mantoux method is a standardized, intracutaneous injection procedure and should be performed only by those trained in its administration and reading. Tubercle bacillus extract (tuberculin), purified protein derivative (PPD), is injected into the intradermal layer of the inner aspect of the forearm, approximately 4 inches below the elbow (see Fig. 19-3). Intermediate-strength PPD, in a tuberculin syringe with a half-inch 26- or 27-gauge needle, is used. The needle, with the bevel facing up, is inserted beneath the skin. Then, 0.1 mL of PPD is injected, creating an elevation in the skin, a well-demarcated wheal 6 to 10 mm in diameter. The site, antigen name, strength, lot number, date, and time of the test are recorded. The test result is read 48 to 72 hours after injection. Tests read after 72 hours tend to underestimate the true size of **induration** (raised hard area or swelling). A delayed localized reaction indicates that the person is sensitive to tuberculin.

A reaction occurs when both induration and erythema (redness) are present. After the area is inspected for induration, it is lightly palpated across the injection site, from the area of normal skin to the margins of the induration. The diameter of the induration (not erythema) is measured in millimeters at its widest part (see Fig. 19-3), and the size of the induration is documented. Erythema without induration is not considered significant.

The size of the induration determines the significance of the reaction. A reaction of 0 to 4 mm is considered not significant. A reaction of 5 mm or greater may be significant in people who are considered to be at risk. It is defined as positive in patients who are HIV positive or have HIV risk factors and are of unknown HIV status, in those who are close contacts of someone with active TB, and in those who have chest x-ray results consistent with TB. An induration of 10 mm or greater is usually considered significant in people who have normal or mildly impaired immunity. A significant reaction indicates past exposure to *M. tuberculosis* or vaccination with bacille Calmette-Guérin (BCG) vaccine. The BCG vaccine is given to produce a greater resistance to development of TB. The BCG vaccine is used in Europe and Latin America but not routinely in the United States.

A significant (positive) reaction does not necessarily mean that active disease is present in the body. More than 90% of people who are tuberculin-significant reactors do not develop clinical TB (CDC, 2018b). However, all significant reactors are candidates for active TB. In general, the more intense the reaction, the greater the likelihood of an active infection. Additional testing is needed to determine if the person has latent TB infection or active TB.

A nonsignificant (negative) skin test means the person's immune system did not react to the test and that latent TB infection or TB disease is not likely. It does not exclude TB infection or disease, because patients who are

immunosuppressed cannot develop an immune response that is adequate to produce a positive skin test. This is referred to as anergy.

QuantiFERON-TB Gold® Plus and T-SPOT®

There are two TB blood tests (called interferon–gamma release assays or IGRAs) available in the United States: the QuantiFERON-TB Gold® Plus (QFT-Plus) test and the T-SPOT®. TB blood tests are the preferred diagnostic tests for patients who have received the BCG vaccine and for patients who are not likely to return for a second appointment to look for a reaction to the tuberculin skin test. The results of both of these tests are available within 24 to 36 hours. A positive IGRA signifies that the patient has been infected with TB bacteria and additional tests are needed. A negative IGRA means that the patient's blood did not react to the test and a latent or active TB infection is not likely (CDC, 2019d; Theel, Hilgart, Breen-Lyles, et al., 2018).

Sputum Culture

A sputum specimen may be used to screen for TB. The presence of AFB on a sputum smear may indicate disease but does not confirm the diagnosis of TB because some AFB are not *M. tuberculosis.* A culture is done to confirm the diagnosis. For all patients, the initial *M. tuberculosis* isolate should be tested for drug resistance (Sterling, 2019).

Gerontologic Considerations

TB may have atypical manifestations in older adult patients, whose symptoms may include unusual behavior and altered mental status, fever, anorexia, and weight loss. In many older adult patients, the tuberculin skin test produces no reaction (loss of immunologic memory) or delayed reactivity for up to 1 week (recall phenomenon). A second skin test is performed in 1 to 2 weeks. Older adults who live in long-term care facilities are at increased risk for primary and reactivated TB as compared to those in the community (Rajagopalan, 2016).

Medical Management

Pulmonary TB is treated primarily with anti-TB agents for 6 to 12 months. A prolonged treatment duration is necessary to ensure eradication of the organisms and to prevent relapse. The continuing and increasing resistance of *M. tuberculosis* to TB medications is a worldwide concern and challenge in TB therapy. Drug resistance must be considered when planning effective therapy, including the following:

- *Multidrug resistance (MDR TB):* Resistance to two agents, isoniazid and rifampin. The populations at greatest risk for multidrug

resistance are those who are HIV positive, institutionalized, or homeless.

- *Extensively drug resistant (XDR TB)*: Resistance to isoniazid and rifampin, in addition to any fluroquinolone, and at least one of three injectable second-line agents (i.e., amikacin, kanamycin, or capreomycin). The populations at greatest risk are those with HIV infection or other immunocompromised conditions (CDC, 2019d).

The increasing prevalence of drug resistance points out the need to begin TB treatment with four or more medications, to ensure completion of therapy, and to develop and evaluate new anti-TB medications.

TABLE 19-4 First-Line Antituberculosis Medications for Active Disease

Commonly Used Agents	Adult Daily Dosage[a]	Most Common Side Effects	Drug Interactions[b]	Nursing Considerations[c]
Isoniazid	5 mg/kg (300 mg maximum daily)	Peripheral neuritis, hepatic enzyme elevation, hepatitis, hypersensitivity	Phenytoin—synergistic Antabuse Alcohol	Bactericidal Pyridoxine is used as prophylaxis for neuritis. Monitor AST and ALT
Rifampin	10 mg/kg (600 mg maximum daily)	Hepatitis, febrile reaction, purpura (rare), nausea, vomiting	Rifampin increases metabolism of oral contraceptives, quinidine, corticosteroids, coumarin derivatives and methadone, digoxin, oral hypoglycemics. PAS may interfere with absorption of rifampin	Bactericidal Orange urine and other body secretions Discoloring of contact lenses Monitor AST and ALT
Rifabutin	5 mg/kg (300 mg maximum daily)		Avoid protease inhibitors	
Rifapentine	10 mg/kg (600 mg twice weekly)	Hepatotoxicity, thrombocytopenia		Orange-red coloration of body secretions, contact lenses, dentures Use with caution in older adults or in those with renal disease
Pyrazinamide	15–30 mg/kg (2 g maximum daily)[d]	Hyperuricemia, hepatotoxicity, skin rash, arthralgias, GI distress		Bactericidal Monitor uric acid, AST, and ALT
Ethambutol	15–25 mg/kg (1.6 g maximum daily dose)[d]	Optic neuritis (may lead to blindness; very rare at 15 mg/kg), skin rash		Bacteriostatic Use with caution with renal disease or when eye testing is not feasible. Monitor visual acuity, color, and discrimination[e]
Combinations: isoniazid + rifampin	150-mg and 300-mg caps (2 caps daily)			

ALT, alanine transaminase; AST, aspartate transaminase; GI, gastrointestinal; PAS, para-aminosalicylic acid.
[a]Check product labeling for detailed information on dose, contraindications, drug interactions, adverse reactions, and monitoring.
[b]Refer to current literature, particularly on rifampin, because it increases hepatic microenzymes and therefore interacts with many drugs.
[c]Initial examination should be performed at start of treatment.
Adapted from Gilbert, D. N., Chambers, H. F., Eliopoulos, G. M., et al. (2018). *The Sanford guide to antimicrobial therapy 2018* (48th ed.). Sperryville, VA: Antimicrobial Therapy, Inc.

In current TB therapy, four first-line medications are used (see Table 19-4): isoniazid, rifampin, pyrazinamide, and ethambutol. Combination medications, such as isoniazid and rifampin or isoniazid, pyrazinamide, and rifampin and medications given twice a week (e.g., rifapentine) are available to help improve patient adherence. However, these medications are more costly.

Multidrug-resistant TB is difficult to treat. Treatment is guided by sputum specimen culture and sensitivity testing as the patient typically is resistant to isoniazid and rifampin. The World Health Organization (WHO, 2019) recently

published recommendations for treatment consisting of multiple medications to combat drug-resistant organisms. It is important to consult current recommendations for treatment (WHO, 2019).

Recommended treatment guidelines for newly diagnosed cases of pulmonary TB have two phases: an initial treatment phase and a continuation phase (CDC, 2019d). The initial phase consists of a multiple-medication regimen of isoniazid, rifampin, pyrazinamide, and ethambutol plus vitamin B_6 50 mg. All are taken once a day and are oral medications. This initial intensive-treatment regimen is given daily for 8 weeks, after which options for the continuation phase of treatment include isoniazid and rifampin or isoniazid and rifapentine. The continuation regimen lasts for an additional 4 or 7 months. The 4-month period is used for the large majority of patients. The 7-month period is recommended for patients with cavitary pulmonary TB whose sputum culture after the initial 2 months of treatment is positive, for those whose initial phase of treatment did not include pyrazinamide, and for those being treated once weekly with isoniazid and rifapentine whose sputum culture is positive at the end of the initial phase of treatment. People are considered noninfectious after 2 to 3 weeks of continuous medication therapy. The total number of doses taken, not simply the duration of treatment, more accurately determines whether a course of therapy has been completed (CDC, 2019d).

Isoniazid also may be used as a prophylactic (preventive) measure for people who are at risk for significant disease, including:

- Household family members of patients with active disease
- Patients with HIV infection who have a PPD test reaction with 5 mm of induration or more
- Patients with fibrotic lesions suggestive of old TB detected on a chest x-ray and a PPD reaction with 5 mm of induration or more
- Patients whose current PPD test results show a change from former test results, suggesting recent exposure to TB and possible infection (skin test converters)
- Patients who use IV/injection drugs who have PPD test results with 10 mm of induration or more
- Patients with high-risk comorbid conditions and a PPD result with 10 mm of induration or more

Other candidates for preventive isoniazid therapy are those 35 years or younger who have PPD test results with 10 mm of induration or more and one of the following criteria:

- Individuals who are foreign-born from countries with a high prevalence of TB
- Populations that are high-risk and medically underserved
- Patients living in institutions

Prophylactic isoniazid treatment involves taking daily doses for 6 to 12 months. Liver enzymes, blood urea nitrogen (BUN), and creatinine levels are monitored monthly. Sputum culture results are monitored for AFB to evaluate the effectiveness of treatment and the patient's adherence to the treatment regimen.

Nursing Management

Nursing management includes promoting airway clearance, advocating adherence to the treatment regimen, promoting activity and nutrition, and preventing transmission.

Promoting Airway Clearance

Copious secretions obstruct the airways in many patients with TB and interfere with adequate gas exchange. Increasing the fluid intake promotes systemic hydration and serves as an effective expectorant. The nurse instructs the patient about correct positioning to facilitate airway drainage, referred to as postural drainage (see Chapter 20). Postural drainage allows the force of gravity to assist in the removal of bronchial secretions.

Promoting Adherence to Treatment Regimen

Adherence to the prescribed treatment regimen is key in treating the disease and controlling the spread of infection. The multiple-medication regimen that the patient must follow can be quite complex. Understanding of the medications, schedule, and side effects is important. The nurse educates the patient that TB is a communicable disease and that taking medications is the most effective means of preventing transmission. The major reason treatment fails is that patients do not take their medications regularly and for the prescribed duration. This may be due to side effects or the complexity of the treatment regimen. Risk factors for nonadherence to the drug regimen include patients who have previously failed to complete the course of therapy; patients who are physically, emotionally, or mentally challenged; patients unable to pay for medication; patients actively abusing illicit substances; and patients who do not understand the importance of treatment (Reichman & Lardizabal, 2019).

The nurse educates the patient to take the medication either on an empty stomach or at least 1 hour before meals, because food interferes with medication absorption (although taking medications on an empty stomach frequently results in gastrointestinal upset). Patients taking isoniazid should avoid foods that contain tyramine and histamine (tuna, aged cheese, red wine, soy sauce, yeast extracts), because eating them while taking isoniazid may result in headache, flushing, hypotension, lightheadedness, palpitations, and

diaphoresis. Patients should also avoid alcohol because of the high potential for hepatoxic effects.

In addition, rifampin can alter the metabolism of certain other medications, making them less effective. These medications include beta-blockers, oral anticoagulants such as warfarin, digoxin, quinidine, corticosteroids, oral hypoglycemic agents, oral contraceptives, theophylline, and verapamil. This issue should be discussed with the primary provider and pharmacist so that medication dosages can be adjusted accordingly. The nurse informs the patient that rifampin may discolor contact lenses and that the patient may want to wear eyeglasses during treatment. The nurse monitors for other side effects of anti-TB medications, including hepatitis, neurologic changes (hearing loss, neuritis), and rash. Liver enzymes, BUN, and serum creatinine levels are monitored to detect changes in liver and kidney function. Sputum culture results are monitored for AFB to evaluate the effectiveness of the treatment regimen and adherence to therapy.

The nurse educates the patient about the risk of drug resistance if the medication regimen is not strictly and continuously followed. The nurse carefully monitors vital signs and observes for spikes in temperature or changes in the patient's clinical status. Caregivers of patients who are not hospitalized are taught to monitor the patient's temperature and respiratory status. Changes in the patient's respiratory status are reported to the primary provider.

For patients at risk for nonadherence, programs used in the community setting may include comprehensive case management and directly observed therapy (DOT). In case management, each patient with TB is assigned a case manager who coordinates all aspects of the patient's care. DOT consists of a health care provider or other responsible person who directly observes that the patient ingests the prescribed medications. Although successful, DOT is a resource intensive program (Herchline, 2020).

Promoting Activity and Adequate Nutrition

Patients with TB are often debilitated from prolonged chronic illness and impaired nutritional status. The nurse plans a progressive activity schedule that focuses on increasing activity tolerance and muscle strength. Anorexia, weight loss, and malnutrition are common in patients with TB. The patient's willingness to eat may be altered by fatigue from excessive coughing; sputum production; chest pain; generalized debilitated state; or cost, if the patient has few resources. Identifying facilities (e.g., shelters, soup kitchens, Meals on Wheels) that provide meals in the patient's neighborhood may increase the likelihood that the patient with limited resources and energy will have access to a more nutritious intake. A nutritional plan that allows for small, frequent meals may be required. Liquid nutritional supplements may assist in meeting basic caloric requirements.

Preventing Transmission of Tuberculosis Infection

To prevent transmission of TB to others, the nurse carefully educates the patient about important hygiene measures, including mouth care, covering the mouth and nose when coughing and sneezing, proper disposal of tissues, and hand hygiene. TB is a disease that must be reported to the health department so that people who have been in contact with the affected patient during the infectious stage can undergo screening and possible treatment, if indicated.

In addition to the risk of transmission of TB infection to other people, it can also be spread to other parts of the body of affected patients. Spread or dissemination of TB infection to nonpulmonary sites of the body is known as miliary TB. Miliary TB is seen in approximately 1.5% of all patients with TB (Lessnau, 2019). It is the result of invasion of the bloodstream by the tubercle bacillus. Usually, it results from late reactivation of a dormant infection in the lung or elsewhere. The origin of the bacilli that enter the bloodstream is either a chronic focus that has ulcerated into a blood vessel or multitudes of miliary tubercles lining the inner surface of the thoracic duct. The organisms migrate from these foci into the bloodstream, are carried throughout the body, and disseminate throughout all tissues, with tiny miliary tubercles developing in the lungs, spleen, liver, kidneys, meninges, and other organs.

The clinical course of miliary TB may vary from an acute, rapidly progressive infection with high fever to a slowly developing process with low-grade fever, anemia, and debilitation. At first, there may be no localizing signs except an enlarged spleen and a reduced number of leukocytes. However, within a few weeks, the chest x-ray reveals small densities scattered diffusely throughout both lung fields; these are the miliary tubercles, which gradually grow.

The possibility of spread to nonpulmonary sites in the body requires careful monitoring for this very serious form of TB. The nurse monitors vital signs and observes for spikes in temperature as well as changes in renal and cognitive function. Few physical signs may be elicited on physical examination of the chest, but at this stage, the patient has a severe cough and dyspnea. Treatment of miliary TB is the same as for pulmonary TB.

Lung Abscess

A lung abscess is a localized collection of pus caused by microbial infection (Kamangar, 2018). It is generally caused by aspiration of anaerobic bacteria. By definition, in a lung abscess, the chest x-ray demonstrates a cavity of at least 2 cm. Patients who are at risk for aspiration of foreign material and development of a lung abscess include those with impaired cough reflexes who cannot close the glottis and those with swallowing difficulties. Other patients at risk include those with central nervous system disorders (e.g., seizure,

stroke), substance use disorder, esophageal disease, or compromised immune function; patients without teeth and those receiving nasogastric tube feedings; and patients with an altered state of consciousness due to anesthesia (Bartlett, 2019a).

Pathophysiology

Most lung abscesses are a complication of bacterial pneumonia or are caused by aspiration of oral anaerobes into the lung. Abscesses also may occur secondary to mechanical or functional obstruction of the bronchi by a tumor, foreign body, or bronchial stenosis, or from necrotizing pneumonias, TB, pulmonary embolism (PE), or chest trauma.

Most lung abscesses are found in areas of the lung that may be affected by aspiration. The site of the lung abscess is related to gravity and is determined by position. For patients who are confined to bed, the posterior segment of an upper lobe and the superior segment of the lower lobe are the most common areas. However, atypical presentations may occur, depending on the position of the patient when the aspiration occurred.

Initially, the cavity in the lung may or may not extend directly into a bronchus. Eventually, the abscess becomes surrounded, or encapsulated, by a wall of fibrous tissue. The necrotic process may extend until it reaches the lumen of a bronchus or the pleural space and establishes communication with the respiratory tract, the pleural cavity, or both. If the bronchus is involved, the purulent contents are expectorated continuously in the form of sputum. If the pleura is involved, the result is an empyema. A communication or connection between the bronchus and pleura is known as a bronchopleural fistula. The organisms frequently associated with lung abscesses are anaerobic; however, aerobic organisms may be involved as well. The organisms vary depending on the underlying predisposing factors (Kamangar, 2018).

Clinical Manifestations

The clinical manifestations of a lung abscess may vary from a mild productive cough to acute illness. Most patients have a fever and a productive cough with moderate to copious amounts of foul-smelling, sometimes bloody, sputum. The fever and cough may develop insidiously and may have been present for several weeks before diagnosis. Leukocytosis may be present. Pleurisy or dull chest pain, dyspnea, weakness, anorexia, and weight loss are common.

Assessment and Diagnostic Findings

Physical examination of the chest may reveal dullness on percussion and decreased or absent breath sounds with an intermittent **pleural friction rub**

(grating or creaking sound) on auscultation. Crackles may be present. Confirmation of the diagnosis is made by chest x-ray, sputum culture, and, in some cases, fiberoptic bronchoscopy. The chest x-ray reveals an infiltrate with an air–fluid level. A computed tomography (CT) scan of the chest may be required to provide more detailed images of different cross-sectional areas of the lung.

Prevention

The following measures reduce the risk of lung abscess:

- Appropriate antibiotic therapy before any dental procedures in patients who must have teeth extracted while their gums and teeth are infected
- Adequate dental and oral hygiene, because anaerobic bacteria play a role in the pathogenesis of lung abscess
- Appropriate antimicrobial therapy for patients with pneumonia

Medical Management

The findings of the history, physical examination, chest x-ray, and sputum culture indicate the type of organism and the treatment required. Adequate drainage of the lung abscess may be achieved through postural drainage and chest physiotherapy. Patients should be assessed for an adequate cough. Some patients require insertion of a percutaneous chest catheter for long-term drainage of the abscess. Therapeutic use of bronchoscopy to drain an abscess is uncommon. A diet high in protein and calories is necessary, because chronic infection is associated with a catabolic state, necessitating increased intake of calories and protein to facilitate healing. Surgical intervention is rare, but pulmonary resection (lobectomy) is performed if massive hemoptysis occurs or if there is little or no response to medical management.

IV antimicrobial therapy depends on the results of the sputum culture and sensitivity and is given for an extended period. Standard treatment of an anaerobic lung infection is clindamycin, ampicillin-sulbactam, or carbapenem (Bartlett, 2019b). Large IV doses are usually required, because the antibiotic must penetrate the necrotic tissue and the fluid in the abscess. The duration of treatment with IV antibiotics is not well studied and remains controversial (Bartlett, 2019b). Treatment with IV antibiotics may continue for 3 weeks and longer, depending upon the clinical severity and organism involved. Improvement is demonstrated by normal temperature, decreased white blood cell count, and improvement on chest x-ray (resolution of surrounding infiltrate, reduction in cavity size, and absence of fluid). Once improvement is demonstrated, IV antibiotics are discontinued and oral administration of

antibiotic therapy is continued for an additional 4 to 12 weeks and sometimes longer. If treatment is stopped too soon, a relapse may occur (Bartlett, 2019b).

Nursing Management

The nurse administers antibiotics and IV treatments as prescribed and monitors for adverse effects. CPT is initiated as prescribed to facilitate drainage of the abscess. The patient is educated on how to perform deep-breathing and coughing exercises to help expand the lungs. To ensure proper nutritional intake, the nurse encourages a diet that is high in protein and calories. The nurse also offers emotional support, because the abscess may take a long time to resolve.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

A patient who has had surgery may return home before the wound closes entirely or with a drain or tube in place. In these cases, the nurse educates the patient or caregivers about how to change the dressings to prevent skin excoriation and odor, how to monitor for signs and symptoms of infection, and how to care for and maintain the drain or tube. The nurse also reminds the patient to perform deep-breathing and coughing exercises every 2 hours during the day and shows caregivers how to perform chest percussion and postural drainage to facilitate expectoration of lung secretions.

Continuing and Transitional Care

A patient whose condition requires therapy at home may need referral for home, transitional, or community-based care. During home visits, the nurse assesses the patient's physical condition, nutritional status, and home environment, as well as the ability of the patient and family to carry out the therapeutic regimen. Patient education is reinforced, and nutritional counseling is provided with the goal of attaining and maintaining an optimal state of nutrition. To prevent relapses, the nurse emphasizes the importance of completing the antibiotic regimen and of following suggestions for rest and appropriate activity. If IV antibiotic therapy is to continue at home, the services of home health nurses may be arranged to initiate IV therapy and to evaluate its administration by the patient or family.

Although most outpatient IV therapy is given in the home setting, the patient may visit a nearby clinic or provider's office for this treatment. In some cases, patients with lung abscess may have ignored their health. Therefore, the nurse should use this opportunity to address health promotion strategies and health screening with the patient.

Sarcoidosis

Sarcoidosis is a type of interstitial lung disease that is also an inflammatory, multisystem, granulomatous disease of unknown etiology (King, 2019a). Although 90% of patients demonstrate thoracic involvement, any organ may be affected. Sarcoidosis usually presents between 20 and 40 years of age and is slightly more common in women than in men (Weinberger et al., 2019). In the United States, the disease is more common in African Americans, and the estimated prevalence is 10 to 20 per 100,000 people (King, 2019a).

Pathophysiology

Sarcoidosis is thought to be a hypersensitivity response to one or more exogenous agents (bacteria, fungi, virus, chemicals) in people with an inherited or acquired predisposition to the disorder. The hypersensitivity response and inflammation result in the formation of a noncaseating granuloma, which is a noninfectious organized collection of macrophages that appear as a nodule. In the lung, granuloma infiltration and fibrosis may occur, resulting in low lung compliance, impaired diffusing capacity, and reduced lung volumes (King, 2019a).

Clinical Manifestations

Hallmarks of sarcoidosis are its insidious onset and lack of prominent clinical signs or symptoms. The clinical picture depends on the systems affected. The lung is most commonly involved; signs and symptoms may include dyspnea, cough, hemoptysis, and congestion. Other signs include uveitis; joint pain; fever; and granulomatous lesions of the skin, liver, spleen, kidney, and central nervous system. With multisystem involvement, patients may also have fatigue, fever, anorexia, and weight loss. The granulomas may disappear or gradually convert to fibrous tissue.

Assessment and Diagnostic Findings

Chest x-rays and CT scans are used to assess pulmonary adenopathy. These may show hilar adenopathy and disseminated miliary and nodular lesions in the lungs. A mediastinoscopy or **transbronchial** biopsy (in which a tissue specimen is obtained through the bronchial wall) may be used to confirm the diagnosis. In rare cases, an open lung biopsy is performed. Diagnosis is confirmed by a biopsy that shows noncaseating granulomas. Pulmonary function test results are abnormal if there is restriction of lung function (reduction in total lung capacity). Arterial blood gas measurements may be

normal or may show hypoxemia (reduced oxygen levels) and hypercapnia (increased carbon dioxide levels).

Medical Management

Many patients undergo remission without specific treatment. Corticosteroids may be beneficial because of their anti-inflammatory effects. Oral corticosteroids have been the most commonly used agents for the relief of symptoms and control of potentially disabling respiratory impairment from pulmonary sarcoidosis. Once begun, corticosteroid therapy is usually continued in tapering doses for 12 months, and longer if the patient has recurrence of symptoms and chest x-ray indications (i.e., continued pulmonary adenopathy) (King, 2019b). Corticosteroids (e.g., prednisone) have been shown to be useful in patients with ocular and myocardial involvement, skin involvement, extensive pulmonary disease that compromises pulmonary function, hepatic involvement, and hypercalcemia. However, it is not known if corticosteroids alter the long-term course of the disease (King, 2019b). When there is inadequate response to prednisone or the dose cannot be decreased, an immune modulator may be added (e.g., methotrexate, azathioprine, leflunomide, mycophenolate). No single test monitors the progression or recurrence of sarcoidosis; multiple tests are used to monitor involved systems.

Nursing Management

The role of the nurse in the care of patients with sarcoidosis includes supporting the medical regimen and providing education and psychosocial support. Since treatment is aimed at reducing inflammation, patients should be educated on the effects and correct usage of corticosteroids. Patients should be instructed to notify their primary provider if symptoms do not improve or respiratory symptoms worsen. Sarcoidosis is a chronic illness warranting follow-ups at 3 to 6 month intervals to assess disease progression. Patients should be encouraged to contact the Foundation for Sarcoidosis Research to identify additional community resources that can be of assistance to them (see Resources section at the end of the chapter).

PLEURAL DISORDERS

Pleural disorders involve the membranes covering the lungs (visceral pleura) and the surface of the chest wall (parietal pleura) or disorders affecting the pleural space.

Pleurisy

Pleurisy (pleuritis) refers to inflammation of both layers of the pleurae (parietal and visceral). Pleurisy may develop in conjunction with pneumonia or an upper respiratory tract infection, TB, or collagen disease; after trauma to the chest, pulmonary infarction, or PE; in patients with primary or metastatic cancer; and after thoracotomy. The parietal pleura has nerve endings, and the visceral pleura does not. When the inflamed pleural membranes rub together during respiration (intensified on inspiration), the result is severe, sharp, knifelike pain.

Clinical Manifestations

The key characteristic of pleuritic pain is its relationship to respiratory movement. Taking a deep breath, coughing, or sneezing worsens the pain. Pleuritic pain is limited in distribution rather than diffuse; it usually occurs only on one side. The pain may become minimal or absent when the breath is held. It may be localized or radiate to the shoulder or abdomen. Later, as pleural fluid develops, the pain decreases (Weinberger et al., 2019).

Assessment and Diagnostic Findings

In the early period, when little fluid has accumulated, a pleural friction rub can be heard with the stethoscope, only to disappear later as more fluid accumulates and separates the inflamed pleural surfaces. Diagnostic tests may include chest x-rays, sputum analysis, thoracentesis to obtain a specimen of pleural fluid for examination, and, less commonly, a pleural biopsy.

Medical Management

The objectives of treatment are to discover the underlying condition causing the pleurisy and to relieve the pain. As the underlying disease (pneumonia, infection) is treated, the pleuritic inflammation usually resolves. At the same time, the patient must be monitored for signs and symptoms of pleural effusion, such as shortness of breath, pain, assumption of a position that decreases pain, and decreased chest wall excursion.

Prescribed analgesic agents and topical applications of heat or cold provide symptomatic relief. A nonsteroidal anti-inflammatory drug may provide pain relief while allowing the patient to take deep breaths and cough more effectively. If the pain is severe, an intercostal nerve block may be required (Weinberger et al., 2019).

Nursing Management

Because the patient has pain on inspiration, the nurse offers suggestions to enhance comfort, such as turning frequently onto the affected side to splint the chest wall and reduce the stretching of the pleurae. The nurse also educates the patient to use the hands or a pillow to splint the rib cage while coughing.

Pleural Effusion

Pleural effusion, a collection of fluid in the pleural space, is rarely a primary disease process; it is usually secondary to other diseases. Normally, the pleural space contains a small amount of fluid (5 to 15 mL), which acts as a lubricant that allows the pleural surfaces to move without friction (see Fig. 19-4). Pleural effusion may be a complication of heart failure, TB, pneumonia, pulmonary infections (particularly viral infections), nephrotic syndrome, connective tissue disease, PE, and neoplastic tumors. The most common malignancy associated with a pleural effusion is bronchogenic carcinoma.

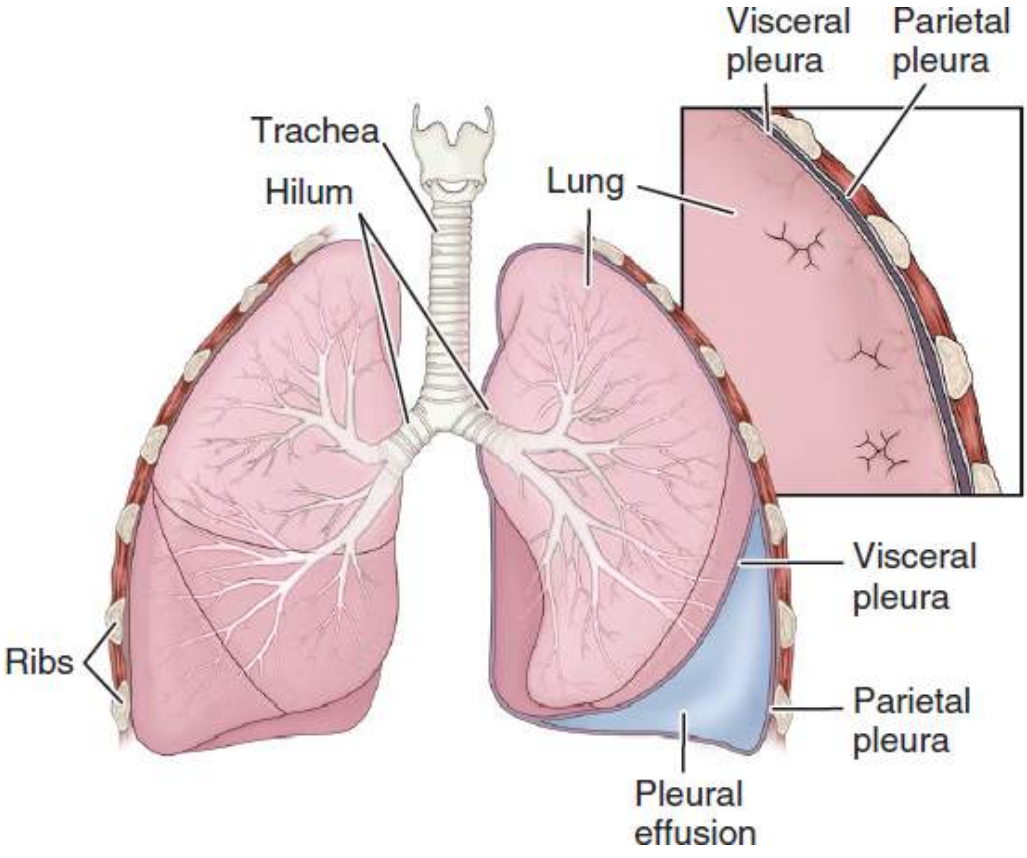


Figure 19-4 • In pleural effusion, an abnormal volume of fluid collects in the pleural space, causing pain and shortness of breath. Pleural effusion is usually secondary to other disease processes.

Pathophysiology

In certain disorders, fluid may accumulate in the pleural space to a point at which it becomes clinically evident. This almost always has pathologic significance. The effusion can be a relatively clear fluid, or it can be bloody or purulent. An effusion of clear fluid may be a transudate or an exudate. A transudate (filtrate of plasma that moves across intact capillary walls) occurs when factors influencing the formation and reabsorption of pleural fluid are altered, usually by imbalances in hydrostatic or oncotic pressures. The finding of a transudative effusion generally implies that the pleural membranes are not diseased. A transudative effusion most commonly results from heart failure. An exudate (extravasation of fluid into tissues or a cavity) usually results from inflammation by bacterial products or tumors involving the pleural surfaces (Heffner, 2019a).

Clinical Manifestations

Usually, the clinical manifestations are caused by the underlying disease. Pneumonia causes fever, chills, and pleuritic chest pain, whereas a malignant effusion may result in dyspnea, difficulty lying flat, and coughing. The severity of symptoms is determined by the size of the effusion, the speed of its formation, and the underlying lung disease. A large pleural effusion causes dyspnea. A small-to-moderate pleural effusion causes minimal or no dyspnea.

Assessment and Diagnostic Findings

Assessment of the area of the pleural effusion reveals decreased or absent breath sounds; decreased fremitus; and a dull, flat sound on percussion. In the case of an extremely large pleural effusion, the assessment reveals a patient in acute respiratory distress. Tracheal deviation away from the affected side may also be apparent.

Physical examination, chest x-ray, chest CT, and thoracentesis confirm the presence of fluid. In some instances, a lateral decubitus x-ray is obtained. For this x-ray, the patient lies on the affected side in a side-lying position. A pleural effusion can be diagnosed because this position allows for the “layering out” of the fluid, and an air–fluid line is visible.

Pleural fluid is analyzed by bacterial culture, Gram stain, AFB stain (for TB), red and white blood cell counts, chemistry studies (glucose, amylase, LDH, and protein), cytologic analysis for malignant cells, and pH. A pleural biopsy also may be performed as a diagnostic tool.

Medical Management

The objectives of treatment are to discover the underlying cause of the pleural effusion; to prevent reaccumulation of fluid; and to relieve discomfort,

dyspnea, and respiratory compromise. Specific treatment is directed at the underlying cause (e.g., heart failure, pneumonia, cirrhosis). If the pleural fluid is an exudate, more extensive diagnostic procedures are performed to determine the cause. Treatment of the primary cause is then instituted.

Thoracentesis is performed to remove fluid, to obtain a specimen for analysis, and to relieve dyspnea and respiratory compromise (see Chapter 17). Thoracentesis may be performed under ultrasound guidance. Depending on the size of the pleural effusion, the patient may be treated by removing the fluid during the thoracentesis procedure or by inserting a chest tube connected to a water-seal drainage system or suction to evacuate the pleural space and re-expand the lung.

However, if the underlying cause is a malignancy, the effusion tends to recur within a few days or weeks. Repeated thoracenteses result in pain, depletion of protein and electrolytes, and sometimes pneumothorax. Once the pleural space is adequately drained, a chemical pleurodesis may be performed to obliterate the pleural space and prevent reaccumulation of fluid. Pleurodesis may be performed using either a thoracoscopic approach or a chest tube. A chemically irritating agent (e.g., talc or another chemical irritant) is instilled or aerosolized into the pleural space. With the chest tube approach, after the agent is instilled, the chest tube is clamped for 60 to 90 minutes and the patient is assisted to assume various positions to promote uniform distribution of the agent and to maximize its contact with the pleural surfaces (Heffner, 2019b). The tube is unclamped as prescribed, and chest drainage may be continued several days longer to prevent reaccumulation of fluid and to promote the formation of adhesions between the visceral and parietal pleurae.

Other treatments for pleural effusions caused by malignancy include surgical pleurectomy, insertion of a small catheter attached to a drainage bottle for outpatient management (e.g., PleurX® catheter), or implantation of a pleuroperitoneal shunt. A pleuroperitoneal shunt consists of two catheters connected by a pump chamber containing two one-way valves. Fluid moves from the pleural space to the pump chamber and then to the peritoneal cavity. The patient manually pumps on the reservoir daily to move fluid from the pleural space to the peritoneal space.

Nursing Management

The nurse's role in the care of a patient with a pleural effusion includes supporting the medical regimen. The nurse prepares and positions the patient for thoracentesis and offers support throughout the procedure. The nurse ensures the thoracentesis fluid amount is recorded and sent for appropriate laboratory testing. If a chest tube drainage and water-seal system is used, the system's function is monitored and the amount of drainage is recorded at

prescribed intervals (see later discussion). Nursing care related to the underlying cause of the pleural effusion is specific to the underlying condition.

Patients with a pleural effusion secondary to a malignancy may have a chest tube inserted to instill talc (Bhatnagar, Piotrowska, Laskawiec-Szkonter, et al., 2019). Pain management is a priority, and the nurse helps the patient assume positions that are the least painful. However, frequent turning and movement are important to facilitate adequate spreading of the talc over the pleural surface. The nurse evaluates the patient's pain level and administers analgesic agents as prescribed and as needed.

If the patient is to be managed as an outpatient with a pleural catheter for drainage, the nurse educates the patient and family about management and care of the catheter and drainage system.

Empyema

An empyema is an accumulation of thick, purulent fluid within the pleural space, often with fibrin development and a loculated (walled-off) area where infection is located (Strange, 2019).

Pathophysiology

Most empyemas occur as complications of bacterial pneumonia or lung abscess. They also result from penetrating chest trauma, hematogenous infection of the pleural space, nonbacterial infections, and iatrogenic causes (after thoracic surgery or thoracentesis). At first the pleural fluid is thin, with a low leukocyte count, but it frequently progresses to a fibropurulent stage and, finally, to a stage where it encloses the lung within a thick exudative membrane (loculated empyema).

Clinical Manifestations

The patient is acutely ill and has signs and symptoms similar to those of an acute respiratory infection or pneumonia (fever, night sweats, pleural pain, cough, dyspnea, anorexia, weight loss). If the patient is immunocompromised, the symptoms may be vague. If the patient has received antimicrobial therapy, the clinical manifestations may be less obvious.

Assessment and Diagnostic Findings

Chest auscultation demonstrates decreased or absent breath sounds over the affected area, and there is dullness on chest percussion as well as decreased

fremitus. The diagnosis is established by chest CT. Usually, a diagnostic thoracentesis is performed, often under ultrasound guidance.

Medical Management

The objectives of treatment are to drain the pleural cavity and to achieve complete expansion of the lung. The fluid is drained, and appropriate antibiotics (usually begun by the IV route) in large doses are prescribed based on the causative organism. Sterilization of the empyema cavity requires 4 to 6 weeks of antibiotics (Strange, 2019). Drainage of the pleural fluid depends on the stage of the disease and is accomplished by one of the following methods:

- Thoracentesis (needle aspiration) with a thin percutaneous catheter, if the volume is small and the fluid is not too purulent or too thick
- Tube thoracostomy (chest drainage using a large-diameter intercostal tube attached to water-seal drainage; see later discussion) with thrombolytic agents instilled through the chest tube in patients with loculated or complicated pleural effusions
- Open chest drainage via thoracotomy, including potential rib resection, to remove the thickened pleura, pus, and debris and to remove the underlying diseased pulmonary tissue

With long-standing inflammation, an exudate can form over the lung, trapping it and interfering with its normal expansion. This exudate must be removed surgically by decortication. The drainage tube is left in place until the pus-filled space is obliterated completely. The complete obliteration of the pleural space is monitored by serial chest x-rays, and the patient should be informed that treatment may be long term (weeks to months). Patients are frequently discharged from the hospital with a chest tube in place, with instructions to monitor fluid drainage at home.

Nursing Management

Resolution of empyema is a prolonged process. The nurse helps the patient cope with the condition and instructs the patient in lung-expanding breathing exercises to restore normal respiratory function. The nurse also provides care specific to the method of drainage of the pleural fluid (e.g., needle aspiration, closed chest drainage, rib resection, and drainage). When the patient is discharged home with a drainage tube or system in place, the nurse instructs the patient and family on care of the drainage system and drain site, measurement and observation of drainage, signs and symptoms of infection, and how and when to contact the primary provider (see later discussion).

Acute Respiratory Failure

Respiratory failure is a sudden and life-threatening deterioration of the gas exchange function of the lungs and indicates their failure to provide adequate oxygenation or ventilation for the blood. Acute respiratory failure is defined as hypoxemia (a decrease in arterial oxygen tension [PaO_2] to less than 60 mm Hg) and hypercapnia (an increase in arterial carbon dioxide tension [$PaCO_2$] to greater than 50 mm Hg), with acidosis (an arterial pH of less than 7.35) (Kaynar, 2018).

It is important to distinguish between acute and chronic respiratory failure. Chronic respiratory failure is defined as deterioration in the gas exchange function of the lungs that has developed insidiously or has persisted for a long period after an episode of acute respiratory failure. The absence of acute symptoms and the presence of a chronic respiratory acidosis suggest the chronicity of the respiratory failure. Two causes of chronic respiratory failure are COPD (discussed in Chapter 20) and neuromuscular diseases (discussed in Chapter 65). Patients with these disorders develop a tolerance to the gradually worsening hypoxemia and hypercapnia. However, patients with chronic respiratory failure can develop acute failure. For example, a patient with COPD may develop an exacerbation or infection that causes additional deterioration of gas exchange. The principles of management of acute versus chronic respiratory failure are different; the following discussion is limited to acute respiratory failure.

Pathophysiology

In acute respiratory failure, the ventilation or perfusion mechanisms in the lung are impaired. Some of the many ventilatory failure mechanisms leading to acute respiratory failure include impaired function of the central nervous system (e.g., drug overdose, head trauma, infection, hemorrhage, sleep apnea), neuromuscular dysfunction (e.g., myasthenia gravis, Guillain–Barré syndrome, amyotrophic lateral sclerosis, spinal cord trauma), musculoskeletal dysfunction (e.g., chest trauma, kyphoscoliosis, malnutrition), and pulmonary dysfunction (e.g., COPD, asthma, cystic fibrosis).

Oxygenation failure mechanisms leading to acute respiratory failure include pneumonia, ARDS, heart failure, COPD, PE, and **restrictive lung diseases** (diseases that cause decrease in lung volumes).

In the postoperative period, especially after major thoracic or abdominal surgery, inadequate ventilation and respiratory failure may occur because of several factors. During this period, for example, acute respiratory failure may be caused by the effects of anesthetic, analgesic, and sedative agents, which may depress respiration (as described earlier) or enhance the effects of opioids

and lead to hypoventilation. Pain may interfere with deep breathing and coughing. A V./Q. mismatch is the usual cause of respiratory failure after major abdominal, cardiac, or thoracic surgery.

Clinical Manifestations

Early signs are those associated with impaired oxygenation and may include restlessness, fatigue, headache, dyspnea, air hunger, tachycardia, and increased blood pressure. As the hypoxemia progresses, more obvious signs may be present, including confusion, lethargy, tachycardia, tachypnea, central cyanosis, diaphoresis, and finally respiratory arrest. Physical findings are those of acute respiratory distress, including the use of accessory muscles, decreased breath sounds if the patient cannot adequately ventilate, and other findings related specifically to the underlying disease process and cause of acute respiratory failure.

Medical Management

The objectives of treatment are to correct the underlying cause and to restore adequate gas exchange in the lungs. ET intubation and mechanical ventilation may be required to maintain adequate ventilation and oxygenation while the underlying cause is corrected (see later discussion on ET intubation and mechanical ventilation).

Nursing Management

Nursing management of patients with acute respiratory failure includes assisting with intubation and maintaining mechanical ventilation. Patients are usually managed in the intensive care unit (ICU). The nurse assesses the patient's respiratory status by monitoring the level of responsiveness, arterial blood gases, pulse oximetry, and vital signs. In addition, the entire respiratory system is assessed and strategies to prevent complications (e.g., turning schedule, mouth care, skin care, and range of motion of extremities) are implemented. The nurse also assesses the patient's understanding of the management strategies that are used and initiates some form of communication to enable the patient to express concerns and needs to the health care team.

Finally, the problems that led to the acute respiratory failure are addressed. As the patient's status improves, the nurse assesses the patient's knowledge of the underlying disorder and provides education as appropriate to address the disorder.

Endotracheal Intubation

Endotracheal intubation involves passing an ET tube through the nose or mouth into the trachea (see Fig. 19-5). The oral route is preferred since oral intubation is associated with less trauma and lesser rates of infection; furthermore, the oral route can typically accommodate a larger diameter ET tube than may be passed when the nasal route is used. Intubation provides a patent airway when the patient is having respiratory distress that cannot be treated with simpler methods and is the method of choice in emergency care. ET intubation is a means of providing an airway for patients who cannot maintain an adequate airway on their own (e.g., patients who are comatose and patients with upper airway obstruction), for patients needing mechanical ventilation, and for suctioning secretions from the pulmonary tree.

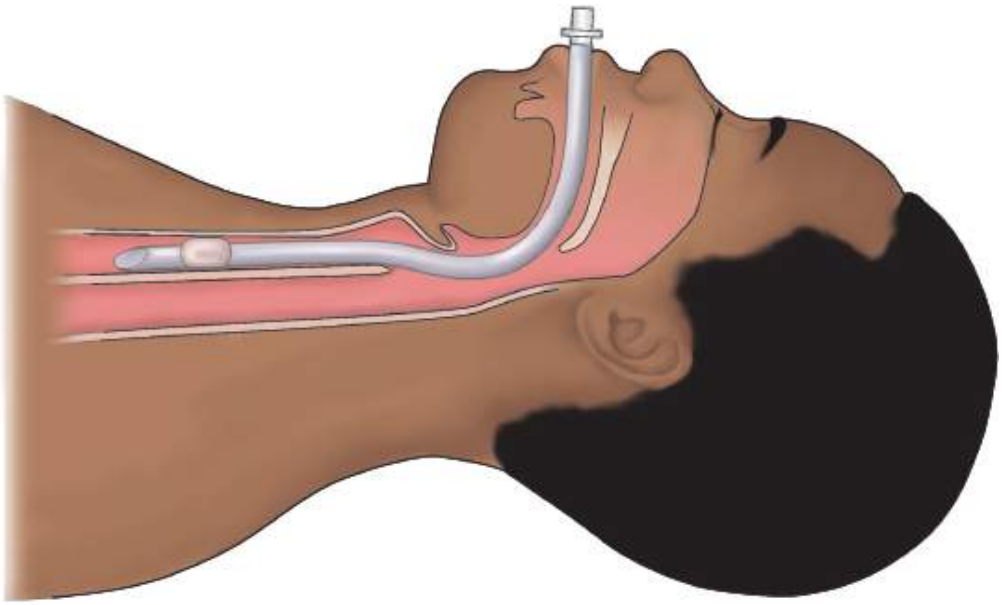


Figure 19-5 • Endotracheal tube in place. The tube has been inserted using the oral route. The cuff has been inflated to maintain the tube's position and to minimize the risk of aspiration.

An ET tube usually is passed with the aid of a laryngoscope by specifically trained medical, nursing, or respiratory therapy personnel. Once the tube is inserted and positioned about 2 cm above the carina, a cuff at the distal end of the ET tube is inflated with the use of a pilot balloon. Inflation of the cuff prevents air from leaking around the outer part of the tube in order to minimize the possibility of aspiration and secure the tube. The position of the ET tube is verified by checking end-tidal carbon dioxide levels and confirmed with chest x-ray. Chart 19-12 discusses the nursing care of the patient with an ET tube.

Complications can occur from pressure exerted by the cuff on the tracheal wall. Cuff pressures should be maintained between 20 and 25 mm Hg (24 and 30 cm H_2O) because high cuff pressure can cause tracheal bleeding, ischemia, and pressure necrosis, whereas low cuff pressure can increase the risk of

aspiration pneumonia. Routine deflation of the cuff is not recommended because of the increased risk of aspiration and **hypoxia** (i.e., decrease in oxygen supply to the tissues and cells) (Urden et al., 2018). Tracheobronchial secretions are suctioned through the tube. Warmed, humidified oxygen should always be introduced through the tube, whether the patient is breathing spontaneously or is receiving ventilatory support. ET intubation may be used for no longer than 14 to 21 days, by which time a tracheostomy must be considered to decrease irritation of and trauma to the tracheal lining, to reduce the incidence of vocal cord paralysis (secondary to laryngeal nerve damage), and to decrease the work of breathing (Wiegand, 2017).

ET and tracheostomy tubes have several disadvantages. The tubes cause discomfort. The cough reflex is depressed because glottis closure is hindered. Secretions tend to become thicker because the warming and humidifying effect of the upper respiratory tract has been bypassed. The swallowing reflexes (glottic, pharyngeal, and laryngeal reflexes) are depressed because of prolonged disuse and the mechanical trauma produced by the ET or tracheostomy tube, increasing the risk of aspiration as well as microaspiration and subsequent VAP (Urden et al., 2018). In addition, ulceration and stricture of the larynx or trachea may develop. Of great concern to the patient is the inability to talk and to communicate needs.

Tracheostomy

A **tracheotomy** is a surgical procedure in which an opening is made into the trachea. The indwelling tube inserted into the trachea is called a **tracheostomy tube** (see Fig. 19-6 for the different types of tracheostomy tubes). A tracheostomy (the stoma that is the product of the tracheotomy) may be either temporary or permanent.

Chart 19-12

Care of the Patient with an Endotracheal Tube

Immediately After Intubation

1. Check symmetry of chest expansion.
2. Auscultate breath sounds of anterior and lateral chest bilaterally.
3. Obtain capnography or end-tidal CO_2 as indicated.
4. Ensure chest x-ray obtained to verify proper tube placement.
5. Check cuff pressure every 6 to 8 hours.
6. Monitor for signs and symptoms of aspiration.
7. Ensure high humidity; a visible mist should appear in the T-piece or ventilator tubing.
8. Administer oxygen concentration as prescribed by the primary provider.
9. Secure the tube to the patient's face with tape, and mark the proximal end for position maintenance.
   a. Cut proximal end of tube if it is longer than 7.5 cm (3 inches) to prevent kinking.
   b. Insert an oral airway or mouth device if orally intubated to prevent the patient from biting and obstructing the tube.
10. Use sterile suction technique and airway care to prevent iatrogenic contamination and infection.
11. Continue to reposition patient every 2 hours and as needed to prevent atelectasis and to optimize lung expansion.
12. Provide oral hygiene and suction the oropharynx whenever necessary.

Extubation (Removal of Endotracheal Tube)

1. Explain procedure.
2. Have self-inflating bag and mask ready in case ventilatory assistance is required immediately after extubation.
3. Suction the tracheobronchial tree and oropharynx, remove tape, and then deflate the cuff.
4. Give 100% oxygen for a few breaths, then insert a new, sterile suction catheter inside tube.
5. Have the patient inhale. At peak inspiration, remove the tube, suctioning the airway through the tube as it is pulled out.

Note: In some hospitals, this procedure can be performed by respiratory therapists; in others, by nurses. Check hospital policy.

Care of Patient Following Extubation

1. Give heated humidity and oxygen by facemask and maintain the patient in a sitting or high-Fowler position.
2. Monitor respiratory rate and quality of chest excursions. Note stridor, color change, and change in mental alertness or behavior.
3. Monitor the patient's oxygen level using a pulse oximeter.

4. Keep patient NPO (nothing by mouth), or give only ice chips for next few hours.
5. Provide mouth care.
6. Educate the patient about how to perform coughing and deep-breathing exercises.

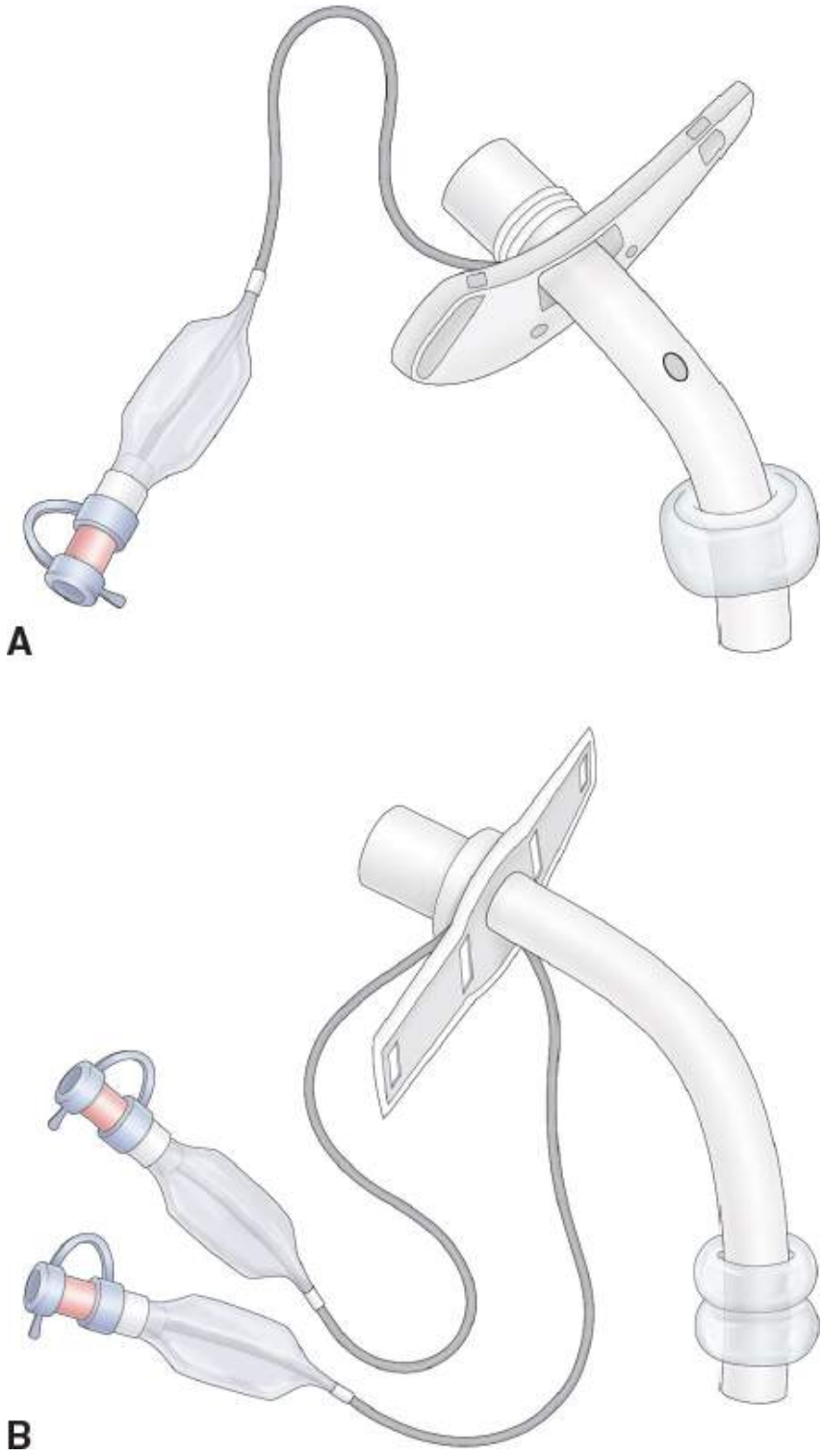


Figure 19-6 • Tracheostomy tubes. **A.** Fenestrated tube, which allows patient to talk. **B.** Double-cuffed tube. Inflating the two cuffs alternately can help prevent tracheal damage.

A tracheotomy is used to maintain a patent airway, bypass an upper airway obstruction, facilitate removal of tracheobronchial secretions, permit the long-term use of mechanical ventilation, replace an ET tube, and prevent aspiration

of oral or gastric secretions in the patient who is unconscious or paralyzed (by closing off the trachea from the esophagus). Many disease processes and emergency conditions make a tracheotomy necessary.

Tracheotomy

The tracheotomy procedure is usually performed in the operating room under general anesthesia, where the patient's ventilation can be well controlled and optimal aseptic technique can be maintained. A surgical opening is made between the second and third tracheal rings. After the trachea is exposed, a cuffed tracheostomy tube of an appropriate size is inserted. The cuff is an inflatable attachment to the tracheostomy tube that is designed to occlude the space between the tracheal walls and the tube, to permit effective mechanical ventilation, and to minimize the risk of aspiration.

For a patient who is intubated and mechanically ventilated, a newer surgical technique referred to as a percutaneous tracheostomy can be performed at the patient's bedside with the use of local anesthesia and sedation and analgesia. Using video-assisted guidance, a bronchoscope is passed down the ET tube. Following ET tube cuff deflation, the ET tube is withdrawn to the subglottic level. An opening is made in the skin between the second and third tracheal ring and enlarged with the use of dilators until the space is large enough to safely insert a tracheostomy tube. The ET tube and bronchoscope are then removed and the tracheostomy is secured into position (Lindman, 2018).

The tracheostomy tube is held in place by a velcro tube holder or twill tape ties fastened around the patient's neck. Usually, a square of sterile gauze is placed between the tube and the skin to absorb drainage and reduce the risk of infection.

Complications

Complications may occur early or late in the course of tracheostomy tube management. They may even occur years after the tube has been removed. Early complications include tube dislodgement, accidental decannulation, bleeding, pneumothorax, air embolism, aspiration, subcutaneous or mediastinal emphysema, recurrent laryngeal nerve damage, and posterior tracheal wall penetration. Long-term complications include airway obstruction from accumulation of secretions or protrusion of the cuff over the opening of the tube, infection, rupture of the innominate artery, dysphagia, tracheoesophageal fistula, tracheal dilation, tracheal ischemia, and necrosis. Tracheal stenosis may develop after the tube is removed. Chart 19-13 outlines measures nurses can take to prevent complications with use of ET and tracheostomy tubes.

Care of the Patient with an Endotracheal Tube or Tracheostomy

The patient requires continuous monitoring and assessment. The newly made opening must be kept patent by proper suctioning of secretions. After the vital signs are stable, the patient is placed in a semi-Fowler position to facilitate ventilation, promote drainage, minimize edema, and prevent strain on the suture lines. Analgesia and sedative agents must be given with caution because of the risk of suppressing the cough reflex.

Chart 19-13

Preventing Complications Associated with Endotracheal and Tracheostomy Tubes

- Administer adequate warmed humidity.
- Maintain cuff pressure at appropriate level.
- Suction as needed per assessment findings.
- Maintain skin integrity. Change tape and dressing as needed or per protocol.
- Auscultate lung sounds.
- Monitor for signs and symptoms of infection, including temperature and white blood cell count.
- Administer prescribed oxygen and monitor oxygen saturation.
- Monitor for cyanosis.
- Maintain adequate hydration of the patient.
- Use sterile technique when suctioning and performing tracheostomy care.

Major objectives of nursing care are to ensure a patent airway, monitor the patient's respiratory status, assess for complications, alleviate the patient's apprehension, and provide an effective means of communication. The nurse keeps paper and pencil or a Magic Slate® or a cellular device and the call light within the patient's reach at all times to ensure a means of communication.

For the procedural guidelines for nursing care of a patient with a tracheostomy tube, go to thepoint.lww.com/Brunner15e.

Suctioning the Tracheostomy or Endotracheal Tube

When a tracheostomy or ET tube is in place, it is usually necessary to suction the patient's secretions because of the decreased effectiveness of the cough mechanism. Tracheal suctioning is performed when adventitious breath sounds are detected or whenever secretions are obviously present. Unnecessary

suctioning can initiate bronchospasm and cause mechanical trauma to the tracheal mucosa.

All equipment that comes into direct contact with the patient's lower airway must be sterile to prevent sepsis.

For the procedural guidelines for suctioning a patient with a tracheostomy tube, go to thepoint.lww.com/Brunner15e.

In patients who are mechanically ventilated (see later discussion), an in-line suction catheter may be used to allow rapid suction when needed and to minimize cross-contamination by airborne pathogens. An in-line suction device allows the patient to be suctioned without being disconnected from the ventilator circuit. In-line suctioning (also called *closed suctioning*) decreases hypoxemia, sustains PEEP, and can decrease patient anxiety associated with suctioning (Wiegand, 2017). Because in-line suctioning protects staff from patient secretions, it can be performed in most cases without using personal protective gear. A notable exception is when the patient has COVID-19, when PPE must be used.

Managing the Cuff

The cuff on an ET or tracheostomy tube should be inflated if the patient requires mechanical ventilation or is at high risk for aspiration. The pressure within the cuff should be the lowest possible pressure (20 to 25 mm Hg) that allows delivery of adequate tidal volumes and prevents pulmonary aspiration (Urden et al., 2018). Cuff pressure must be monitored by the respiratory therapist or nurse at least every 8 hours by attaching a handheld pressure gauge to the pilot balloon of the tube or by using the minimal leak volume or minimal occlusion volume technique.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care. If the patient is pending discharge to the home setting with a tracheostomy tube, the nurse should ensure that suction and other appropriate equipment is in place in the home prior to discharge. The nurse also educates the patient and family about daily care, including techniques to prevent infection, as well as measures to take in an emergency. The nurse provides the patient and family with a list of community contacts for education and support needs.

Continuing and Transitional Care. A referral for home, community-based, or transitional care is indicated for ongoing assessment of the patient and of the ability of the patient and family to provide appropriate and safe

care. The nurse assesses the patient's and family's ability to cope with the physical changes and psychological issues associated with having a tracheostomy. Minimizing the amount of dust or particles in the air and providing adequate humidification may make it easier for the patient to breathe. Dust and particles in the air can be decreased by removing drapes and upholstered furniture; using air filters; and washing floors, dusting, and vacuuming frequently. The nurse identifies resources and makes referrals for appropriate services to assist the patient and family to manage the tracheostomy tube at home.

Mechanical Ventilation

Mechanical ventilation may be required to manage acute respiratory failure. It may also be indicated for a variety of other reasons including to: control the patient's respirations during surgery or treatment, oxygenate the blood when the patient's ventilatory efforts are inadequate, and rest the respiratory muscles. Many patients placed on a ventilator can breathe spontaneously, although the effort needed to do so may be exhausting.

A **mechanical ventilator** is a positive- or negative-pressure breathing device that can maintain ventilation and oxygen delivery for a prolonged period.

Indications

If a patient has evidence of respiratory failure or a compromised airway, ET intubation and mechanical ventilation are indicated. This clinical evidence may be corroborated by a continuous decrease in PaO_2, an increase in $PaCO_2$, and a persistent acidosis (decreased pH); however, if the patient's status appears emergent, then waiting for these laboratory results prior to ensuring these ventilator support measures is imprudent. Conditions such as thoracic or abdominal surgery, drug overdose, neuromuscular disorders, inhalation injury, COPD, multiple trauma, shock, multisystem failure, and coma may lead to respiratory failure and the need for mechanical ventilation. General indications for mechanical ventilation are displayed in Chart 19-14.

Classification of Ventilators

Mechanical ventilators were traditionally classified according to the method by which they supported ventilation. The two general categories are negative- and positive-pressure ventilators. Figure 19-7 displays commonly used positive-pressure ventilators. Negative-pressure ventilators (e.g., "iron lungs," chest cuirass) are older modes of ventilatory support that are rarely utilized today.

Positive-Pressure Ventilators

Positive-pressure ventilators inflate the lungs by exerting positive pressure on the airway, pushing air in, similar to a bellows mechanism, and forcing the

alveoli to expand during inspiration. Expiration occurs passively. ET intubation or tracheostomy is usually necessary. These ventilators are widely used in the hospital setting and are increasingly used in the home for patients with primary lung disease. Three types of positive-pressure ventilators are classified by the method of ending the inspiratory phase of respiration: volume-cycled, pressure-cycled, and high-frequency oscillatory support. The fourth type, noninvasive positive-pressure ventilation (NIPPV), does not require intubation (Wiegand, 2017).

Chart 19-14

Indications for Mechanical Ventilation

Laboratory Values

PaO_2 <55 mm Hg
$PaCO_2$ >50 mm Hg and pH <7.32
Vital capacity <10 mL/kg
Negative inspiratory force <25 cm H_2O
FEV_1 <10 mL/kg

Clinical Manifestations

Apnea or bradypnea
Respiratory distress with confusion
Increased work of breathing not relieved by other interventions
Confusion with need for airway protection
Circulatory shock
Controlled hyperventilation (e.g., patient with a severe head injury)

Adapted from Amitai, A. (2018). Introduction to ventilator management. *Medscape.* Retrieved on 2/2/2020 at: emedicine.medscape.com/article/810126-overview

Volume-Cycled Ventilators. Volume-cycled ventilators deliver a preset volume of air with each inspiration. Once this preset volume is delivered to the patient, the ventilator cycles off and exhalation occurs passively. From breath to breath, the volume of air delivered by the ventilator is relatively constant, ensuring consistent, adequate breaths despite varying airway pressures. A major disadvantage to using volume-cycled ventilators is that patients may experience barotrauma (trauma to the trachea or alveoli secondary to positive pressure) because the pressures required to deliver the breaths may be excessive. This trauma causes damage to the alveolar capillary membrane and air to leak into the surrounding tissues (Urden et al., 2018).

Figure 19-7 • Positive-pressure ventilators. **A.** The AVEA can be used to both ventilate and monitor neonatal, pediatric, and adult patients. It can also deliver noninvasive ventilation with Heliox to adult and pediatric patients. Courtesy of Vyaire Medical Inc., Yorba Linda, CA. **B.** The Puritan-Bennett 840 Ventilator System has volume, pressure, and mixed modes designed for adult, pediatric, and infant ventilation. Courtesy of Tyco Healthcare/Nellcor Puritan Bennett, Pleasanton, CA.

Pressure-Cycled Ventilators. When the pressure-cycled ventilator cycles on, it delivers a flow of air (inspiration) until it reaches a preset pressure, and then cycles off, and expiration occurs. The major limitation is the volume of air or oxygen can vary as the patient's airway resistance or compliance changes. As a result, the **tidal volume** delivered (i.e., volume of air inspired and expired with each breath) may be inconsistent, possibly compromising ventilation.

High-Frequency Oscillatory Support Ventilators. These types of ventilators deliver very high respiratory rates (i.e., 180 to 900 breaths/min) that are accompanied by very low tidal volumes and high airway pressures (hence the name *high-frequency oscillatory support*). These small pulses of oxygen-enriched air move down the center of the airways, allowing alveolar air to exit the lungs along the margins of the airways. This ventilatory mode is used to open the alveoli in situations characterized by closed small airways, such as

atelectasis and ARDS and it is also thought to protect the lung from pressure injury (Wiegand, 2017).

Noninvasive Positive-Pressure Ventilation. NIPPV is a method of positive-pressure ventilation that can be given via facemasks that cover the nose and mouth, nasal masks, or other oral or nasal devices such as the nasal pillow (a small nasal cannula that seals around the nares to maintain the prescribed pressure). NIPPV eliminates the need for ET intubation or tracheostomy and decreases the risk of nosocomial infections such as pneumonia. The most comfortable mode for the patient is pressure-controlled ventilation with pressure support. This eases the work of breathing and enhances gas exchange. The ventilator can be set with a minimum backup rate for patients with periods of apnea.

Patients are candidates for NIPPV if they have acute or chronic respiratory failure, acute pulmonary edema, COPD, chronic heart failure, or a sleep-related breathing disorder. The technique also may be used at home to improve tissue oxygenation and to rest the respiratory muscles while patients sleep at night. NIPPV is contraindicated for those who have experienced respiratory arrest, serious arrhythmias, cognitive impairment, or head or facial trauma. NIPPV may also be used for obstructive sleep apnea, for patients at the end of life, and for those who do not want ET intubation but may need short- or long-term ventilatory support (Wiegand, 2017).

Continuous positive airway pressure (CPAP) provides positive pressure to the airways throughout the respiratory cycle. Although it can be used as an adjunct to mechanical ventilation with a cuffed ET tube or tracheostomy tube to open the alveoli, it is also used with a leak-proof mask to keep alveoli open, thereby preventing respiratory failure. CPAP is an effective treatment of obstructive sleep apnea because the positive pressure acts as a splint, keeping the upper airway and trachea open during sleep. To use CPAP, the patient must be breathing independently.

Bilevel positive airway pressure (BiPAP) ventilation offers independent control of inspiratory and expiratory pressures while providing pressure support ventilation (PSV). It delivers two levels of positive airway pressure provided via a nasal or oral mask, nasal pillow, or mouthpiece with a tight seal and a portable ventilator. Each inspiration can be initiated either by the patient or by the machine if it is programmed with a backup rate. The backup rate ensures that the patient receives a set number of breaths per minute. BiPAP is most often used for patients who require ventilatory assistance at night, such as those with severe COPD or sleep apnea. Tolerance is variable; BiPAP usually is most successful with patients who are highly motivated.

Ventilator Modes

Ventilator mode refers to how breaths are delivered to the patient. The most commonly used modes are controlled mechanical ventilation, continuous

mandatory ventilation, also known as assist–control (A/C), intermittent mandatory ventilation (IMV), synchronized intermittent mandatory ventilation (SIMV), PSV, and airway pressure release ventilation (APRV) (see Fig. 19-8).

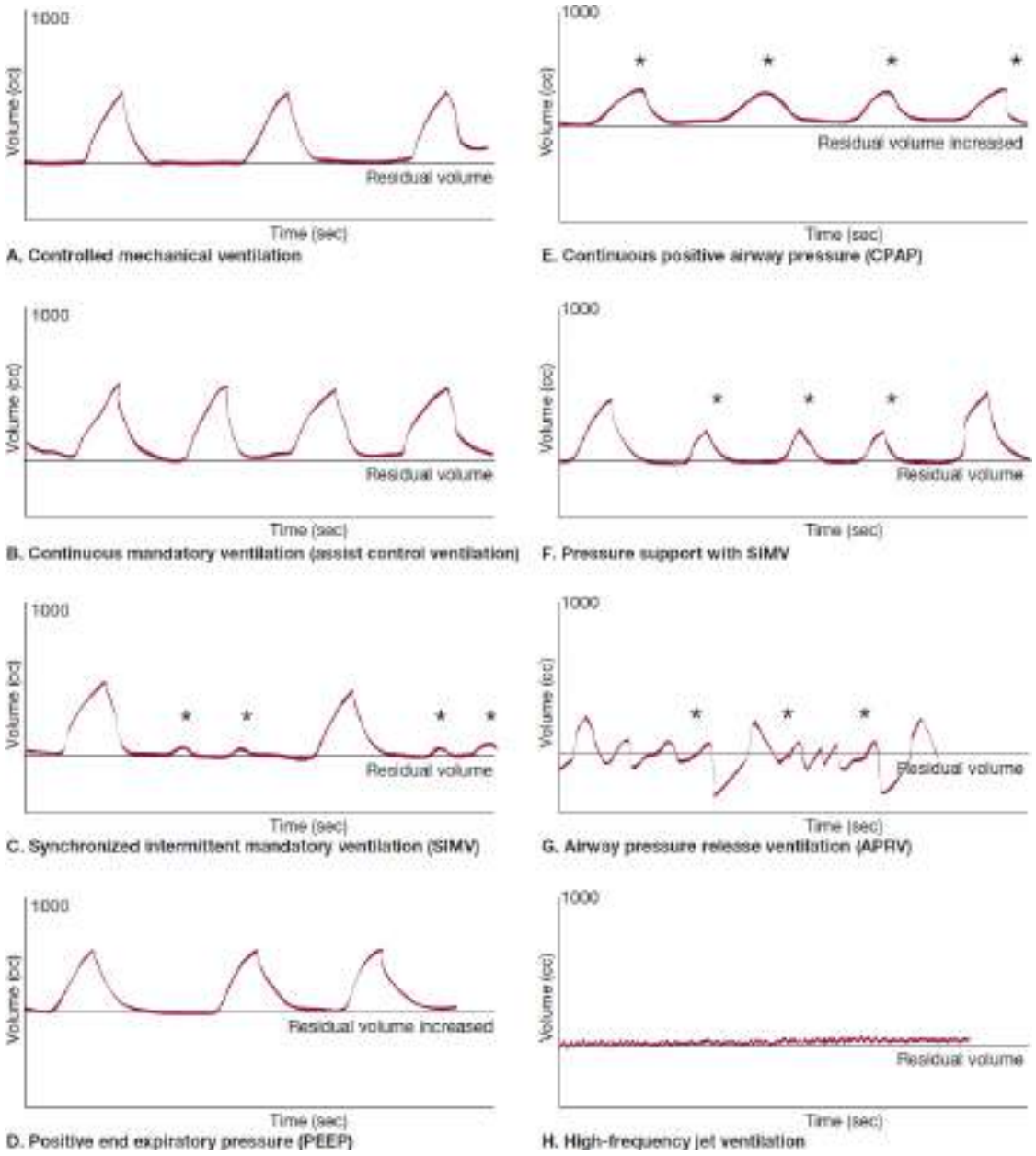


Figure 19-8 • Modes of mechanical ventilation with airflow waveforms. Inhalations marked with an asterisk (*) are spontaneous.

Controlled mechanical ventilation provides full ventilator support by delivering a preset tidal volume and respiratory rate. This mode of ventilation is indicated for patients who are apneic. In A/C ventilation, more commonly called **continuous mandatory (volume or pressure) ventilation (CMV)**, the ventilator delivers a preset tidal volume or pressure at a preset rate of

respirations. However, if the patient initiates a breath between the machine's breaths, the ventilator delivers at the preset volume or pressure (assisted breath). Therefore, every breath is the preset volume or pressure, regardless of whether it is initiated by the patient or the ventilator. Two variations to CMV include: pressure-regulated volume control ventilation (PRVCV) and pressure-controlled inverse ratio ventilation (PC-IRV). PRVCV delivers a preset tidal volume using the minimal amount of airway pressure in patients with rapidly changing airway resistance and lung compliance. PC-IRV provides prolonged inspiratory time in refractory to positive end-expiratory pressure (PEEP) in a patient with hypoxia.

Intermittent mandatory (volume or pressure) ventilation (IMV) provides a combination of mechanically assisted breaths and spontaneous breaths. Mechanical breaths are delivered at preset intervals and a preselected tidal volume, regardless of the patient's efforts. Although the patient can increase the respiratory rate by initiating inspiration between ventilator-delivered breaths, these spontaneous breaths are limited to the tidal volume generated by the patient. IMV allows patients to use their own muscles for ventilation to help prevent muscle atrophy. It lowers mean airway pressure, which can assist in preventing barotrauma. However, patient-ventilator dyssynchrony, evidenced by the patient "fighting the ventilator" or "bucking the ventilator" (i.e., trying to exhale when the ventilator is delivering a breath) may increase.

Synchronized intermittent mandatory ventilation (SIMV) also delivers a preset tidal volume and number of breaths per minute. Between ventilator-delivered breaths, the patient can breathe spontaneously with no assistance from the ventilator on those extra breaths. Because the ventilator senses patient breathing efforts and does not initiate a breath in opposition to the patient's efforts, patient-ventilator dyssynchrony is reduced. As the patient's ability to breathe spontaneously increases, the preset number of ventilator breaths is decreased and the patient does more of the work of breathing. Like IMV, SIMV can be used to provide full or partial ventilatory support. Nursing interventions for patients receiving IMV or SIMV include monitoring progress by recording respiratory rate, minute volume, spontaneous and machine-generated tidal volume, FiO_2, and arterial blood gas levels.

Pressure support ventilation (PSV) applies a pressure plateau to the airway throughout the patient-triggered inspiration to decrease resistance within the tracheal tube and ventilator tubing. Pressure support is reduced gradually as the patient's strength increases. An SIMV backup rate may be added for extra support. The nurse must closely observe the patient's respiratory rate and tidal volumes on initiation of PSV. It may be necessary to adjust the pressure support to avoid tachypnea or large tidal volumes.

An additional mode of ventilation used to facilitate weaning is volume-assisted pressure support ventilation (VAPSV) also referred to as pressure

augmentation (PA). This mode of ventilation ensures the patient receives a minimum tidal volume with each pressure support breath.

A newer mode of ventilation which requires an esophageal catheter to monitor electrical activity of the diaphragm is neurally adjusted ventilatory assist (NAVA). This mode delivers assisted breaths in synchrony with the patient's own breath. The esophageal catheter monitors electrical activity of the diaphragm and signals the ventilator when to initiate a breath.

Another unique mode of ventilation used in special circumstances is independent lung ventilation (ILV). This mode is used in patients with unilateral lung disease. Each lung is ventilated separately via a double lumen ET tube (Urden et al., 2018).

Airway pressure release ventilation (APRV) is a time-triggered, pressure-limited, time-cycled mode of mechanical ventilation that allows unrestricted, spontaneous breathing throughout the ventilatory cycle. The inflation period is long, and breaths may be initiated spontaneously as well as by the ventilator. APRV allows alveolar gas to be expelled through the lungs' natural recoil. APRV has the important advantages of causing less ventilator-induced lung injury and fewer adverse effects on cardiocirculatory function and being associated with lower need for sedation and neuromuscular blockade.

Proportional assist ventilation (PAV) provides partial ventilatory support in which the ventilator generates pressure in proportion to the patient's inspiratory efforts. With every breath, the ventilator synchronizes with the patient's ventilatory efforts. The more inspiratory pressure the patient generates, the more pressure the ventilator generates, amplifying the patient's inspiratory effort without any specific preselected target pressure or volume. It generally adds "additional muscle" to the patient's effort; the depth and frequency of breaths are controlled by the patient.

Other modes of mechanical ventilation that incorporate computerized control of ventilation include adaptive support ventilation (ASV), which adjusts minute ventilation and pressure support based on patient need (Urden et al., 2018).

With various modes of mechanical ventilation, the ventilator constantly monitors many variables and adjusts gas delivery during individual breaths; these within-breath adjustment systems include automatic tube compensation, volume-ensured pressure support, and proportional support ventilation. In other modes, the ventilator evaluates gas delivery during one breath and uses that information to adjust the next breath; these between-breath adjustment systems can be made to ensure a preset tidal volume by adjusting pressure, up to a preset maximum, and include pressure volume support, pressure-regulated volume control, and ASV.

Adjusting the Ventilator

The ventilator is adjusted so that the patient is comfortable and breathes synchronously (i.e., "in sync") with the machine. Minimal alteration of the normal cardiovascular and pulmonary dynamics is desired. If the volume ventilator is adjusted appropriately, the patient's arterial blood gas values will be satisfactory and there will be little or no cardiovascular compromise. Chart 19-15 describes initial ventilator settings.

Chart 19-15

Initial Ventilator Settings

The following guide is an example of the steps involved in operating a mechanical ventilator. The nurse, in collaboration with the respiratory therapist, always reviews the manufacturer's instructions, which vary according to the equipment, before beginning mechanical ventilation.

1. Set the machine to deliver the tidal volume required (6 to 10 mL/kg) or (4 to 8 mL/kg for patients with ARDS).
2. Adjust the machine to deliver the lowest concentration of oxygen to maintain normal PaO_2 (greater than 60 mm Hg) or an SpO_2 level greater than 92%. This setting may be high initially but will gradually be reduced based on arterial blood gas (ABG) results.
3. Record peak inspiratory pressure.
4. Set mode (continuous mandatory ventilation [also known as assist–control], or synchronized intermittent mandatory ventilation) and rate as prescribed by the primary provider. (See the glossary for definitions of modes of mechanical ventilation.) Set positive end-expiratory pressure (PEEP) and pressure support if prescribed.
5. Set sigh settings (usually set at 1.5 times the tidal volume and ranging from 1 to 3 per hour), if applicable.
6. Adjust sensitivity so that the patient can trigger the ventilator with a minimal effort (usually 2 mm Hg negative inspiratory force).
7. Record minute volume and obtain ABGs to measure carbon dioxide partial pressure ($PaCO_2$), pH, and PaO_2 after 20 minutes of continuous mechanical ventilation.
8. Adjust setting (FiO_2 and rate) according to results of ABG analysis to provide normal values or those set by the primary provider.
9. If there is poor coordination between the breathing rhythms of the patient and the ventilator (i.e., patient-ventilator dyssynchrony), assess for hypoxia and manually ventilate on 100% oxygen with a resuscitation bag.

Adapted from Amitai, A. (2018). Introduction to ventilator management. *Medscape.* Retrieved on 2/2/2020 at: emedicine.medscape.com/article/810126-overview

NURSING PROCESS

The Patient Receiving Mechanical Ventilation

Nursing management of patients with acute respiratory failure includes assisting with intubation and maintaining mechanical ventilation. Furthermore, caring for a patient on mechanical ventilation has become an integral part of nursing care for many patients in critical care or general medical-surgical units, extended care facilities, and the home. Nurses, physicians, and respiratory therapists must understand each patient's specific pulmonary needs and work together to set realistic goals. Positive patient outcomes depend on an understanding of the principles of mechanical ventilation and the patient's care needs as well as open communication among members of the health care team about the goals of therapy, weaning plans, and the patient's tolerance of changes in ventilator settings.

Assessment

The nurse plays a vital role in assessing the patient's status and the functioning of the ventilator. In assessing the patient, the nurse evaluates the patient's physiologic status and how they are coping with mechanical ventilation. Physical assessment includes systematic assessment of all body systems, with an in-depth focus on the respiratory system. Respiratory assessment includes vital signs, respiratory rate and pattern, breath sounds, evaluation of spontaneous ventilatory effort, and potential evidence of hypoxia (e.g., skin color). Increased adventitious breath sounds may indicate a need for suctioning. The nurse maintains the patient's head of the bed so that it is elevated 30 degrees or higher unless contraindicated to prevent the risk of aspiration and VAP. The nurse verifies endotracheal tube position as applicable and evaluates the settings and functioning of the mechanical ventilator. Although the nurse may not be primarily responsible for adjusting the settings on the ventilator or measuring ventilator parameters (these are usually responsibilities of the respiratory therapist), the nurse is responsible for the patient and therefore needs to evaluate how the ventilator affects the patient's overall status.

When monitoring the ventilator, the nurse notes the following:

- Controlling mode (e.g., CMV ventilation and SIMV).
- Tidal volume and rate settings (tidal volume is usually set at 6 to 10 mL/kg [ideal body weight] or 4 to 8 mL/kg for the patient with ARDS [ideal body weight]; rate is usually set at 12 to 16 breaths/min).
- FiO_2 setting may be set between 21% and 100% to maintain an optimal PaO_2 level (e.g., greater than 60 mm Hg) or SpO_2 level greater than 92%.

- Peak inspiratory pressure (PIP) (normal is 15 to 20 cm H_2O; this increases if there is increased airway resistance or decreased compliance).
- Sensitivity (A 2 cm H_2O inspiratory force should trigger the ventilator).
- Inspiratory-to-expiratory ratio (usually 1:2 [1 second of inspiration to 2 seconds of expiration] unless inverse ratio is ordered).
- Minute volume (tidal volume × respiratory rate).
- Sigh settings (usually set at 1.5 times the tidal volume and ranging from 1 to 3 per hour), if applicable.
- Water in the tubing, disconnection or kinking of the tubing, which, if present, are corrected.
- Humidification (humidifier filled with water) and temperature.
- Alarms (turned on and functioning properly at all times per The Joint Commission [TJC] Alarm Safety Goal) (TJC, 2020).
- PEEP and pressure support level, if applicable.

As is true with any type of patient-sensitive life support equipment, mechanical ventilators have multiple alarms that are set to alert the health care team of potential patient problems. With the increased number of alarms and their high sensitivity to subtle changes, members of the health care team, including nurses, are at risk for experiencing alarm fatigue, which means that they may become desensitized to alarms and not respond to them with sufficient speed. According to the National Patient Safety Goals (TJC, 2020), measures must be instituted to prevent alarm fatigue.

Quality and Safety Nursing Alert

To prevent alarm fatigue associated with mechanical ventilators, nurses can manage the physical layout of the critical care unit (e.g., avoid locating patients on mechanical ventilators in close proximity); devise protocols for setting of alarms based upon best practices; and educate staff on how to set alarms and when and how to respond to them.

Assessment also addresses the patient's neurologic status and effectiveness of coping with the need for assisted ventilation and the changes that accompany it. The nurse assesses the patient's comfort level and ability to communicate as well. Because weaning from mechanical ventilation requires adequate nutrition, it is important to assess the patient's gastrointestinal system and nutritional status.

Diagnosis

Nursing Diagnoses

Based on the assessment data, major nursing diagnoses may include:

- Impaired gas exchange associated with underlying illness, ventilator setting adjustments, or weaning
- Impaired airway clearance associated with increased mucus production associated with presence of the tube in trachea or continuous positive-pressure mechanical ventilation
- Risk for injury and infection associated with endotracheal intubation or tracheostomy
- Impaired mobility associated with ventilator dependency
- Impaired verbal communication associated with endotracheal tube or tracheostomy tube
- Difficulty coping associated with ventilator dependency

TABLE 19-5 Troubleshooting Problems with Mechanical Ventilation

Problem	Cause	Solution
Ventilator Problems		
Increase in peak airway pressure	Coughing or plugged airway tube	Suction airway for secretions; empty condensation fluid from circuit.
	Patient-ventilator dyssynchrony	Adjust sensitivity; consider administering sedatives as prescribed
	Decreasing lung compliance	Manually ventilate patient. Assess for hypoxia or bronchospasm. Check arterial blood gas values. Sedate only if necessary.
	Tubing kinked	Check tubing; reposition patient; insert oral airway if necessary.
	Pneumothorax	Manually ventilate patient; notify primary provider.
	Atelectasis or bronchospasm	Clear secretions.
Decrease in pressure or loss of volume	Increase in compliance	None.
	Leak in ventilator or tubing; cuff on tube/humidifier not tight	Check entire ventilator circuit for patency. Correct leak.
Patient Problems		
Cardiovascular compromise	Decrease in venous return due to application of positive pressure to lungs	Assess for adequate volume status by measuring heart rate, blood pressure, central venous pressure, pulmonary capillary wedge pressure, and urine output; notify primary provider if values are abnormal.
Barotrauma/pneumothorax	Application of positive pressure to lungs; high mean airway pressures lead to alveolar rupture	Notify primary provider. Prepare patient for chest tube insertion. Avoid high pressure settings for patients with COPD, ARDS, or history of pneumothorax.
Pulmonary infection	Bypass of normal defense mechanisms; frequent breaks in ventilator circuit; decreased mobility;	Use strict aseptic technique. Provide frequent mouth care. Optimize nutritional status.

	impaired cough reflex

ARDS, acute respiratory distress syndrome; COPD, chronic obstructive pulmonary disease.

Collaborative Problems/Potential Complications

Based on the assessment data, potential complications may include the following (see Table 19-5):

- Ventilator problems (increase in peak airway pressure or decrease in pressure or loss of volume)
- Alterations in cardiac function
- Barotrauma and pneumothorax
- Pulmonary infection and sepsis (e.g., VAP; see Chart 19-6)
- Delirium and postintensive care syndrome

Planning and Goals

The major goals for the patient may include achievement of optimal gas exchange, maintenance of a patent airway, absence of injury or infection, attainment of optimal mobility, adjustment to nonverbal methods of communication, acquisition of successful coping measures, and absence of complications.

Nursing Interventions

Nursing care of the patient who is mechanically ventilated requires expert technical and interpersonal skills. Nursing interventions are similar regardless of the setting; however, the frequency of interventions and the stability of the patient vary from setting to setting. Nursing interventions for the patient who is mechanically ventilated are not uniquely different from those for patients with other pulmonary disorders, but astute nursing assessment and a therapeutic nurse–patient relationship are critical. The specific interventions used by the nurse are determined by the underlying disease process and the patient's response.

Two general nursing interventions that are important in the care of the patient who is mechanically ventilated are pulmonary auscultation and interpretation of arterial blood gas measurements. The nurse is often the first to note changes in physical assessment findings or significant trends in blood gases that signal the development of a serious problem (e.g., pneumothorax, tube displacement, pulmonary embolus).

Enhancing Gas Exchange

The purpose of mechanical ventilation is to optimize gas exchange by maintaining alveolar ventilation and oxygen delivery. The alteration in gas exchange may be caused by the underlying illness or by mechanical factors related to adjustment of the ventilator to the patient. The health care team,

including the nurse, physician, and respiratory therapist, continually assesses the patient for adequate gas exchange, signs and symptoms of hypoxia, and response to treatment. Therefore, the nursing diagnosis of impaired gas exchange is, by its complex nature, multidisciplinary and collaborative. The team members must share goals and information freely. All other goals directly or indirectly relate to this primary goal.

Nursing interventions to promote optimal gas exchange include judicious administration of analgesic agents to relieve pain without suppressing the respiratory drive and frequent repositioning to diminish the pulmonary effects of immobility. The nurse also monitors for adequate fluid balance by assessing for the presence of peripheral edema, calculating daily intake and output, and monitoring daily weights. The nurse administers medications prescribed to control the primary disease and monitors for their side effects.

Promoting Effective Airway Clearance

Continuous positive-pressure ventilation increases the production of secretions regardless of the patient's underlying condition. The nurse assesses for the presence of secretions by lung auscultation at least every 2 to 4 hours. Measures to clear the airway of secretions include suctioning, CPT, frequent position changes, and increased mobility as soon as possible. Frequency of suctioning should be determined by patient assessment. If excessive secretions are identified by inspection or auscultation techniques, suctioning should be performed. Sputum is not produced continuously or every 1 to 2 hours but as a response to a pathologic condition. Therefore, there is no rationale for routine suctioning of all patients every 1 to 2 hours. Although suctioning is used to aid in the clearance of secretions, it can damage the airway mucosa and impair cilia action.

The sigh mechanism on the ventilator may be adjusted to deliver at least 1 to 3 sighs per hour at 1.5 times the tidal volume if the patient is receiving A/C ventilation. Periodic sighs prevent atelectasis and the further retention of secretions. Because of the risk for hyperventilation and trauma to pulmonary tissue from excess ventilator pressure (barotrauma, pneumothorax), the sigh feature is not used frequently. If the SIMV mode is being used, the mandatory ventilations act as sighs because they are of greater volume than the patient's spontaneous breaths.

Humidification of the airway via the ventilator is maintained to help liquefy secretions so that they are more easily removed. Bronchodilators may be indicated to dilate the bronchioles in patients with acute lung injury or COPD and are classified as adrenergic or anticholinergic. Adrenergic bronchodilators (see Chapter 20, Table 20-4) are mostly inhaled and work by stimulating the beta-receptor sites, mimicking the effects of epinephrine in the body. The desired effect is smooth muscle relaxation, which dilates the constricted bronchial tubes. Anticholinergic bronchodilators (see

Chapter 20, Table 20-4) produce airway relaxation by blocking cholinergic-induced bronchoconstriction. Patients receiving bronchodilator therapy of either type should be monitored for adverse effects, including dizziness, nausea, decreased oxygen saturation, hypokalemia, increased heart rate, and urine retention. Mucolytic agents (e.g., acetylcysteine) may also be indicated in these patients to liquefy secretions so that they are more easily mobilized. Nursing management of patients receiving mucolytic therapy includes assessment of an adequate cough reflex, sputum characteristics, and (in patients not receiving mechanical ventilation) improvement in incentive spirometry. Side effects include nausea, vomiting, bronchospasm, stomatitis (oral ulcers), urticaria, and rhinorrhea (runny nose) (Karch, 2020).

Preventing Injury and Infection

Maintaining the endotracheal or tracheostomy tube is an essential part of airway management. Cuff pressure is monitored every 8 hours to maintain the pressure at 20 to 25 mm Hg (Urden et al., 2018). The nurse assesses for the presence of a cuff leak at the same time. The nurse positions the ventilator tubing so that there is minimal pulling or distortion of the tube in the trachea, reducing the risk of trauma to the trachea. Unintentional or premature removal of the tube is a potentially life-threatening complication of endotracheal intubation. Removal of the tube is a frequent problem in intensive care units (ICUs) and occurs mainly during nursing care or by the patient. Nurses must instruct and remind patients and family members about the purpose of the tube and the dangers of removing it. Baseline and ongoing assessment of the patient and of the equipment ensures effective care. Providing comfort measures, including opioid analgesia and sedation, can improve the patient's tolerance of the endotracheal tube.

Quality and Safety Nursing Alert

Inadvertent removal of an endotracheal tube can cause laryngeal swelling, hypoxemia, bradycardia, hypotension, and even death. Measures must be taken to prevent premature or inadvertent removal.

To prevent tube removal by the patient, the nurse should explain to the patient and family the purpose of the tube, distract the patient through one-to-one interaction or with television, and maintain comfort measures. If the patient cannot move the arms and hands to the endotracheal tube, restraints are not needed. If the patient is alert, oriented, able to follow directions, and cooperative to the point that it is highly unlikely that they will remove the endotracheal tube, restraints are not needed. However, if the nurse

determines there is a risk that the patient may try to remove the tube, the least invasive method of restraints (e.g., soft wrist restraints and hand mitts) may be appropriate as prescribed by the primary provider (check agency policy) (TJC, 2019). The rationale for use of restraints should be documented, and the patient's significant others should receive explanations why restraints are necessary. Close monitoring of the patient is essential to ensure safety and prevent harm.

Patients with an endotracheal or tracheostomy tube do not have the normal defenses of the upper airway. In addition, these patients frequently have multiple additional body system disturbances that lead to immune compromise. Tracheostomy care is performed at least every 8 hours, and more frequently if needed, because of the increased risk of infection. The ventilator circuit tubing and in-line suction tubing are replaced periodically, according to infection prevention guidelines, to decrease the risk of infection.

The nurse administers oral hygiene frequently because the oral cavity is a primary source of contamination of the lungs in the patient who is intubated. The presence of a nasogastric tube in the patient who is intubated can increase the risk of aspiration, leading to nosocomial pneumonia. The nurse positions the patient with the head elevated above the stomach as much as possible. Chart 19-6 provides an overview of strategies to prevent VAP.

Promoting Optimal Level of Mobility

Being connected to a ventilator limits the patient's mobility. Immobility in patients who are mechanically ventilated is associated with decreases in muscle strength and increases length of hospital stay, as well as increased mortality rates (Hodgson, Capell, & Tipping, 2018). The nurse helps the patient whose condition has become stable to get out of bed and move to a chair as soon as possible. If the patient is unable to get out of bed, the nurse encourages performance of active range-of-motion exercises at least every 6 to 8 hours. If the patient cannot perform these exercises, the nurse performs passive range-of-motion exercises at least every 8 hours to prevent contractures and venous stasis.

Promoting Optimal Communication

It is important to develop alternative methods of communication for the patient who is receiving mechanical ventilation. The nurse assesses the patient's communication abilities to evaluate for limitations. Questions to consider when assessing the ability of the patient who is ventilator dependent to communicate include the following:

- Is the patient conscious and able to communicate? Can the patient nod or shake their head?

- Is the patient's mouth unobstructed by the tube so that words can be mouthed?
- Is the patient's dominant hand strong and available for writing? For example, if the patient is right handed, the IV line should be placed in the left arm if possible so that the right hand is free.
- Is the patient a candidate for a fenestrated tracheostomy tube or a one-way speaking valve (such as Passy-Muir valve® or Olympic Trach-Talk®) that permits talking?

Once the patient's limitations are known, the nurse offers several appropriate communication approaches: lip or speech reading (use single key words), pad and pencil or Magic Slate®, iPad® or tablet, communication board, gesturing, sign language, or electric larynx. The use of a "talking" or fenestrated tracheostomy tube or one-way valve may be suggested to the primary provider, which would allow the patient to talk while on the ventilator. The nurse makes sure that the patient's eyeglasses, hearing aid, sign interpreter, and language translator are available if needed to enhance the patient's ability to communicate.

Some communication methods may be frustrating to the patient, family, and nurse; these need to be identified and minimized. A speech therapist can assist in determining the most appropriate method.

Promoting Coping Ability

Dependence on a ventilator is frightening to both the patient and the family and disrupts even the most stable families. Encouraging the family to verbalize their feelings about the ventilator, the patient's condition, and the environment in general is beneficial. Explaining procedures every time they are performed helps reduce anxiety and familiarizes the patient with ventilator procedures. To restore a sense of control, the nurse encourages the patient to use alternative methods of communication in order to participate in decisions about care, schedules, and treatment when possible. The patient may become withdrawn or depressed while receiving mechanical ventilation, especially if its use is prolonged. To promote effective coping, the nurse informs the patient about progress when appropriate. It is important to provide diversions such as watching television, playing music, or taking a walk (if appropriate and possible). Stress reduction techniques (e.g., a back rub, relaxation measures) relieve tension and help the patient deal with anxieties and fears about both the condition and the dependence on the ventilator.

Monitoring and Managing Potential Complications

Alterations in Cardiac Function. Alterations in cardiac output may occur as a result of positive-pressure ventilation. The positive intrathoracic pressure during inspiration compresses the heart and great vessels, thereby reducing venous return and cardiac output. This is usually corrected during

exhalation when the positive pressure is off. The patient may have decreased cardiac output and resultant decreased tissue perfusion and oxygenation.

To evaluate cardiac function, the nurse first observes for signs and symptoms of hypoxia (restlessness, apprehension, confusion, tachycardia, tachypnea, pallor progressing to cyanosis, diaphoresis, transient hypertension, and decreased urine output). If a pulmonary artery catheter is in place, cardiac output, cardiac index, and other hemodynamic values can be used to assess the patient's status (see Chapter 21).

Barotrauma and Pneumothorax. Excessive positive pressure can cause lung damage, or barotrauma, which may result in a spontaneous pneumothorax, which may quickly develop into a tension pneumothorax, further compromising venous return, cardiac output, and blood pressure (see later discussion). The nurse considers any sudden changes in oxygen saturation or the onset of respiratory distress to be a life-threatening emergency requiring immediate action.

Pulmonary Infection. The patient is at high risk for infection, as described earlier. The nurse reports fever or a change in the color or odor of sputum to the primary provider for follow-up (see earlier discussion of VAP). Subglottic secretions may increase the patients' risk for the development of VAP. Patients expected to be intubated for longer than 72 hours may benefit from the use of an endotracheal tube with a subglottic suction port. This extra port that is connected to continuous suction (20 to 30 cm H_2O) allows for the removal of secretions above the cuff (Urden et al., 2018).

Delirium and Postintensive Care Syndrome. Patients who are critically ill are at risk for delirium during their time in the ICU. They are also at risk for cognitive impairment at a level consistent with mild dementia that may persist for months after they are discharged to the home setting. This critical illness-associated cognitive impairment is called postintensive care syndrome (PICS). The *A*wakening and *B*reathing *C*oordination, *D*elirium monitoring and management, *E*arly mobility, *F*amily engagement and empowerment (ABCDEF) bundle proposes an interdisciplinary process using evidence-based practice to manage delirium and weakness in the patient who is critically ill. It is believed that implementing this bundle can mitigate risks for delirium and possibly PICS. The goals of this bundle are to improve communication among members of the health care team, standardize care related to the assessment and use of sedation, provide nonpharmacologic interventions in the management of delirium, provide early exercise and ambulation, and incorporate family's concerns and participation in care planning (see Chart 19-16) (Marra, Ely, Pandharipande, et al., 2017).

Chart 19-16

The ABCDEF Bundle

The *A*wakening and *B*reathing *C*oordination, *D*elirium monitoring and management, *E*arly mobility, *F*amily engagement and empowerment bundle

Overview: Typically, patients on mechanical ventilators require some form of sedation or analgesia during their hospital stay. Recent studies suggest a correlation between the use of potent sedatives and analgesia and ICU-acquired delirium, oversedation, prolonged mechanical ventilation, and postintensive care syndrome (PICS).

Key components of each of the categories of the ABCDEF Bundle include:

1. *Awakening and spontaneous breathing trials*

Using predefined criteria:

- The nurse determines if it is safe to stop sedation.
- If determined safe, the nurse will determine if patient tolerated the sedation interruption.
- If the patient tolerated the interruption, the respiratory therapist will determine if the patient is a candidate for a breathing trial.
- If the patient is a candidate for a breathing trial, the respiratory therapist and nurse will evaluate the patient's response.

2. *Monitoring and management of delirium*

- The nurse assesses the patient at least every 2 to 4 hours using a sedation assessment scale (e.g., the CAM-ICU, see Chapter 11).

3. *Early Mobility*

The nurse assesses the patient using the following criteria for mobility:

- The patient is able to respond to verbal stimuli.
- The patient is receiving less than 60% FiO_2 and less than 10 cm of PEEP.
- The patient has no circulatory or central catheters or injuries that may contraindicate mobility.

4. *Family Engagement*

- The nurse encourages engagement of family members and ensures unrestricted access for a designated family support person.

ICU, intensive care unit; PEEP, positive end-expiratory pressure.

Adapted from Shay, A. (2018). Optimizing the ABCDEF bundle. *American Nurse Today*, *13*(7), 21–23.

Increasingly, patients are being cared for in extended care facilities or at home while receiving mechanical ventilation, with a tracheostomy tube, or receiving oxygen therapy. Patients receiving home ventilator care usually have a chronic neuromuscular condition or COPD. Providing the opportunity for patients who are ventilator dependent to return home to live with their families in familiar surroundings can be a positive experience. The ultimate goal of home ventilator therapy is to enhance the patient's quality of life, not simply to support or prolong life.

Educating Patients About Self-Care. Caring for the patient with mechanical ventilator support at home can be accomplished successfully. A home or transitional care team consisting of the nurse, physician, respiratory therapist, social service or home care agency, and equipment supplier is needed. The home is evaluated to determine whether the electrical equipment needed can be operated safely. Chart 19-17 summarizes the basic assessment criteria needed for successful home care.

Once the decision to initiate mechanical ventilation at home is made, the nurse prepares the patient and family for home care. The nurse educates the patient and family about the ventilator, suctioning, tracheostomy care, signs of pulmonary infection, cuff inflation and deflation, and assessment of vital signs. Education begins in the hospital and continues at home. Nursing responsibilities include evaluating the patient's and family's understanding of the information presented.

The nurse educates the family about cardiopulmonary resuscitation, including mouth-to-tracheostomy tube (instead of mouth-to-mouth) breathing. The family is also instructed how to handle a power failure, which usually involves converting the ventilator from an electrical power source to a battery power source. Conversion is automatic in most types of home ventilators and lasts approximately 1 hour. In addition, instructions are provided on the use of a manual self-inflation bag, should it be necessary. Chart 19-18 lists some of the patient's and family's responsibilities.

Chart 19-17

Criteria for Successful Home Ventilator Care

The decision to proceed with home ventilation therapy is usually based on the following parameters.

Patient Criteria

- The patient has a chronic underlying pulmonary or neuromuscular disorder.
- The patient's clinical pulmonary status is stable.
- The patient is willing to go home on mechanical ventilation.

Home Criteria

- The home environment is conducive to care of the patient.
- The electrical facilities are adequate to operate all equipment safely.
- The home environment is controlled, without drafts in cold weather and with proper ventilation in warm weather.
- Space is available for cleaning and storing ventilator equipment.

Family Criteria

- Family members are competent, dependable, and willing to spend the time required for proper training as primary caregivers.
- Family members understand the diagnosis and prognosis.
- Family has sufficient financial and supportive resources and can obtain professional support if necessary.

Chart 19-18 HOME CARE CHECKLIST

Ventilator Care

At the completion of education, the patient and/or caregiver will be able to:

- Name the procedure that was performed, as indicated, and how the patient's present status impacts physiologic functioning, ADLs, IADLs, relationships, and spirituality.
- State the name, dose, side effects, frequency, and schedule for all medications.
- State what types of changes are needed (if any) to maintain a clean home environment and prevent infection.
- State how to contact the primary provider, the team of home care professionals overseeing care, respiratory vendor and obtain supplies.
- Complete CPR training program for caregivers.
- Identify a plan for operation of ventilator and other devices during a power outage or other emergency.
- State proper care of patient on ventilator:
  - Observe physical signs such as color, secretions, breathing pattern, and state of consciousness.
  - Perform physical care such as suctioning, postural drainage, and ambulation.
  - Observe the tidal volume and pressure manometer regularly. Intervene when they are abnormal (i.e., suction if airway pressure increases).
  - Provide a communication method for the patient (e.g., pad and pencil, electric larynx, talking tracheostomy tube, and sign language).
  - Monitor vital signs as directed.
  - Use a predetermined signal to indicate when feeling short of breath or in distress.
- Care for and maintain equipment properly:
  - Check the ventilator settings twice each day and whenever the patient is removed from the ventilator.
  - Adjust the volume and pressure alarms if needed.
  - Fill humidifier as needed and check its level three times a day.
  - Empty water in tubing as needed.
  - Use a clean humidifier when circuitry is changed.
  - Keep exterior of ventilator clean and free of any objects.
  - Change external circuitry once a week or more often as indicated.
  - Report malfunction or strange noises immediately.

- Identify the contact details for support services for patients and their caregivers/families.

Resources

See Chapter 20, Figure 20-6 for additional information on postural drainage positions.

For the procedural guidelines for caring for a patient with a tracheostomy tube and performing tracheal suction, go to thepoint.lww.com/Brunner15e.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Continuing and Transitional Care. A home health or transitional care nurse monitors and evaluates how well the patient and family are adapting to providing care in the home. The nurse assesses the adequacy of the patient's ventilation and oxygenation as well as airway patency. The nurse addresses any unique adaptation problems that the patient may have and listens to the patient's and family's anxieties and frustrations, offering support and encouragement where possible. The nurse helps identify and contact community resources that may assist in home management of the patient with mechanical ventilation.

The technical aspects of the ventilator are managed by vendor follow-up. A respiratory therapist usually is assigned to the patient and makes home visits to evaluate the patient and perform a maintenance check of the ventilator as needed.

Transportation services are identified in case the patient requires transportation in an emergency. These arrangements must be made before an emergency arises.

Evaluation

Expected patient outcomes may include:

1. Exhibits adequate gas exchange, as evidenced by normal breath sounds, acceptable arterial blood gas levels, and vital signs
2. Demonstrates adequate ventilation with minimal mucus accumulation
3. Is free of injury or infection, as evidenced by normal temperature, white blood cell count, and clear sputum
4. Is mobile within limits of ability
   a. Gets out of bed to chair, bears weight, or ambulates as soon as possible
   b. Performs range-of-motion exercises every 6 to 8 hours

5. Communicates effectively through written messages, gestures, or other communication strategies
6. Copes effectively
    a. Verbalizes fears and concerns about condition and equipment
    b. Participates in decision making when possible
    c. Uses stress reduction techniques when necessary
7. Absence of complications
    a. Absence of cardiac compromise, as evidenced by stable vital signs and adequate urine output
    b. Absence of pneumothorax, as evidenced by bilateral chest excursion, normal chest x-ray, and adequate oxygenation
    c. Absence of pulmonary infection, as evidenced by normal temperature, clear pulmonary secretions, and negative sputum cultures
    d. Absence of delirium and of postintensive care syndrome, as evidenced by no patient-ventilator dyssynchrony, and being oriented to person, place, and time

Weaning the Patient from the Ventilator

Respiratory weaning, the process of withdrawing the patient from dependence on the ventilator, takes place in three stages: the patient is gradually removed from the ventilator, then from either the ET or tracheostomy tube, and finally from oxygen. Weaning from mechanical ventilation is performed at the earliest possible time consistent with patient safety. The decision must be made from a physiologic rather than a mechanical viewpoint. A thorough understanding of the patient's clinical status is required in making this decision. Weaning is started when the patient is physiologically and hemodynamically stable, demonstrates spontaneous breathing capability, recovering from the acute stage of medical and surgical problems, and when the cause of respiratory failure is sufficiently reversed (Wiegand, 2017). Chart 19-19 presents information about patient care during weaning from mechanical ventilation.

Successful weaning involves collaboration among the primary provider, respiratory therapist, and nurse. Each health care provider must understand the scope and function of other team members in relation to patient weaning to conserve the patient's strength, use resources efficiently, and maximize successful outcomes.

Criteria for Weaning

Careful assessment is required to determine whether the patient is ready to be removed from mechanical ventilation. If the patient is stable and showing signs of improvement or reversal of the disease or condition that caused the need for mechanical ventilation, weaning indices should be assessed (see Chart 19-19).

Stable vital signs and arterial blood gases are also important predictors of successful weaning. Once readiness has been determined, the nurse records baseline measurements of weaning indices to monitor progress.

Patient Preparation

To maximize the likelihood of success of weaning, the nurse must consider the patient as a whole, taking into account factors that impair the delivery of oxygen and elimination of carbon dioxide as well as those that increase oxygen demand (e.g., sepsis, seizures, thyroid imbalances) or decrease the patient's overall strength (e.g., inadequate nutrition, neuromuscular disease). Adequate psychological preparation is necessary before and during the weaning process.

Methods of Weaning

Successful weaning depends on the combination of adequate patient preparation, available equipment, and an interdisciplinary approach to solve patient problems (see Chart 19-19). All usual modes of ventilation can be used for weaning.

CPAP (also known as spontaneous mode ventilation in this context) allows the patient to breathe spontaneously while applying positive pressure throughout the respiratory cycle to keep the alveoli open and promote oxygenation. Providing CPAP during spontaneous breathing also offers the advantage of an alarm system and may reduce patient anxiety if the patient has been taught that the machine is keeping track of breathing. It also maintains lung volumes and improves the patient's oxygenation status. CPAP is often used in conjunction with PSV. Nurses should carefully assess for

tachypnea, tachycardia, reduced tidal volumes, decreasing oxygen saturations, and increasing carbon dioxide levels.

Chart 19-19

Care of the Patient Being Weaned from Mechanical Ventilation

1. Assess patient for weaning criteria:
   a. Vital capacity: 10 to 15 mL/kg
   b. Maximum inspiratory pressure (MIP) at least –20 cm H_2O
   c. Tidal volume: 7 to 9 mL/kg
   d. Minute ventilation: 6 L/min
   e. Rapid/shallow breathing index: Below 100 breaths/min/L; PaO_2 >60 mm Hg with FiO_2 <40%
2. Monitor activity level, assess dietary intake, and monitor results of laboratory tests of nutritional status. Reestablishing independent spontaneous ventilation can be physically exhausting. It is crucial that the patient have enough energy reserves to succeed.
3. Assess the patient's and family's understanding of the weaning process and address any concerns about the process. Explain that the patient may feel short of breath initially and provide encouragement as needed. Reassure the patient that they will be attended closely and that if the weaning attempt is not successful, it can be tried again later.
4. Implement the weaning method as prescribed (e.g., continuous positive airway pressure [CPAP] and T-piece).
5. Monitor vital signs, pulse oximetry, electrocardiogram, and respiratory pattern constantly for the first 20 to 30 minutes and every 5 minutes after that until weaning is complete. Monitoring the patient closely provides ongoing indications of success or failure.
6. Maintain a patent airway; monitor arterial blood gas levels and pulmonary function tests. Suction the airway as needed.
7. In collaboration with the primary provider, terminate the weaning process if adverse reactions occur. These include a heart rate increase of 20 bpm, systolic blood pressure increase of 20 mm Hg, a decrease in oxygen saturation to <90%, respiratory rate <8 or >20 breaths/min, ventricular arrhythmias, fatigue, panic, cyanosis, erratic or labored breathing, paradoxical chest movement.
8. If the weaning process continues, measure tidal volume and minute ventilation every 20 to 30 minutes; compare with the patient's desired values, which have been determined in collaboration with the primary provider.
9. Assess for psychological dependence if the physiologic parameters indicate that weaning is feasible and the patient still resists. Possible causes of psychological dependence include fear of dying and depression from chronic illness. It is important to address this issue before the next weaning attempt.

Adapted from Wiegand, D. J. L. (2017). *AACN procedure manual for critical care* (6th ed.). St. Louis, MO: Elsevier Saunders.

SIMV can also be used as a weaning method. The patient is placed on SIMV mode of ventilation and the rate is slowly decreased by 1 to 3 breaths/min until the patient is fully breathing on their own (Urden et al., 2018).

Furthermore, T-piece spontaneous breathing trials can also be used. When the patient can breathe spontaneously, weaning trials using a T-piece for the patient with an ET tube or tracheostomy mask for the patient with a tracheostomy tube (see Fig. 19-6) are normally conducted with the patient disconnected from the ventilator, receiving humidified oxygen only and performing all work of breathing. Because patients do not have to overcome the resistance of the ventilator, they may find this mode more comfortable, or they may become anxious as they breathe with no support from the ventilator. During these trial periods, the nurse monitors the patient closely and provides encouragement. This method of weaning is usually used when the patient is awake and alert, is breathing without difficulty, has good gag and cough reflexes, and is hemodynamically stable. During the weaning process, the patient is maintained on the same or a higher oxygen concentration than when receiving mechanical ventilation. While the patient is using the T-piece or tracheostomy mask, they are observed for signs and symptoms of hypoxia, increasing respiratory muscle fatigue, or systemic fatigue. These include restlessness, increased respiratory rate (greater than 35 breaths/min), the use of accessory muscles, tachycardia with premature ventricular contractions, and paradoxical chest movement (asynchronous breathing, chest contraction during inspiration and expansion during expiration). Fatigue or exhaustion is initially manifested by an increased respiratory rate associated with a gradual reduction in tidal volume; later there is a slowing of the respiratory rate.

If the patient appears to be tolerating the T-piece/tracheostomy mask trial, a second set of arterial blood gas measurements is drawn 20 minutes after the patient has been on spontaneous ventilation at a constant FiO_2 PSV. (Alveolar–arterial equilibration takes 15 to 20 minutes to occur.)

Signs of exhaustion and hypoxia correlated with deterioration in the blood gas measurements indicate the need for ventilatory support. The patient is placed back on the ventilator each time signs of fatigue or deterioration develop.

If clinically stable, the patient usually can be extubated within 2 or 3 hours after weaning and allowed spontaneous ventilation by means of a mask with humidified oxygen. Patients who have had prolonged ventilatory assistance usually require more gradual weaning; it may take days or even weeks. They are weaned primarily during the day and placed back on the ventilator at night to rest.

Because patients respond in different manners to weaning methods, there is no definitive way to assess which method is best. Regardless of the weaning method being used, ongoing assessment of respiratory status is essential to monitor patient progress.

Successful weaning from the ventilator is supplemented by intensive pulmonary care. The following methods are used: oxygen therapy; arterial blood gas evaluation; pulse oximetry; bronchodilator therapy; CPT; adequate nutrition, hydration, and humidification; blood pressure measurement; and incentive spirometry. Daily spontaneous breathing trials may be used to evaluate the patient's ability to breathe without ventilatory support. If the patient is receiving IV sedatives (e.g., propofol, dexmedetomidine), current guidelines recommend that the patient's sedative dose be decreased by 25% to 50% prior to weaning. In order to decrease agitation in patients who do not tolerate withdrawal of sedation, dexmedetomidine may be initiated for spontaneous breathing trials without causing significant respiratory depression (Devlin, Skrobik, Gélinas, et al., 2018; Urden et al., 2018). A patient may still have borderline

pulmonary function and need vigorous supportive therapy before their respiratory status returns to a level that supports activities of daily living.

Removal of the Tracheostomy Tube

Removal of the tracheostomy tube is considered when the patient can breathe spontaneously; maintain an adequate airway by effectively coughing up secretions, swallow, and move the jaw. Secretion clearance and aspiration risks are assessed to determine whether active pharyngeal and laryngeal reflexes are intact.

Once the patient can clear secretions adequately, a trial period of mouth breathing or nose breathing is conducted. This can be accomplished by several methods. The first method requires changing to a smaller size tube to increase the resistance to airflow or plugging the tracheostomy tube (deflating the cuff first). The smaller tube is sometimes replaced by a cuffless tracheostomy tube, which allows the tube to be plugged at lengthening intervals to monitor patient progress. A second method involves changing to a fenestrated tube (a tube with an opening or window in its bend). This permits air to flow around and through the tube to the upper airway and enables talking. A third method involves switching to a smaller tracheostomy button (stoma button). A tracheostomy button is a plastic tube approximately 1 inch long that helps keep the windpipe open after the larger tracheostomy tube has been removed. Finally, when the patient demonstrates the ability to maintain a patent airway, the tube can be removed. An occlusive dressing is placed over the stoma, which heals in several days to weeks.

Weaning from Oxygen

The patient who has been successfully weaned from the ventilator, cuff, and tube and has adequate respiratory function is then weaned from oxygen. The FiO_2 is gradually reduced until the PaO_2 is in the range of 70 to 100 mm Hg while the patient is breathing room air. If the PaO_2 is less than 70 mm Hg on room air, supplemental oxygen is recommended. To be eligible for financial reimbursement from the Centers for Medicare and Medicaid Services (CMS) for in-home oxygen, the patient must have a PaO_2 at or less than 55 mm Hg while awake and at rest or arterial oxygen saturation at or below 88%, breathing room air (American Association of Respiratory Care, 2007; CMS, 1993).

Nutrition

Success in weaning the patient who is long-term ventilator dependent requires early and aggressive but judicious nutritional support. The respiratory muscles (diaphragm and especially intercostals) become weak or atrophied after just a few days of mechanical ventilation and may be catabolized for energy, especially if nutrition is inadequate. Compensation for inadequate nutrition must be undertaken with care; excessive intake can increase the production of carbon dioxide and the demand for oxygen and lead to prolonged ventilator dependence and difficulty in weaning. Because the metabolism of fat produces less carbon dioxide than the metabolism of carbohydrates, it was long presumed that a high-fat and limited carbohydrate diet would be most therapeutic; however, evidence-based findings do not support its efficacy (Seres, 2020). Adequate protein intake is important in increasing respiratory muscle strength. Protein intake should be approximately 25% of total daily kilocalories, or 1.2 to 1.5 g/kg/day. Daily nutrition should be closely monitored.

Soon after the patient is admitted, a consultation with a dietitian or nutrition support team should be arranged to plan the best form of nutritional replacement. Adequate nutrition may decrease the duration of mechanical ventilation and prevent other complications, especially sepsis. Sepsis can occur if bacteria enter the bloodstream and release toxins that, in turn, cause vasodilation and hypotension, fever, tachycardia, increased respiratory rate, and coma. Aggressive treatment of sepsis is essential to reverse this threat to survival and to promote weaning from the ventilator when the patient's condition improves.

Acute Respiratory Distress Syndrome

Acute respiratory distress syndrome (ARDS) can be thought of as a spectrum of disease, progressing from mild to moderate to its most severe, fulminant form. **Acute lung injury** is a term commonly used to describe mild ARDS. ARDS is a clinical syndrome characterized by a severe inflammatory process causing diffuse alveolar damage that results in sudden and progressive pulmonary edema, increasing bilateral infiltrates on chest x-ray, hypoxemia unresponsive to oxygen supplementation regardless of the amount of PEEP, and the absence of an elevated left atrial pressure (Siegel, 2019a). Patients often demonstrate reduced lung compliance. A wide range of factors are associated with the development of ARDS (see Chart 19-20), including direct injury to the lungs (e.g., smoke inhalation) or indirect insult to the lungs (e.g., shock). ARDS has been associated with a mortality rate ranging from 27% to 50%. Patients who survive the initial cause of ARDS may die later, commonly from HCAP or sepsis (Anesi, 2020; Siegel, 2019a).

Chart 19-20 RISK FACTORS

Acute Respiratory Distress Syndrome

- Aspiration (gastric secretions, drowning, hydrocarbons)
- COVID-19 pneumonia
- Drug ingestion and overdose
- Fat or air embolism
- Hematologic disorders (disseminated intravascular coagulation, massive transfusions, cardiopulmonary bypass)
- Localized infection (bacterial, fungal, viral pneumonia)
- Major surgery
- Metabolic disorders (pancreatitis, uremia)
- Prolonged inhalation of high concentrations of oxygen, smoke, or corrosive substances
- Sepsis
- Shock (any cause)
- Trauma (pulmonary contusion, multiple fractures, head injury)

COVID-19, coronavirus disease 2019.

Adapted from Cascella, M., Rajnik, M., Cuomo, A., et al. (2020). Features, evaluation and treatment Coronavirus (COVID-19). *StatPearls*. Treasure Island, FL: StatPearls Publishing. Retrieved on 6/9/2020 at: www.ncbi.nlm.nih.gov/books/NBK554776/; Siegel, M. D. (2019a). Acute respiratory distress syndrome: Epidemiology, pathophysiology, pathology, and etiology in adults. *UpToDate*. Retrieved on 9/23/2019 at: www.uptodate.com/contents/acute-respiratory-distress-syndrome-epidemiology-pathophysiology-pathology-and-etiology-in-adults

Quality and Safety Nursing Alert

Be alert for the development of acute lung injury in the patient population using e-cigarettes, also known as vaping. This syndrome is called e-cigarette or vaping associated acute lung injury (EVALI). According to the CDC (2019c), patients diagnosed with EVALI have been identified in most states.

Pathophysiology

Inflammatory triggers initiate the release of cellular and chemical mediators, causing injury to the alveolar capillary membrane in addition to other structural damage to the lungs. Severe V./Q. mismatching occurs. Alveoli collapse because of the inflammatory infiltrate, blood, fluid, and surfactant dysfunction. Small airways are narrowed because of interstitial fluid and bronchial obstruction. Lung compliance may markedly decrease, resulting in decreased functional residual capacity and severe hypoxemia. The blood returning to the lung for gas exchange is pumped through the nonventilated, nonfunctioning areas of the lung, causing shunting. This means that blood is interfacing with nonfunctioning alveoli and gas exchange is markedly impaired, resulting in severe, refractory hypoxemia. Figure 19-9 shows the sequence of pathophysiologic events leading to ARDS.

Clinical Manifestations

Initially, ARDS closely resembles severe pulmonary edema. The acute phase of ARDS is marked by a rapid onset of severe dyspnea that usually occurs less than 72 hours after the precipitating event. Arterial hypoxemia that does not respond to supplemental oxygen is characteristic. ARDS is classified according to the severity of hypoxemia experienced by the patient as (Siegel, 2019a):

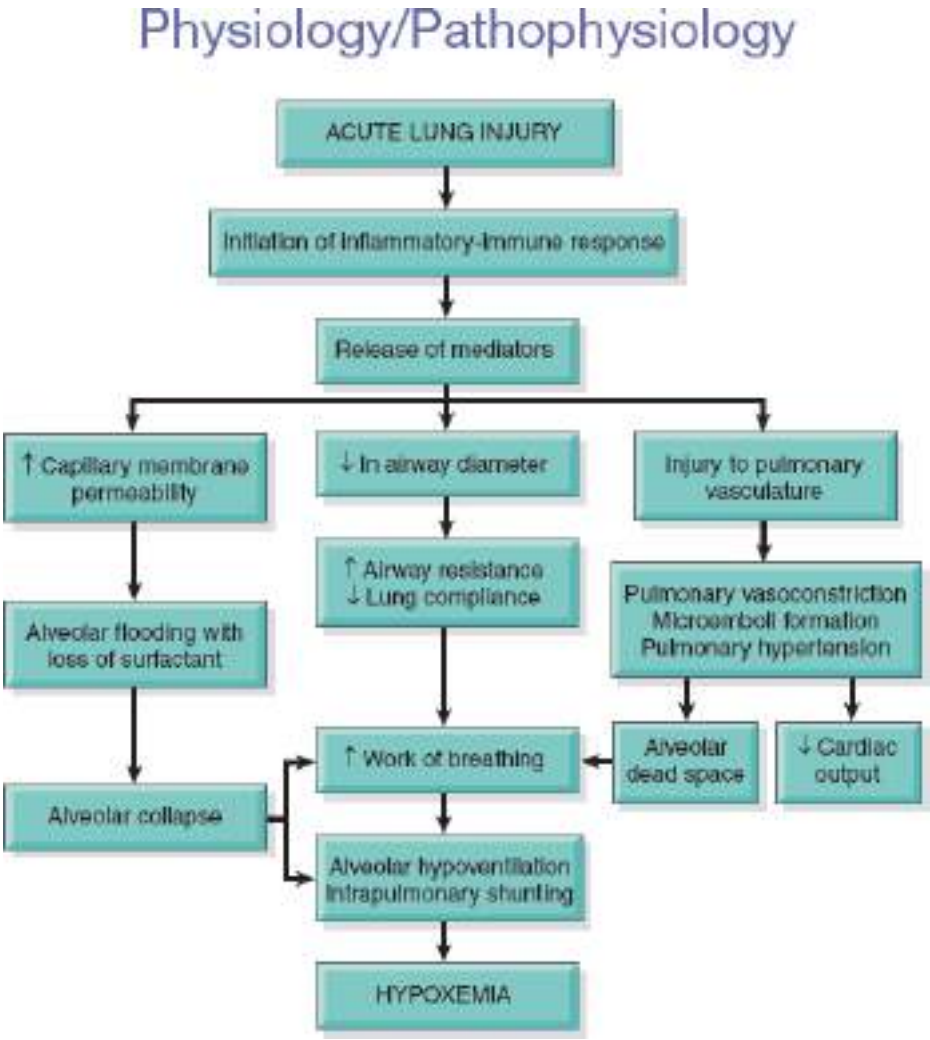


Figure 19-9 • Pathogenesis and pathophysiology of acute respiratory distress syndrome.

- mild ARDS, with arterial oxygen tension (PaO_2)/fraction of inspired oxygen (FIO_2) > 200 mm Hg but ≤300 mm Hg,
- moderate ARDS, with PaO_2/FIO_2 > 100 mm Hg but ≤200 mm Hg, or
- severe ARDS, with PaO_2/FIO_2 ≤ 100 mm Hg.

Findings on chest x-ray are similar to those seen with cardiogenic pulmonary edema and are visible as bilateral infiltrates that quickly worsen. Mild ARDS progresses to fibrosing alveolitis with persistent, severe hypoxemia. The patient also has increased alveolar dead space (ventilation to alveoli but poor perfusion) and typically has

decreased pulmonary compliance ("stiff lungs," which are difficult to ventilate). Clinically, the patient is thought to be in the recovery phase if the hypoxemia gradually resolves, the chest x-ray improves, and the lungs become more compliant.

Assessment and Diagnostic Findings

On physical examination, intercostal retractions and crackles may be present as the fluid begins to leak into the alveolar interstitial space. Common diagnostic tests performed in patients with potential ARDS include plasma brain natriuretic peptide (BNP) levels, echocardiography, and pulmonary artery catheterization. The BNP level is helpful in distinguishing ARDS from cardiogenic pulmonary edema. Transthoracic echocardiography may be used if the BNP is not conclusive.

Medical Management

The primary focus in the management of ARDS includes identification and treatment of the underlying condition. Aggressive, supportive care must be provided to compensate for the severe respiratory dysfunction. This supportive therapy almost always includes ET intubation and mechanical ventilation. In addition, circulatory support, adequate fluid volume, and nutritional support are important. Supplemental oxygen is used as the patient begins the initial spiral of hypoxemia. As the hypoxemia progresses, intubation and mechanical ventilation are instituted. The concentration of oxygen and ventilator settings and modes are determined by the patient's status. This is monitored by arterial blood gas analysis, pulse oximetry, and bedside pulmonary function testing.

Providing ventilatory PEEP support is a critical part of the treatment of ARDS. PEEP usually improves oxygenation, but it does not influence the natural history of the syndrome. The use of PEEP helps increase functional residual capacity and reverse alveolar collapse by keeping the alveoli open, resulting in improved arterial oxygenation and a reduction in the severity of the V./Q. imbalance. By using PEEP, a lower FiO_2 may be required. The goal is a PaO_2 greater than 60 mm Hg or an oxygen saturation level of greater than 90% at the lowest possible FiO_2.

Systemic hypotension may occur in ARDS as a result of hypovolemia secondary to leakage of fluid into the interstitial spaces and depressed cardiac output from high levels of PEEP therapy. Hypovolemia must be carefully treated without causing further overload. Inotropic or vasopressor agents may be required. Additional supportive treatments may include prone positioning, sedation, paralysis, and nutritional support (Siegel, 2019b).

Pharmacologic Therapy

There is no specific pharmacologic treatment of ARDS except supportive care. Neuromuscular blocking agents, sedatives, and analgesics may be used to improve patient–ventilator synchronization and help to decrease severe hypoxemia (see later discussion in Ventilator Considerations section). Inhaled nitric oxide (an endogenous vasodilator) was thought to reduce V./Q. mismatch and improve oxygenation; however, findings from clinical trials have not shown an improvement in mortality rates between patients who did and did not receive nitric oxide (Harman, 2018).

Nutritional Therapy

Adequate nutritional support is vital in the treatment of ARDS. Patients with ARDS require 35 to 45 kcal/kg/day to meet caloric requirements. Enteral feeding is the first consideration; however, parenteral nutrition also may be required.

Nursing Management

General Measures

A patient with ARDS is critically ill and requires close monitoring in an ICU. Respiratory modalities used in this situation include oxygen administration, nebulizer therapy, CPT, ET intubation or tracheostomy, mechanical ventilation, suctioning, and bronchoscopy. Frequent assessment of the patient's status is necessary to evaluate the effectiveness of treatment.

In addition to supporting the medical plan of care, the nurse considers other needs of the patient. Positioning is important. The nurse turns the patient frequently to improve ventilation and perfusion in the lungs and enhance secretion drainage. However, the nurse must closely monitor the patient for deterioration in oxygenation with changes in position. Oxygenation in patients with ARDS is sometimes improved in the prone position; this seems to be particularly true for patients with COVID-19 and ARDS (see later discussion). This position may be evaluated for improvement in oxygenation and used in special circumstances. Devices and specialty beds are available to assist the nurse in placing the patient in a prone position.

The patient is extremely anxious and agitated because of the increasing hypoxemia and dyspnea. It is important to reduce the patient's anxiety because anxiety increases oxygen expenditure by preventing rest. Rest is essential to limit oxygen consumption and reduce oxygen needs.

Ventilator Considerations

Several considerations must be addressed for the patient intubated and receiving mechanical ventilation with PEEP. PEEP, which causes increased end-expiratory pressure, is an unnatural pattern of breathing and feels strange to the patient. The patient may be anxious, and patient-ventilator dyssynchrony may be the consequence. Nursing assessment is important to identify problems with ventilation that may be causing the anxiety reaction: tube blockage by kinking or retained secretions, other acute respiratory problems (e.g., pneumothorax and pain), a sudden decrease in the oxygen level, the level of dyspnea, or ventilator malfunction. In some cases, sedation may be required to decrease the patient's oxygen consumption, allow the ventilator to provide full support of ventilation, and decrease the patient's anxiety. Sedatives that may be prescribed are lorazepam, midazolam, dexmedetomidine, propofol, and short-acting barbiturates.

If the PEEP level cannot be maintained despite the use of sedatives, neuromuscular blocking agents (paralytic agents) may be given to paralyze the patient. Examples of these agents include pancuronium, vecuronium, atracurium, and rocuronium. The resulting paralysis allows the patient to be ventilated more easily. With paralysis, the patient appears to be unconscious; loses motor function; and cannot breathe, talk, or blink independently. However, the patient retains sensation and is awake and able to

hear. The nurse must reassure the patient that the paralysis is a result of the medication and is temporary. Paralysis should be used for the shortest possible time and never without adequate sedation and pain management.

Peripheral nerve stimulators are used to assess nerve impulse transmissions at the neuromuscular junction of select skeletal muscles when neuromuscular blocking agents are used. A "train-of-four" test may be used to measure the level of neuromuscular blockade. With this test, four consecutive stimuli are delivered along the path of a nerve, and the response of the muscle is measured in order to evaluate whether or not stimuli are effectively blocked. Four equal muscle contractions, seen as "twitches," will result if there is no neuromuscular blockade. However, if neuromuscular blockade is present, there will be a loss of twitch height and number, which will indicate the degree of blockade. If all four stimulations result in an absence of twitches, it is estimated that 100% of the receptors are blocked (Wiegand, 2017).

The use of neuromuscular blocking agents has many dangers and side effects. The nurse must be sure the patient does not become disconnected from the ventilator, because respiratory muscles are paralyzed and the patient will be apneic. Consequently, the nurse ensures that the patient is closely monitored; all ventilator and patient alarms must be on at all times. Eye care is important as well, because the patient cannot blink, increasing the risk of corneal abrasions. Neuromuscular blockers predispose the patient to venous thromboembolism (VTE), muscle atrophy, foot drop, stress ulcers that may cause hemorrhage, and skin breakdown.

Quality and Safety Nursing Alert

Nursing assessment is essential to minimize the complications related to neuromuscular blockade. The patient may have discomfort or pain but cannot communicate these sensations. In addition, frequent oral care and suctioning may be needed.

Analgesia must be given concurrently with neuromuscular blocking agents (Saenz, 2019). The nurse must anticipate the patient's needs regarding pain and comfort. The nurse checks the patient's position to ensure it is comfortable without excessive pressure points and in normal alignment. Talking to and not about the patient while in the patient's presence is important.

In addition, the nurse must describe the purpose and effects of the neuromuscular blocking agents to the patient's family. If family members are unaware that these agents have been given, they may become distressed by the change in the patient's status.

COVID-19 Considerations

The most serious complication and most frequent cause of death among patients with COVID-19 is ARDS (Anesi, 2020). In China, where the SARS-CoV-2 virus first emerged, approximately one quarter of patients who were hospitalized in the early days of the pandemic required treatment in critical care units, the majority with respiratory

failure and ARDS. Of these, 52.4% died secondary to complications of ARDS (Niederman, Richeldi, Chotirmall, et al., 2020; Wu & McGoogan, 2020).

The pathogenesis of ARDS in patients with COVID-19 pneumonia appears to have some differences from other cases of ARDS. In particular, although there is evidence of damage to epithelial cells within alveoli, epithelial cells within the pulmonary endothelium are not damaged, resulting in less exudative pathologic changes than with other types of ARDS. In terms of clinical manifestations, some patients with severe COVID-19 pneumonia do not voice complaints of dyspnea but nonetheless may deteriorate rapidly into respiratory failure. Furthermore, some patients with COVID-19 and ARDS who are mechanically ventilated do not exhibit the poor lung compliance that is a classic manifestation of typical ARDS. In addition, the onset of most non-COVID-19 cases of ARDS is typically one week or less from the time of the causative insult; however, the median time from onset of COVID-19 symptoms to ARDS is longer, at between 8 to 12 days (Li & Ma, 2020).

The same classification system used to diagnosis other cases of ARDS is used to classify patients with COVID-19 pneumonia with ARDS (i.e., as having mild, moderate, or severe ARDS) (Cascella et al., 2020). Many of the same strategies used to manage patients without COVID-19 who have ARDS apply to the patient with COVID-19 and ARDS. For instance, it is recommended that the patient with COVID-19 and ARDS who is mechanically ventilated receive low tidal volumes (i.e., 4 to 8 mL/kg ideal body weight). However, there are some specific differences in the recommended treatment of the adult with COVID-19 and ARDS who is mechanically ventilated, which include the following (Alhazzani, Moller, Arabi, et al., 2020; Anesi, 2020):

- PEEP > 5 cm H_2O should be delivered (although the patient should be closely monitored for barotrauma if the PEEP is >10 cm H_2O);
- Low dosages of intravenous corticosteroids (e.g., dexamethasone, methylprednisolone) may be prescribed;
- Nitric oxide should not be routinely prescribed; however, for patients with severe ARDS refractory to other treatments, nitric oxide might be tried;
- For the patient with moderate or severe ARDS, prone positioning for 12 to 16 hours daily is recommended, if feasible; and
- For the patient with moderate or severe ARDS, intermittent boluses of neuromuscular blocking agents are preferred over continuous infusions, unless there is persistent patient-ventilator dyssynchrony.

Other treatments recommended for patients with severe COVID-19 pneumonia should also be followed (see previous discussion on COVID-19 pneumonia).

It has been reported that more patients with COVID-19 and ARDS who are mechanically ventilated have neurologic impairment (e.g., delirium, encephalopathy) than other patients with ARDS who are mechanically ventilated. Therefore, sedative requirements for these patients are reportedly higher than for most other patients with ARDS (Anesi, 2020). These neurologic manifestations are that much more difficult to manage because family members and friends, who may be a source of solace to the patient who is agitated, are typically not permitted to visit. Furthermore, the nurse caring for these patients must also practice isolation precautions and minimize interactions with the patient, which can serve to make the patient feel more isolated and agitated.

PULMONARY VASCULAR DISORDERS

Pulmonary Edema (Noncardiogenic)

Pulmonary edema is defined as abnormal accumulation of fluid in the lung tissue, the alveolar space, or both. It is a severe, life-threatening condition. Pulmonary edema can be classified as cardiogenic or noncardiogenic (see Chapter 25 for further discussion of cardiogenic pulmonary edema). Noncardiogenic pulmonary edema occurs due to damage of the pulmonary capillary lining. It may be due to direct injury to the lung (e.g., chest trauma, aspiration, and smoke inhalation), hematogenous injury to the lung (e.g., sepsis, pancreatitis, multiple transfusions, cardiopulmonary bypass), or injury plus elevated hydrostatic pressures. Management of noncardiogenic pulmonary edema mirrors that of cardiogenic pulmonary edema; however, hypoxemia may persist despite high concentrations of supplemental oxygen, due to the intrapulmonary shunting of blood.

Pulmonary Hypertension

Pulmonary hypertension (PH) is characterized by elevated pulmonary arterial pressure greater than 25 mm Hg at rest and greater than 30 mm Hg with exercise and secondary right heart ventricular failure (Rubin & Hopkins, 2019). It may be suspected in a patient with dyspnea with exertion without other clinical manifestations. Unlike systemic blood pressure, the pulmonary pressures cannot be measured indirectly. In the absence of these measurements, clinical recognition becomes the only indicator of PH. However, PH is a condition that is often not clinically evident until late in its progression. Patients are classified by the World Health Organization (WHO) into five groups based upon the mechanism of PH (Rubin & Hopkins, 2019) (see Chart 19-21).

Pathophysiology

Conditions such as collagen vascular disease, congenital heart disease, anorexigens (specific appetite depressants), chronic use of stimulants, portal hypertension, and HIV infection increase the risk of PH in susceptible patients. Vascular injury occurs with endothelial dysfunction and vascular smooth muscle dysfunction, which leads to disease progression (vascular smooth muscle hypertrophy, adventitial and intimal proliferation [thickening of the wall], and advanced vascular lesion formation). Normally, the pulmonary vascular bed can handle the blood volume delivered by the right ventricle. It has a low resistance to blood flow and compensates for increased blood volume by dilation of the vessels in the pulmonary circulation. However, if the pulmonary vascular bed is destroyed or obstructed, as in PH, the ability to handle whatever flow or volume of blood it receives is impaired, and the increased blood flow then increases the pulmonary artery pressure. As the pulmonary arterial pressure increases, the pulmonary vascular resistance also increases. Both pulmonary artery constriction (as in hypoxemia or hypercapnia) and a reduction of the pulmonary

vascular bed (which occurs with PE) result in increased pulmonary vascular resistance and pressure. This increased workload affects right ventricular function. The myocardium ultimately cannot meet the increasing demands imposed on it, leading to right ventricular hypertrophy (enlargement and dilation) and failure. Passive hepatic congestion may also develop.

Chart 19-21

Clinical Classification of Pulmonary Hypertension (PH)

Group 1: Pulmonary Arterial Hypertension (PAH)

- Sporadic idiopathic PAH
- Heritable idiopathic PAH
- Drug and toxin-induced PAH
- PAH due to diseases such as connective tissues disorders, HIV infection, portal hypertension, congenital heart disease

Group 2: PH due to left heart disease

- Systolic dysfunction
- Diastolic dysfunction
- Valvular heart disease

Group 3: PH due to chronic lung diseases and/or hypoxemia

- Chronic obstructive pulmonary disease
- Interstitial lung disease
- Mixed restrictive and obstructive lung disease
- Sleep disordered breathing

Group 4: Chronic thromboembolic pulmonary hypertension (CTEPH)

- Due to thromboembolic occlusion of the proximal or distal pulmonary vasculature

Group 5: PH with unclear multifactorial mechanisms

- Hematologic disorders
- Systemic disorders (e.g., sarcoidosis)
- Metabolic disorders

Adapted from Rubin, L., & Hopkins, W. (2019). Overview of pulmonary hypertension in adults. *UpToDate.* Retrieved on 8/22/2019 at: www.uptodate.com/contents/overview-of-pulmonary-hypertension-in-adults

Clinical Manifestations

Dyspnea, the main symptom of PH, occurs at first with exertion and eventually at rest. Substernal chest pain also is common. Other signs and symptoms include weakness, fatigue, syncope, occasional hemoptysis, and signs of right-sided heart failure (peripheral edema, ascites, distended neck veins, liver engorgement, crackles, heart murmur). Anorexia and abdominal pain in the right upper quadrant may also occur.

Assessment and Diagnostic Findings

Diagnostic testing is used to confirm that PH exists, determine its severity, and identify its causes. Initial diagnostic evaluation includes a history, physical examination, chest x-ray, pulmonary function studies, electrocardiogram (ECG), and echocardiogram. Echocardiography can be used to estimate the pulmonary artery systolic pressure and to assess right ventricular size, thickness, and function. It can also evaluate the right atrial size, left ventricular system, and diastolic function as well as valve function. Right heart catheterization is necessary to confirm the diagnosis of PH and to accurately assess the hemodynamic abnormalities. PH is confirmed with a mean pulmonary artery pressure greater than 25 mm Hg. If left heart disease is identified via echocardiography and correlates with the degree of estimated PH, then exercise testing and both a right and left heart catheterization may be done to determine the functional severity of the disease and the abnormalities in pressures (left heart filling, pulmonary vascular resistance, transpulmonary gradient) (Rubin & Hopkins, 2019).

Pulmonary function studies may be normal or show a slight decrease in vital capacity and lung compliance, with a mild decrease in the diffusing capacity. The PaO_2 also is decreased (hypoxemia). The ECG reveals right ventricular hypertrophy, right axis deviation, and tall peaked P waves in inferior leads; tall anterior R waves; and ST-segment depression, T-wave inversion, or both anteriorly. An echocardiogram can assess the progression of the disease and rule out other conditions with similar signs and symptoms. A V./Q. scan or pulmonary angiography detects defects in pulmonary vasculature, such as PE.

Medical Management

The primary goal of treatment is to manage the underlying condition related to PH if the cause is known. Recommendations regarding therapy are tailored to the patient's individual situation, functional New York Heart Association class, and specific needs (Rubin & Hopkins, 2019). All patients with PH should be considered for the following therapies: diuretics, oxygen, anticoagulation, digoxin, and exercise training. Diuretics and oxygen should be added as needed. Appropriate oxygen therapy reverses the vasoconstriction and reduces the PH in a relatively short time. Most patients with PH do not have hypoxemia at rest but require supplemental oxygen with exercise. Anticoagulation should be considered for patients at risk for intrapulmonary thrombosis. Digoxin may improve right ventricular ejection fraction in some patients and may help to control heart rate; however, patients must be monitored closely for potential complications (Rubin & Hopkins, 2019).

Pharmacologic Therapy

Recent advances in pharmacologic management and medication delivery options have offered more effective treatment regimens for patients affected with PH. Medications prescribed to treat PH include calcium channel blockers and specific pathogenetic therapies, including prostanoids, endothelin receptor antagonists, phosphodiesterase-5 inhibitors, and soluble guanylate cyclase stimulants. The choice of therapeutic agents is based on many facets, including the classification group status of the patient with PH (see Chart 19-21), as well as the cost and the patient's tolerance of the agents (Hopkins

& Rubin, 2019). In addition, a vasoreactivity test may be done to identify which medication is best suited for the patient with PH; this is done during cardiac catheterization using vasodilating medications such as inhaled nitric oxide, adenosine, or prostacyclin. A positive vasoreactivity test occurs when there is a decrease of at least 10 mm Hg in the pulmonary artery pressure with an overall pressure that is less than 40 mm Hg in the presence of both an increased or unchanged cardiac output and a minimally decreased or unchanged systemic blood pressure (Hopkins & Rubin, 2019).

Patients with a positive vasoreactivity test and who do not have right-sided heart failure may be prescribed calcium channel blockers. Calcium channel blockers have a significant advantage over some medications taken to treat PH in that they may be taken orally and are generally less costly; however, because calcium channel blockers are indicated in only a small percentage of patients, other treatment options, including prostanoids, are often necessary (Hopkins & Rubin, 2019).

Prostanoids mimic the effect of the prostaglandin prostacyclin. Prostacyclin relaxes vascular smooth muscle by stimulating the production of cyclic 3′,5′-adenosine monophosphate (AMP) and inhibits the growth of smooth muscle cells. Prostanoids used to treat PH include epoprostenol, iloprost, treprostinil, and selexipag. Limitations of the prostanoids include their short half-life and variable patient responses to therapy (Hopkins & Rubin, 2019). IV epoprostenol was the first FDA-approved prostanoid and is the most widely studied advanced therapy for PH. Epoprostenol has a half-life of less than 3 minutes and must be continuously delivered through a permanently implanted central venous catheter using a portable infusion pump in order to maintain therapeutic effectiveness. Although a useful therapy, it requires extensive patient education and caregiver support. An advantage to iloprostis over epoprostenol is that it is an inhaled preparation; however, it needs to be administered six to nine times daily. The first formulations of treprostinil could only be taken parenterally; however, it has recently been approved in an inhaled formulation, and an oral preparation is under development. Parenteral trepostinil can be administered IV or subcutaneously, although the subcutaneous method causes severe pain at the injection site (Hopkins & Rubin, 2019). Selexipag is the newest FDA-approved prostanoid. It is available in tablet form administered in twice-daily doses, a clear advantage over-the-other prostanoids. However, it is a costly medication and not all insurance plans cover all of its costs (Pulmonary Hypertension Association Scientific Leadership Council, 2016).

Endothelin receptor antagonists bind to vascular endothelin-1 receptors, effectively blocking constriction of the pulmonary arteries, resulting in vasodilation. Endothelin receptor antagonists used to treat PH include bosentan, ambrisentan, and macitentan. These medications are available as oral preparations. A disadvantage to them is that they are hepatotoxic. Liver function must be monitored in patients using these agents.

The oral medications sildenafil, tadalafil, and vardenafil are potent, specific phosphodiesterase-5 inhibitors that degrade cyclic 3′,5′-guanosine monophosphate (cGMP) and promotes pulmonary vasodilation. These drugs are also prescribed to treat erectile dysfunction (Hopkins & Rubin, 2019; Korokina, Zhernakova, Korokin, et al., 2018).

Soluble guanylate cyclase stimulants, which act on the nitrous oxide pathway, are currently undergoing clinical trials to target many cardiopulmonary diseases. Riociguat, a medication in this category, is newly FDA approved for use in PH. Riociguat, an oral preparation administered three times daily, is contraindicated in patients with liver or kidney disease (Tsai, Sung, & de Jesus Perez, 2016).

Surgical Management

Lung transplantation remains an option for a select group of patients with PH who are refractory to medical therapy. Bilateral lung or heart–lung transplantation is the procedure of choice. Atrial septostomy may be considered for select patients with severe disease (Hopkins & Rubin, 2019); this procedure results in shunting of blood from the right side of the heart to the left, decreasing the strain on the right side of the heart and maintaining left ventricular output.

Nursing Management

The major nursing goal is to identify patients at high risk for PH, such as those with COPD, PE, congenital heart disease, and mitral valve disease so that early treatment can commence. The nurse must be alert for signs and symptoms, administer oxygen therapy appropriately, and instruct the patient and family about the use of home oxygen therapy. In patients treated with some of the prostanoids, education about the need for central venous access (epoprostenol), subcutaneous infusion (treprostinil), proper administration and dosing of the medication, pain at the injection site, and potential severe side effects is extremely important. Emotional and psychosocial aspects of this disease must be addressed. It is important to provide contact details for support services for patients and families.

Pulmonary Heart Disease (Cor Pulmonale)

Cor pulmonale is a condition that results from PH, which causes the right side of the heart to enlarge because of the increased work required to pump blood against high resistance through the pulmonary vascular system. This causes right-sided heart failure (see Chapter 25 for further discussion of management of right-sided heart failure).

Pulmonary Embolism

PE refers to the obstruction of the pulmonary artery or one of its branches by a thrombus (or thrombi) that originates somewhere in the venous system or in the right side of the heart. Deep vein thrombosis (DVT), a related condition, refers to thrombus formation in the deep veins, usually in the calf or thigh, but sometimes in the arm, especially in patients with peripherally inserted central catheters. VTE is a term that includes both DVT and PE. (VTE and the medical and nursing management of patients with DVT and with PE are discussed in detail in Chapter 26.)

OCCUPATIONAL LUNG DISEASE: PNEUMOCONIOSES

Pneumoconiosis is a general term given to any lung disease caused by dusts that are breathed in and then deposited deep in the lungs causing damage. Pneumoconiosis is usually considered an occupational lung disease, and includes asbestosis, silicosis and coal workers' pneumoconiosis, also known as "Black Lung Disease" (American Lung Association [ALA], 2018a) (see Table 19-6). Pneumoconiosis refers to a non-

neoplastic alteration of the lung resulting from inhalation of mineral or inorganic dust (e.g., "dusty lung"). This alteration results in pulmonary fibrosis and parenchymal changes. Usually, extended exposure to irritating or toxic substances accounts for these changes, although severe single exposures may also lead to chronic lung disease. Occupational lung disease is the number one work-related illness in the United States based on its frequency, severity, and preventability (ALA, 2018a). Many people with early pneumoconiosis are asymptomatic, but advanced disease often is accompanied by disability and premature death.

TABLE 19-6 Occupational Lung Diseases: Pneumoconioses

Disease (Source)	Pathophysiology	Clinical Manifestations
Silicosis (glass manufacturing, foundry work, stone cutting)	Inhaled silica dust produces nodular lesions in the lungs. Nodules enlarge and coalesce. Dense masses form on upper portion of lungs, resulting in loss of pulmonary volume. Fibrotic destruction of pulmonary tissue can lead to restrictive lung disease, emphysema, pulmonary hypertension, and cor pulmonale	*Acute silicosis:* dyspnea, fever, cough, weight loss *Chronic silicosis:* progressive symptoms indicative of hypoxemia, severe airflow obstruction, and right-sided heart failure
Asbestosis (shipbuilding, building demolition)	Inhaled asbestos fibers enter alveoli and are surrounded by fibrous tissue. Fibrous changes can also affect the pleura, which thicken and develop plaque. These changes lead to restrictive lung disease, with a decrease in lung volume, diminished exchange of oxygen and carbon dioxide, hypoxemia, cor pulmonale, and respiratory failure. It also increases risk of lung cancer, mesothelioma, and pleural effusion	Progressive dyspnea; persistent, dry cough; mild-to-moderate chest pain; anorexia; weight loss; malaise; clubbing of the fingers
Coal worker's pneumoconiosis	Encompasses a variety of lung diseases; is also known as black lung disease. Inhaled dusts that are mixtures of coal, kaolin, mica, and silica are deposited in the alveoli and respiratory bronchioles. When macrophages that engulf the dust can no longer be cleared, they aggregate and fibroblasts appear. The bronchioles and alveoli become clogged with dust, dying macrophages, and fibroblasts, leading to formation of coal macules. Fibrotic lesions develop and subsequently localized emphysema develops, with cor pulmonale and respiratory failure	Chronic cough, dyspnea, and expectoration of black or gray sputum, especially in coal workers who smoke and who have cavitation in the lungs

Adapted from American Lung Association (ALA). (2018a). Lung health & diseases: Pneumoconiosis. Retrieved on 10/4/2019 at: www.lung.org/lung-health-and-diseases/lung-disease-lookup/pneumoconiosis

Diseases of the lungs occur in numerous occupations as a result of exposure to several different types of agents, such as mineral dusts, metal dusts, biologic dusts, and

toxic fumes. Smoking may compound the problem and may increase the risk of lung cancers in people exposed to the mineral asbestos and other potential carcinogens (ALA, 2018b). The effects of inhaling these materials depend on the composition of the substance, its concentration, its ability to initiate an immune response, its irritating properties, the duration of exposure, and the person's response or susceptibility to the irritant.

These diseases are not curable; however, they are preventable. Therefore, a major role for nurses, especially occupational health nurses, is that of advocate for employees. Nurses need to make every effort to promote measures to reduce the exposure of workers to industrial products. Strategies to control exposure should be identified and encouraged; these strategies include the use of protective devices (facemasks, hoods, industrial respirators) to minimize exposure and screening/monitoring of individuals at risk.

Key aspects of any assessment of patients with a potential occupational respiratory history include job and job activities, exposure levels, general hygiene, time frame of exposure, smoking history, effectiveness of respiratory protection used, and direct versus indirect exposures (Goldman, 2019). Specific information that should be obtained includes the following:

- Exposure to an agent known to cause an occupational disorder
- Length of time from exposure of agent to onset of symptoms
- Congruence of symptoms with those of known exposure-related disorder
- Lack of other more likely explanations of the signs and symptoms

More than one million workers are exposed to silica each year. Symptoms rarely develop in less than 5 years. Progression of the disease results in extreme shortness of breath, loss of appetite, chest pains, and potentially respiratory failure (ALA, 2018a). Asbestosis is progressive and causes severe scarring of the lung, which leads to fibrosis. The lungs become stiff, making it difficult to breathe or to oxygenate well. The disease may not evidence manifestations until 10 to 40 years after exposure (ALA, 2018a). Coal worker's pneumoconiosis is a collection of lung disease caused by exposure to inhaled dusts.

The nurse provides education about preventive measures to patients and their families, assesses patients for a history of exposure to environmental agents, and makes referrals so that pulmonary function can be evaluated and the patient can be treated early in the course of the disease. These diseases have no effective treatment because damage is irreversible. Supportive therapy is aimed at preventing infections and managing complications.

Veterans Considerations

Many American veterans who served in Iraq and Afghanistan are experiencing respiratory disorders as a result of exposure to pollutants in situations such as sand storms and car bombings. Their illnesses can range from a new onset of asthma to constrictive bronchiolitis (Harrington, Schmidt, Szema, et al., 2017). These veterans could also have been exposed to organic contamination within the sand that could further irritate airways. When providing care to a veteran, it is important to assess

exposure to airway irritants, particularly when the patient is complaining of chronic respiratory symptoms.

CHEST TUMORS

Tumors of the lung may be benign or malignant. A malignant chest tumor can be primary, arising within the lung, chest wall, or mediastinum or it can be a metastasis from a primary tumor site elsewhere in the body.

Lung Cancer (Bronchogenic Carcinoma)

Lung cancer is the leading cancer killer among men and women in the United States, with about 1 out of 4 cancer deaths from lung cancer; over 135,000 deaths were estimated in 2018 (Midthun, 2019). Each year, more people die of lung cancer than of colon, breast, and prostate cancers combined. Approximately 228,820 new cases of lung cancer are diagnosed annually; 13% of new cancers for men and women involve the lung or bronchus (American Cancer Society [ACS], 2019). In approximately 48.5% of patients with lung cancer, the disease has spread to regional lymphatics and other sites by the time of diagnosis. As a result, the long-term survival rate is low. Overall, the 5-year survival rate is 21.7% (ALA, 2020; Thomas & Gould, 2019).

Pathophysiology

The most common cause of lung cancer is inhaled carcinogens, most often cigarette smoke (>85%); other carcinogens include radon gas and occupational and environmental agents (ALA, 2020). Lung cancers arise from a single transformed epithelial cell in the tracheobronchial airways, in which the carcinogen binds to and damages the cell's DNA. This damage results in cellular changes, abnormal cell growth, and eventually a malignant cell. As the damaged DNA is passed on to daughter cells, the DNA undergoes further changes and becomes unstable. With the accumulation of genetic changes, the pulmonary epithelium undergoes malignant transformation from normal epithelium eventually to invasive carcinoma. Carcinoma tends to arise at sites of previous scarring in the lung (e.g., TB, fibrosis).

Classification and Staging

For purposes of staging and treatment, over 95% of lung cancers are classified into one of two major categories: small cell lung cancer (SCLC) and non-small cell lung cancer (NSCLC). SCLC represents approximately 13% of tumors, and includes small cell and combined small cell cancers. NSCLC represents approximately 84% of tumors, and these are further classified by cell type, including squamous cell (20%), large cell (5%), adenocarcinoma (41%), and others, some of which cannot be classified (18%) (ACS, 2019; Midthun, 2019).

TABLE 19-7 Five-Year Relative Survival Rates for Lung Cancer based on Surveillance, Epidemiology, End Results (SEER) Stage[a]

SEER Stage	5-Year Relative Survival Rate (%)
NSCLC	
Localized	60
Regional	33
Distant	6
All SEER stages combined	23
SCLC	
Localized	29
Regional	15
Distant	3
All SEER stages combined	6

[a]Data are for patients diagnosed between the years 2009 and 2015. The SEER database does not group patients by the TNM system; rather, SEER categorizes patients based upon whether or not cancer has spread to distant organs/tissues (*distant*), or to proximal tissues or lymph nodes (*regional)*, or has not spread outside the lung (*localized*).

NSCLC, non-small cell lung cancer; SCLC, small cell lung cancer; TNM system, a tumor staging system promulgated by the American Joint Committee on Cancer that stages cancer based upon evidence of the size of the tumor (*T*), extent of lymph node involvement (*N*), and whether or not metastasis has occurred (*M*).

Adapted from American Cancer Society (ACS). (2019). Lung cancer survival rates. Last updated 10/1/2019. Retrieved on 10/4/2019 at: www.cancer.org/cancer/lung-cancer/detection-diagnosis-staging/survival-rates.html

In terms of specific types of NSCLC, squamous cell cancer is usually more centrally located and arises more commonly in the segmental and subsegmental bronchi. Adenocarcinoma is the most prevalent carcinoma of the lung in both men and women; it occurs peripherally as peripheral masses or nodules and often metastasizes. Large cell carcinoma (also called *undifferentiated carcinoma*) is a fast-growing tumor that tends to arise peripherally. Bronchoalveolar cell cancer is found in the terminal bronchi and alveoli and is usually slower growing compared with other bronchogenic carcinomas.

In addition to classification according to cell type, lung cancers are staged using the TNM staging system. The stage of the tumor refers to the size of the tumor, its location, whether lymph nodes are involved, and whether the cancer has spread (ACS, 2019). NSCLC is staged as I to IV. Stage I is the earliest stage and has the highest cure rate, whereas stage IV designates metastatic spread. Survival rates for NSCLC are shown in Table 19-7. (Diagnostic tools and further information on staging are described in Chapter 12.)

Risk Factors

The National Comprehensive Cancer Network (NCCN; 2020) asserts that 85% to 90% of all lung cancer cases are caused by cigarette smoke, whether it is from voluntary or involuntary (secondhand) smoking. Other factors that have been associated with lung cancer include genetic predisposition, dietary deficits, and underlying respiratory

diseases, such as COPD and TB. Some familial predisposition to lung cancer exists. The incidence of lung cancer in close relatives of patients with lung cancer is two to three times higher than the general population, regardless of smoking status (ACS, 2019).

Tobacco Smoke

The risk of developing lung cancer is about 23 times higher in men who smoke and 13 times higher in women who smoke compared to individuals who have never smoked (ACS, 2019). Risk is determined by the pack-year history (number of packs of cigarettes used each day, multiplied by the number of years smoked), the age of initiation of smoking, the depth of inhalation, and the tar and nicotine levels in the cigarettes smoked. The younger a person is when they start smoking, the greater the risk of developing lung cancer. People who smoke and use smokeless products as a supplemental source of nicotine have an increased overall risk of lung cancer (ACS, 2019).

Almost all cases of SCLC are due to cigarette smoking. SCLC is rare in people who have never smoked. It is the most aggressive form of lung cancer, grows quickly, and usually starts in the airways in the center of the chest (ACS, 2019).

Electronic Nicotine Delivery Systems

Electronic nicotine delivery systems (ENDS) include e-cigarettes, e-pens, e-pipes, e-hookahs, and e-cigars. According to a 2018 survey of 44,000 high school adolescents, 37% of 12th graders self-reported use of e-cigarettes (NIH News in Health, 2019). The amounts of nicotine and other substances a person gets from each cartridge are also unclear and have been found to vary greatly even when comparing same brand cartridges from the same manufacturer. Since these ENDS products have only been available for about a decade, the link between their use and lung cancer is unclear at the present time (ACS, 2019).

Secondhand Smoke

Secondhand or involuntary smoking has been identified as a cause of lung cancer in people who do not smoke. People who are involuntarily exposed to tobacco smoke in a closed environment (house, automobile, building) have an increased risk of lung cancer when compared with unexposed individuals who do not smoke (CDC, 2018a; NCCN, 2020).

Environmental and Occupational Exposure

Various carcinogens have been identified in the atmosphere, including motor vehicle emissions and pollutants from refineries and manufacturing plants. Evidence suggests that the incidence of lung cancer is greater in urban areas as a result of the buildup of pollutants and motor vehicle emissions (ALA, 2018b).

Radon is a colorless, odorless gas found in soil and rocks. For many years, it has been associated with uranium mines, but it is now known to seep into homes through ground rock. High levels of radon have been associated with the development of lung cancer, especially when combined with cigarette smoking. Homeowners are advised to

have radon levels checked in their houses and to arrange for special venting if the levels are high.

Chronic exposure to industrial carcinogens, such as arsenic, asbestos, mustard gas, chromates, coke oven fumes, nickel, oil, and radiation, has been associated with the development of lung cancer. Laws have been passed to control exposure to these carcinogens in the workplace.

Genetic Mutations

Genetic mutations can cause certain changes in the DNA of lung cells. These changes can lead to abnormal cell growth and, sometimes, cancer. Acquired mutations in lung cells often result from exposure to factors in the environment, such as cancer-causing chemicals in tobacco smoke (ACS, 2019). The most common genetic mutations occur in *EGFR* (the gene that produces epidermal growth factor receptor) and the *K-RAS* or *ALK* oncogenes. *EGFR* is abnormal in about 50% of all patients with lung cancer. Abnormalities in *K-RAS* or *ALK* oncogenes are thought to be important in the development of NSCLC (ACS, 2019).

Clinical Manifestations

Often, lung cancer develops insidiously and is asymptomatic until late in its course. The signs and symptoms depend on the location and size of the tumor, the degree of obstruction, and the existence of metastases to regional or distant sites.

The most frequent symptom of lung cancer is cough or change in a chronic cough. People frequently ignore this symptom and attribute it to smoking or a respiratory infection. The cough may start as a dry, persistent cough, without sputum production. When obstruction of airways occurs, the cough may become productive due to infection.

Quality and Safety Nursing Alert

A cough that changes in character should arouse suspicion of lung cancer.

Dyspnea is prominent in patients early in their disease. Causes of dyspnea may include tumor occlusion of the airway or lung parenchyma, pleural effusion, pneumonia, or complications of treatment. Hemoptysis or blood-tinged sputum may be expectorated. Chest or shoulder pain may indicate chest wall or pleural involvement by a tumor. Pain also is a late manifestation and may be related to metastasis to the bone.

In some patients, a recurring fever is an early symptom in response to a persistent infection in an area of pneumonitis distal to the tumor. In fact, cancer of the lung should be suspected in people with repeated unresolved upper respiratory tract infections. If the tumor spreads to adjacent structures and regional lymph nodes, the patient may present with chest pain and tightness, hoarseness (involving the recurrent laryngeal nerve), dysphagia, head and neck edema, and symptoms of pleural or pericardial effusion. The most common sites of metastases are lymph nodes, bone, brain, contralateral lung, adrenal glands, and liver (see Fig. 19-10). Nonspecific

symptoms of weakness, anorexia, and weight loss also may be present (Eldridge, 2020).

Assessment and Diagnostic Findings

If pulmonary symptoms occur in individuals who currently smoke or who formerly smoked, or in people chronically exposed to secondhand smoke, cancer of the lung should be considered. A chest x-ray is performed to search for pulmonary density, a solitary pulmonary nodule (coin lesion), atelectasis, and infection. CT scans of the chest are used to identify small nodules not easily visualized on the chest x-ray and also to serially examine areas for lymphadenopathy. Additionally, the U.S. Preventive Services Task Force (USPSTF) recommends annual lung cancer screening using low dose CT (LDCT) for adults 55 to 80 years of age who have a 30 pack-year smoking history and either currently smoke or have quit smoking less than 15 years ago. Each pack-year is calculated based upon smoking one pack of cigarettes daily for 1 year; for instance, a 30 pack-year is defined as smoking one pack of cigarettes daily for 30 years, or 3 packs daily for 10 years (CDC, 2019e).

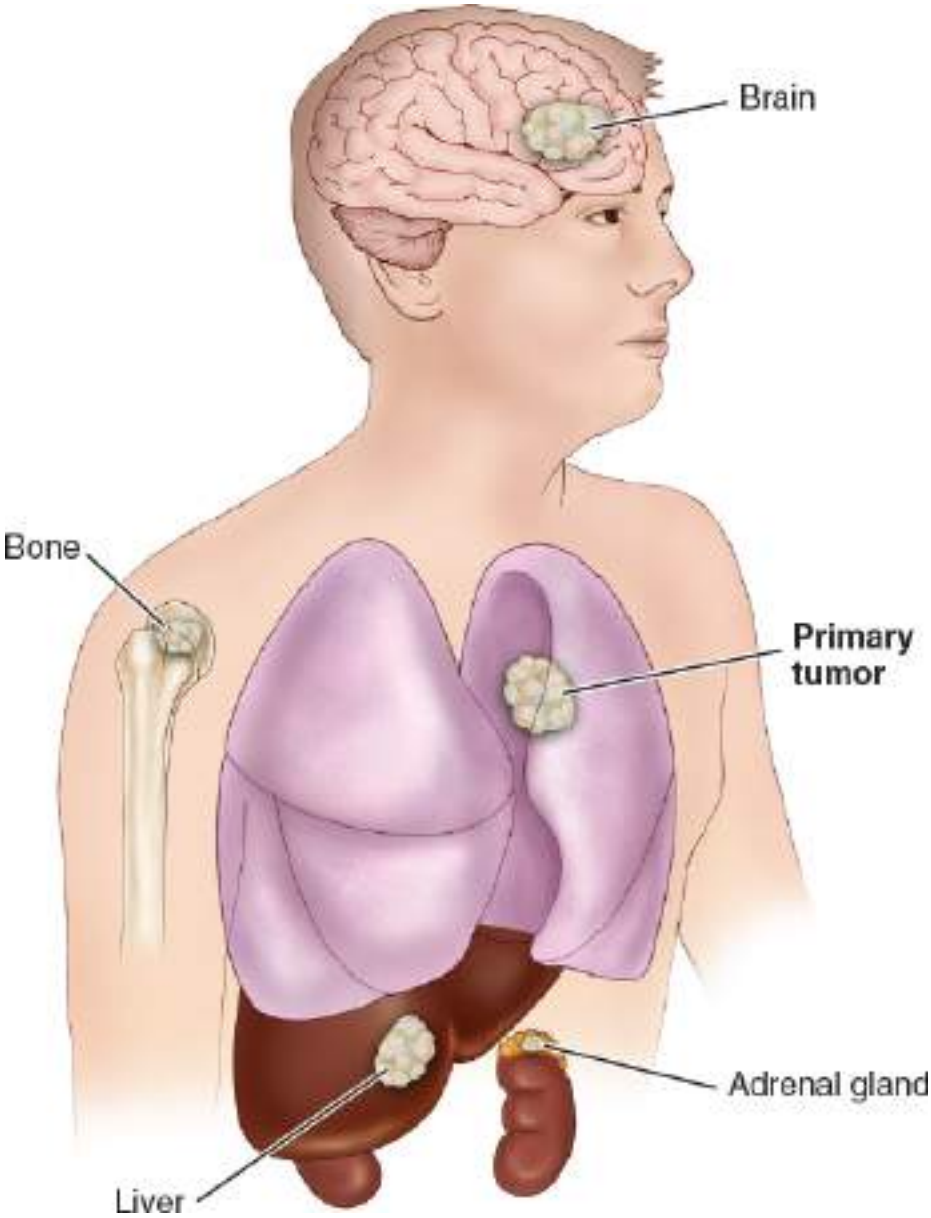


Figure 19-10 • Frequent sites of lung cancer metastasis.

Fiberoptic bronchoscopy is commonly used to diagnose lung cancer; it provides a detailed study of the tracheobronchial tree and allows for brushings, washings, and biopsies of suspicious areas. For peripheral lesions not amenable to bronchoscopic biopsy, a transthoracic fine-needle aspiration may be performed under CT guidance to aspirate cells from a suspicious area.

A variety of scans may be used to assess for metastasis of the cancer. These may include bone scans, abdominal scans, positron emission tomography (PET) scans, and liver ultrasound. CT scan of the brain, magnetic resonance imaging (MRI), and other neurologic diagnostic procedures are used to detect central nervous system metastases. Mediastinoscopy or mediastinotomy may be used to obtain biopsy samples from lymph nodes in the mediastinum. Endobronchial ultrasound biopsy of mediastinal nodes is also used. In some circumstances, an endoscopy with esophageal ultrasound may be used to obtain a transesophageal biopsy of enlarged subcarinal lymph nodes.

If surgery is a potential treatment, the patient is evaluated to determine whether the tumor is resectable and whether the patient can tolerate the physiologic impairment resulting from such surgery. Preoperative diagnostic studies provide a baseline for comparison during the postoperative period and detect additional abnormalities. Studies can be comprehensive and may include a bronchoscopic examination (a lighted scope is inserted into the airways to examine the bronchi), chest x-ray, MRI, ECG (for arteriosclerotic heart disease, conduction defects), nutritional assessment, determination of BUN and serum creatinine levels (to assess renal function), determination of glucose tolerance or blood glucose level (to check for diabetes), serum electrolytes and protein levels, blood volume determinations, complete blood cell count (CBC), pulmonary function tests, arterial blood gas analysis, V./Q. scans, and exercise testing.

Medical Management

The objective of management is to provide a cure, if possible. Treatment depends on the cell type, the stage of the disease, and the patient's physiologic status (particularly cardiac and pulmonary status). In general, treatment for patients with NSCLC may involve surgery, radiation therapy, chemotherapy, immunotherapy—or a combination of these. Immunotherapy specifically targets patients' immune cells so that they are primed to more effectively kill cancer cells. Gene therapy using agents that target specific genetic mutations including *EGFR* mutations and *ALK* and *ROS1* rearrangements have shown promising results (Eldridge, 2020).

Treatment for patients with SCLC may include surgery (but only if the cancer is in one lung and there is no metastasis), radiation therapy, laser therapy to open airways blocked by tumor growth, and endoscopic stent placement (to open an airway). Although the cancer cells are small, they grow very quickly and create large tumors. These tumors often metastasize (spread) rapidly to other parts of the body, including the brain, liver, and bone. Typically, by the time a patient is diagnosed with SCLC, it is late in the course of the disease and metastasis has occurred.

Surgical Management: Thoracotomy

A **thoracotomy** (creation of a surgical opening into the thoracic cavity) may be performed to treat lung cancer. As noted previously, surgery is primarily used for patients with NSCLC, because SCLC grows rapidly and metastasizes early and extensively. Surgical resection is the preferred method of treating patients with localized NSCLCs without evidence of metastatic spread, and with adequate cardiopulmonary function. However, coronary artery disease, pulmonary insufficiency, and other comorbidities may contraindicate surgical intervention. The cure rate of surgical resection depends on the type and stage of the cancer. Several different types of lung resection may be performed (see Chart 19-22). The most common surgical procedure for a small, apparently curable tumor of the lung is lobectomy (removal of a lobe of the lung). In some cases, pneumonectomy (removal of an entire lung) may be required.

Nursing Management of the Patient Having a Thoracotomy

Patients are typically admitted on the day of surgery. The nurse in the outpatient surgical clinic setting is responsible for performing the preoperative assessment and education and for alleviating the anxiety experienced by the patient and family members by providing them with anticipatory guidance. Postoperatively, the patient may be managed by the nurse in the ICU. Successfully managing transitions in care for the patient from the ICU to other inpatient acute care settings (e.g., medical-surgical unit, step-down unit) to the outpatient setting is a key nursing responsibility.

Educating the Patient Preoperatively

The nurse informs the patient about what to expect, from administration of anesthesia to thoracotomy, and the likely use of chest tubes and a drainage system in the postoperative period. The patient is also informed about the usual postoperative administration of oxygen to facilitate breathing and the possible use of a ventilator. It is essential to explain the importance of frequent turning to promote drainage of lung secretions. Instruction in the use of incentive spirometry begins before surgery to familiarize the patient with its correct use. The nurse educates the patient on the use of diaphragmatic and pursed-lip breathing, and the patient should begin practicing these techniques (see Chapter 20, Chart 20-5).

Because a coughing schedule is necessary in the postoperative period to promote the clearance or removal of secretions, the nurse instructs the patient in the technique of coughing and warns the patient that the coughing routine may be uncomfortable. The nurse educates the patient about how to splint the incision with the hands, a pillow, or a folded towel.

Encouraging the use of forced expiratory technique (FET) may be helpful for the patient with diminished expiratory flow rates or for the patient who refuses to cough because of severe pain. FET is the expulsion of air through an open glottis. This technique stimulates pulmonary expansion and assists in alveolar inflation (Kacmarek, Stoller, Heuer, et al., 2017). The nurse instructs the patient as follows:

- Take a deep diaphragmatic breath and exhale forcefully against the hand in a quick, distinct pant, or huff.
- Practice doing small huffs and progress to one strong huff during exhalation.

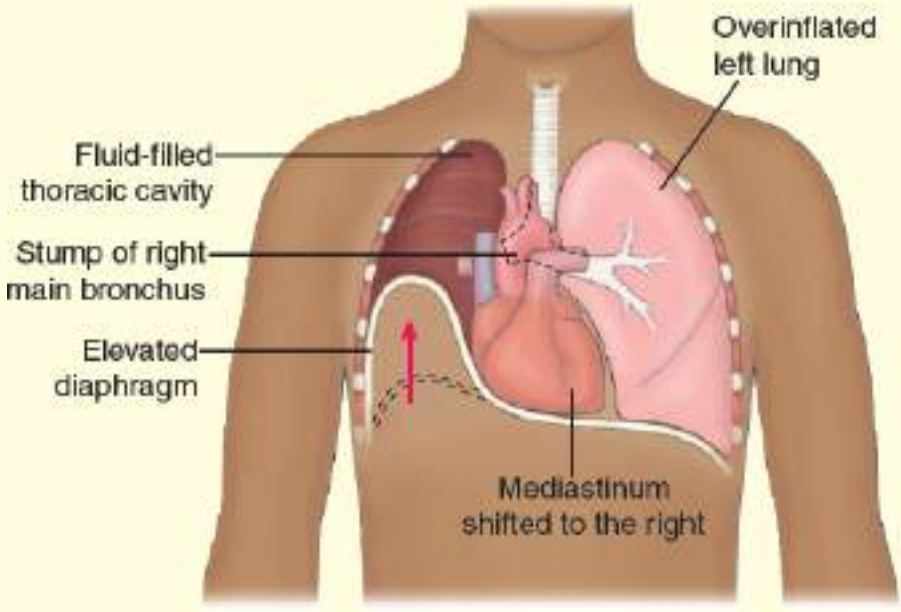
Patients should be informed preoperatively that blood and other fluids may be given, oxygen will be given, and vital signs will be checked often for several hours after surgery. If a chest tube is indicated (see later discussion on Chest Drainage Systems), the patient should be informed that it will drain the fluid and air that normally accumulate after chest surgery. The patient and family are informed that the patient may be admitted to the ICU for 1 to 2 days after surgery, that the patient may experience pain at the incision site, and that medication is available to relieve pain and discomfort.

Chart 19-22

Pneumonectomy

The removal of an entire lung, referred to as pneumonectomy, is performed chiefly for cancer when the lesion cannot be removed by a less extensive procedure. It also may be performed for lung abscesses, bronchiectasis, or extensive unilateral tuberculosis. The removal of the right lung is riskier than the removal of the left, because the right lung has a larger vascular bed and its removal imposes a greater physiologic burden.

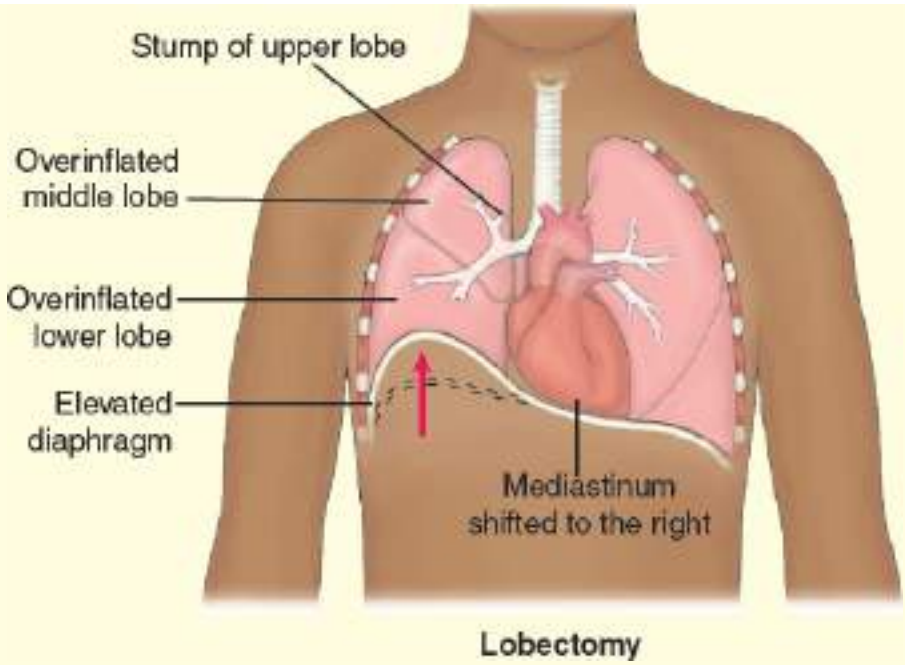
A posterolateral or anterolateral thoracotomy incision is made, sometimes with resection of a rib. The pulmonary artery and the pulmonary veins are ligated and severed. The main bronchus is divided and the lung removed. The bronchial stump is stapled, and usually no drains are used because the accumulation of fluid in the empty hemithorax prevents mediastinal shift.



Pneumonectomy

Lobectomy

When the pathology is limited to one area of a lung, a lobectomy (removal of a lobe of a lung) is performed. Lobectomy, which is more common than pneumonectomy, may be carried out for bronchogenic carcinoma, giant emphysematous blebs or bullae, benign tumors, metastatic malignant tumors, bronchiectasis, and fungal infections.



Lobectomy

The surgeon makes a thoracotomy incision. Its exact location depends on the lobe to be resected. When the pleural space is entered, the involved lung collapses and the lobar vessels and the bronchus are ligated and divided. After the lobe is removed, the remaining lobes of the lung are re-expanded. Usually, two chest catheters are inserted for drainage. The upper tube is for air removal; the lower one is for fluid drainage. Sometimes, only one catheter is needed. The chest tube is connected to a chest drainage apparatus for several days.

Segmentectomy (Segmental Resection)

Some lesions are located in only one segment of the lung. Bronchopulmonary segments are subdivisions of the lung that function as individual units. They are held together by delicate connective tissue. Disease processes may be limited to a single segment. Care is used to preserve as much healthy and functional lung tissue as possible, especially in patients who already have limited cardiopulmonary reserve. Single segments can be removed from any lobe; the right middle lobe, which has only two small segments, invariably is removed entirely. On the left side, corresponding to a middle lobe, is a “lingular” segment of the upper lobe. This can be removed as a single segment or by lingulectomy. This segment frequently is involved in bronchiectasis.

Wedge Resection

A wedge resection of a small, well-circumscribed lesion may be performed without regard to the location of the intersegmental planes. The pleural cavity usually is drained because of the possibility of an air or blood leak. This procedure is performed for diagnostic lung biopsy and for the excision of small peripheral nodules.

Bronchoplastic or Sleeve Resection

Bronchoplastic resection is a procedure in which only one lobar bronchus, together with a part of the right or left bronchus, is excised. The distal bronchus is reanastomosed to the proximal bronchus or trachea.

Lung Volume Reduction

Lung volume reduction is a surgical procedure involving the removal of 20% to 30% of a patient's lung through a midsternal incision or video thoracoscopy. The diseased lung tissue is identified on a lung perfusion scan. This surgery leads to significant improvements in dyspnea, exercise capacity, quality of life, and survival of a subgroup of people with end-stage emphysema.

Video Thoracoscopy

A video thoracoscopy is an endoscopic procedure that allows the surgeon to look into the thorax without making a large incision. The procedure is performed to obtain specimens of tissue for biopsy, to treat recurrent spontaneous pneumothorax, and to diagnose either pleural effusions or pleural masses. Thoracoscopy has also been found to be an effective diagnostic and therapeutic alternative for the treatment of mediastinal disorders. Some advantages of video thoracoscopy are rapid diagnosis and treatment of some conditions, a decrease in postoperative complications, and a shortened hospital stay.

Adapted from Urden, L. D., Stacy, K. M., & Lough, M. E. (2018). *Critical care nursing: Diagnosis and management* (8th ed.). St. Louis, MO: Elsevier Mosby.

The nurse listens to the patient and family to evaluate their feelings about the illness and proposed treatment. The nurse also determines the patient's motivation to return to normal or baseline function. The patient may reveal significant concerns: fear of hemorrhage because of bloody sputum, fear of discomfort from a chronic cough and chest pain, fear of ventilator dependence, or fear of death because of dyspnea and the underlying disease.

The nurse helps the patient to address fears and to cope with the stress of surgery by correcting any misconceptions, supporting the patient's decision to undergo surgery, and dealing honestly with questions about pain and discomfort and the patient's treatment. The management and control of pain begin before surgery, when the nurse informs the patient that many postoperative problems can be overcome by following certain routines related to deep breathing, coughing, turning, and moving. Nonopioid preemptive analgesic agents (e.g., acetaminophen and nonsteroidal anti-inflammatory drugs [NSAIDs]) may also be prescribed to help decrease the dose of postoperative opioid agents. This also helps to facilitate deep-breathing techniques and return to normal respiratory function. If patient-controlled analgesia (PCA) or patient-controlled epidural analgesia (PCEA) is to be used after surgery, the nurse instructs the patient in its use.

Postoperative Management

After surgery, the vital signs are checked frequently. Oxygen is given by a mechanical ventilator, nasal cannula, or mask for as long as necessary. A reduction in lung capacity requires a period of physiologic adjustment, and fluids may be given at a low hourly rate to prevent fluid overload and pulmonary edema. After the patient has recovered from anesthesia and the vital signs have stabilized, the head of the bed may be elevated 30 to 45 degrees. Careful positioning of the patient is important. After pneumonectomy, a patient is usually turned every hour from the back to the operative side and should not be completely turned to the unoperated side. This allows the fluid left in the space to consolidate and prevents the remaining lung and the heart from

shifting (mediastinal shift) toward the operative side. The patient with a lobectomy may be turned to either side, and a patient with a segmental resection usually is not turned onto the operative side unless the surgeon prescribes this position (see Chart 19-23: Plan of Nursing Care: Care of the Patient After Thoracotomy).

Complications after thoracic surgery are always possible and must be identified and managed early. The nurse monitors the patient at regular intervals for signs of respiratory distress or developing respiratory failure, arrhythmias, bronchopleural fistula, hemorrhage and shock, atelectasis, and incisional or pulmonary infection. Arrhythmias are often related to the effects of hypoxia or the surgical procedure. They are treated with antiarrhythmic medication and supportive therapy (see Chapter 22). Pulmonary infections or effusion, often preceded by atelectasis, may occur a few days into the postoperative course.

Pneumothorax may occur after thoracic surgery if there is an air leak from the surgical site to the pleural cavity or from the pleural cavity to the environment. Failure of the chest drainage system prevents return of negative pressure in the pleural cavity and results in pneumothorax. In the patient who is postoperative, pneumothorax is often accompanied by hemothorax. The nurse maintains the chest drainage system and monitors the patient for signs and symptoms of pneumothorax (see later discussions): increasing shortness of breath, tachycardia, increased respiratory rate, and increasing respiratory distress. Bronchopleural fistula is a serious but rare complication that prevents the return of negative intrathoracic pressure and lung re-expansion. Depending on its severity, it is treated with continued closed chest drainage and mechanical ventilation.

Hemorrhage and shock are managed by treating the underlying cause, whether by reoperation or by administration of blood products or fluids. Pulmonary edema from overinfusion of IV fluids is a significant danger. Early symptoms are dyspnea; crackles; tachycardia; and pink, frothy sputum. This constitutes an emergency and must be reported and treated immediately (see Chapter 25 for further discussion).

Medication for pain is needed for several days after surgery; it is usually a combination of epidural analgesia, PCA, and scheduled or as-needed oral analgesics. Because coughing can be painful, the patient should be encouraged to splint the chest as taught in the preoperative period. Exercises are resumed early in the postoperative period to facilitate lung ventilation. The nurse assesses for signs of complications, including cyanosis, dyspnea, and acute chest pain. These may indicate atelectasis and should be reported immediately. Increased temperature or white blood cell count may indicate an infection, and pallor and increased pulse may indicate internal hemorrhage. Dressings are assessed for fresh bleeding.

Promoting Home, Community-Based, and Transitional Care

The nurse educates the patient and family about postoperative care that will be continued in the community setting and at home.

Educating Patients About Self-Care

The nurse explains signs and symptoms that should be reported to the primary provider. These include the following:

- Change in respiratory status, such as increasing shortness of breath, fever, increased restlessness or other changes in mental or cognitive status, increased respiratory rate, change in respiratory pattern, change in amount or color of sputum
- Bleeding or other drainage from the surgical incision or chest tube exit sites
- Increased chest pain

In addition, respiratory care and other treatment modalities (oxygen; incentive spirometry; CPT; and oral, inhaled, or IV medications) may be continued at home. Therefore, the nurse needs to instruct the patient and family in their correct and safe use.

The nurse emphasizes the importance of progressively increased activity. The patient is instructed to ambulate within limits and informed that return of strength is likely to be very gradual. Another important aspect of patient education addresses shoulder exercises. The patient is instructed to do these exercises five times daily (see Chart 19-24). Additional patient education is described in Chart 19-25.

Chart 19-23 PLAN OF NURSING CARE

Care of the Patient After Thoracotomy

NURSING DIAGNOSIS: Impaired gas exchange associated with lung impairment and surgery
Goal: Improvement of gas exchange and breathing

Nursing Interventions	Rationale	Expected Outcomes
1. Monitor pulmonary status as directed and as needed. a. Auscultate breath sounds. b. Check rate, depth, and pattern of respirations. c. Assess blood gases for signs of hypoxemia or CO_2 retention. d. Evaluate patient's color for cyanosis. 2. Monitor and record blood pressure, apical pulse, and temperature every 2 to 4 hours, and central venous pressure (if indicated) every 2 hours. 3. Monitor continuous electrocardiogram for pattern and arrhythmias. 4. Elevate head of bed 30° to 40° when patient is oriented and hemodynamic status is stable. 5. Encourage deep-breathing exercises and effective use of incentive spirometer. 6. Encourage and promote an effective cough routine to be performed every hour during first 24 hours. 7. Assess and monitor the chest drainage system.[a] a. Assess for leaks and patency as needed (see procedural guidelines for setting up and managing chest drainage systems at thepoint.lww.com/Brunner15e). b. Monitor amount and character of drainage and document every 2 hours. Notify primary provider if drainage is ≥150 mL/h.	1. Changes in pulmonary status indicate improvement or onset of complications. 2. Vital signs aid in evaluating effect of surgery on cardiac status. 3. Arrhythmias (especially atrial fibrillation and atrial flutter) are more frequently seen after thoracic surgery. A patient with total pneumonectomy is especially prone to cardiac irregularity. 4. Maximum lung excursion is achieved when patient is as close to upright as possible. 5. Helps to achieve maximal lung inflation and to open closed airways 6. Coughing is necessary to remove retained secretions. 7. System is used to eliminate any residual air or	• Lungs are clear on auscultation. • Respiratory rate is within acceptable range with no episodes of dyspnea. • Vital signs are stable. • Arrhythmias are not present or are treated effectively. • Demonstrates deep, controlled, effective breathing to allow maximal lung expansion. • Uses incentive spirometer every 2 hours while awake. • Demonstrates deep, effective coughing technique. • Lungs are expanded to capacity (evidenced by chest x-ray).

	fluid after thoracotomy.	

NURSING DIAGNOSIS: Impaired airway clearance associated with lung impairment, anesthesia, and pain
Goal: Improvement of airway clearance and achievement of a patent airway

Nursing Interventions	Rationale	Expected Outcomes
1. Maintain an open airway. 2. Perform endotracheal suctioning until patient can cough effectively. 3. Assess and medicate for pain. Encourage deep-breathing and coughing exercises. Help splint incision during coughing. 4. Monitor amount, viscosity, color, and odor of sputum. Notify primary provider if sputum is excessive or contains bright-red blood. 5. Administer humidification and small-volume nebulizer therapy as prescribed. 6. Perform postural drainage, percussion, and vibration as prescribed. Do not percuss or vibrate directly over operative site. 7. Auscultate both sides of chest to determine changes in breath sounds.	1. Provides for adequate ventilation and gas exchange. 2. Endotracheal secretions are present in excessive amounts in patients who are postthoracotomy due to trauma to the tracheobronchial tree during surgery, diminished lung ventilation, and cough reflex. 3. Helps to achieve maximal lung inflation and to open closed airways. Coughing is painful; incision needs to be supported. 4. Changes in sputum suggest presence of infection or change in pulmonary status. Colorless sputum is not unusual; opacification or coloring of sputum may indicate	• Airway is patent. • Coughs effectively. • Splints incision while coughing. • Sputum is clear or colorless. • Lungs are clear on auscultation.

	dehydration or infection. 5. Secretions must be moistened and thinned if they are to be raised from the chest with the least amount of effort. 6. Chest physiotherapy uses gravity to help remove secretions from the lung. 7. Indications for tracheal suctioning are determined by chest auscultation.	
NURSING DIAGNOSIS: Acute pain associated with incision, drainage tubes, and the surgical procedure **Goal:** Relief of pain and discomfort		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Evaluate location, character, quality, and severity of pain. Administer analgesic medication as prescribed and as needed. Observe for respiratory effect of opioid. Note if patient seems too somnolent to cough or if respirations are depressed. 2. Maintain care postoperatively in positioning the patient. a. Place patient in semi-Fowler position. b. Patients with limited respiratory reserve may not be able to turn on unoperated side. c. Assist or turn patient every 2 hours. 3. Assess incision area every 8 hours for redness, heat,	1. Pain limits chest excursions and thereby decreases ventilation. 2. The patient who is comfortable and free of pain will be less likely to splint the chest while breathing. A semi-Fowler position permits residual air in the pleural space to rise to upper portion of pleural space	• Asks for pain medication but verbalizes that they expect some discomfort while deep breathing and coughing. • Verbalizes that they are comfortable and not in acute distress. • No signs of incisional infection evident.

induration, swelling, separation, and drainage. 4. Request order for patient-controlled analgesia pump if appropriate for patient.	and be removed via the upper chest catheter. 3. These signs indicate possible infection. 4. Encouraging patient control over frequency and dose improves comfort and adherence with treatment regimen.	
NURSING DIAGNOSIS: Anxiety associated with outcomes of surgery, pain, technology **Goal:** Reduction of anxiety to a manageable level		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Explain all procedures in understandable language. 2. Assess for pain and medicate, especially before potentially painful procedures. 3. Silence all *unnecessary* alarms on technology (monitors, ventilators). 4. Encourage and support patient while increasing activity level. 5. Mobilize resources (family, clergy, social worker) to help patient cope with outcomes of surgery (diagnosis, change in functional abilities).	1. Explaining what can be expected in understandable terms decreases anxiety and increases cooperation. 2. Premedication before painful procedures or activities improves comfort and minimizes undue anxiety. 3. *Unnecessary* alarms increase the risk of sensory overload and may increase anxiety. *Essential* alarms must be turned on at all times.	• States that anxiety is at a manageable level. • Participates with health care team in treatment regimen. • Uses appropriate coping skills (verbalization; pain relief strategies; the use of support systems such as family, clergy). • Demonstrates basic understanding of technology used in care.

	4. Positive reinforcement improves patient motivation and independence. 5. A multidisciplinary approach promotes the patient's strengths and coping mechanisms.	
NURSING DIAGNOSIS: Impaired mobility of the upper extremities associated with thoracic surgery **Goal:** Increased mobility of the affected shoulder and arm		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Assist patient with normal range of motion and function of shoulder and trunk. a. Educate about use of breathing exercises to mobilize thorax. b. Encourage skeletal exercises to promote abduction and mobilization of shoulder (see Chart 19-23). c. Assist out of bed to chair as soon as pulmonary and circulatory systems are stable (usually by evening of surgery). 2. Encourage progressive activities according to level of fatigue.	1. Necessary to regain normal mobility of arm and shoulder and to speed recovery and minimize discomfort 2. Increases patient's use of affected shoulder and arm	• Demonstrates arm and shoulder exercises and verbalizes intent to perform them on discharge. • Regains previous range of motion in shoulder and arm.

NURSING DIAGNOSIS: Risk for hypovolaemia associated with the surgical procedure
Goal: Maintenance of adequate fluid volume

Nursing Interventions	Rationale	Expected Outcomes

1. Monitor and record hourly intake and output. Urine output should be at least 0.5 mL/kg/h over 6 hours and at least 400 mL in 24 hours after surgery.
2. Administer blood component therapy and parenteral fluids and diuretics as prescribed to restore and maintain fluid volume.
	1. Fluid management may be altered before, during, and after surgery, and patient's response to and need for fluid management must be assessed.
	2. Pulmonary edema due to transfusion or fluid overload is an ever-present threat; after pneumonectomy, the pulmonary vascular system has been greatly reduced.
		• Patient is adequately hydrated, as evidenced by:
		  • Urine output >0.5 mL/kg/h over 6 hours, and >400 mL in 24 hours
		  • Vital signs stable, heart rate, and central venous pressure approaching normal
		  • No excessive peripheral edema

NURSING DIAGNOSIS: Lack of knowledge of home care procedures
Goal: Increased ability to carry out care procedures at home

Nursing Interventions	Rationale	Expected Outcomes
1. Encourage patient to practice arm and shoulder exercises 5 times daily at home. 2. Instruct patient to practice assuming a functionally erect position	1. Exercise accelerates recovery of muscle function and reduces long-term pain and discomfort. 2. Practice will help restore normal posture. 3. Knowing what to expect facilitates recovery.	• Demonstrates arm and shoulder exercises. • Verbalizes need to try to assume an erect posture. • Verbalizes the importance of relieving discomfort, alternating walking and rest, performing breathing exercises, avoiding heavy lifting, avoiding undue fatigue, avoiding bronchial irritants, preventing colds or lung infections, getting influenza

	in front of a full-length mirror.	vaccine, keeping follow-up visits, and stopping smoking.
3.	Instruct patient about home care (see Chart 19-25).	

[a]A patient with a pneumonectomy usually does not have water-seal chest drainage because it is desirable that the pleural space fill with an effusion, which eventually obliterates this space. Some surgeons do use a modified water-seal system.

Continuing and Transitional Care

Depending on the patient's physical status and the availability of family assistance, a referral for home, community-based, or transitional care may be indicated. The home health nurse assesses the patient's recovery from surgery, with special attention to respiratory status, the surgical incision, chest drainage, pain control, ambulation, and nutritional status. The patient's use of respiratory modalities is assessed to ensure that they are being used correctly and safely. In addition, the nurse assesses the patient's adherence to the postoperative treatment plan and identifies acute or late postoperative complications.

The recovery process may take longer than the patient had expected, and providing support to the patient is an important task for the nurse. Because of shorter hospital stays, follow-up appointments with the primary provider are essential. The nurse educates the patient about the importance of keeping follow-up appointments and completing laboratory tests as prescribed to assist the primary provider in evaluating recovery. The nurse provides continuous encouragement and education to the patient and family during the process. As recovery progresses, the patient and family are reminded about the importance of participating in health promotion activities and recommended health screening.

Radiation Therapy

Radiation therapy may offer cure in a small percentage of patients with lung cancer. It is useful in controlling neoplasms that cannot be surgically resected but are responsive to radiation. Irradiation also may be used to reduce the size of a tumor, to make an inoperable tumor operable, or to relieve the pressure of the tumor on vital structures. It can reduce symptoms of spinal cord metastasis and superior vena caval compression. In addition, prophylactic brain irradiation is used in certain patients to treat microscopic metastases to the brain. Radiation therapy may help relieve cough, chest pain, dyspnea, hemoptysis, and bone and liver pain. Relief of symptoms may last from a few weeks to many months and is important in improving the quality of the remaining period of life. Stereotactic ablative radiotherapy (SABR) is a treatment option that delivers higher-than-typical doses of radiation directly to the tumor. This treatment is given over 1 to 5 days and is indicated for early stages of lung cancers in

patients who either elect to not have surgery or are considered ineligible for surgery (ACS, 2019).

Chart 19-24 PATIENT EDUCATION

Performing Arm and Shoulder Exercises

Arm and shoulder exercises are performed after thoracic surgery to restore movement, prevent painful stiffening of the shoulder, and improve muscle power. The nurse instructs the patient to perform these exercises as follows:

Hold hand of the affected side with the other hand, palms facing in. Raise the arms forward, upward, and then overhead, while taking a deep breath. Exhale while lowering the arms. Repeat five times.

Raise arm sideward, upward, and downward in a waving motion.

Place arm at side. Raise arm sideward, upward, and then overhead. Repeat five times. These exercises can also be performed while lying in bed.

Extend the arm up and back, out to the side and back, down at the side, and back.

Place hands in small of back. Push elbows as far back as possible.

Sit erect in an armchair; place the hands on arms of the chair. Press down on hands, consciously pulling the abdomen in and stretching up from the waist. Inhale while raising the body until elbows are extended completely. Hold this position a moment, and begin exhaling while lowering the body slowly to the original position.

Radiation therapy usually is toxic to normal tissue within the radiation field, and this may lead to complications such as esophagitis, pneumonitis, and radiation lung fibrosis, although the incidence of these complications has decreased over time with improvements in delivery of radiation therapy (ACS, 2019). These complications may impair ventilatory and diffusion capacity and significantly reduce pulmonary reserve. The patient's nutritional status, psychological outlook, fatigue level, and signs of

anemia and infection are monitored throughout the treatment (see Chapter 12 for management of the patient receiving radiation therapy).

Chart 19-25 HOME CARE CHECKLIST

The Patient with a Thoracotomy

At the completion of education, the patient and/or caregiver will be able to:

- Name the procedure that was performed and identify any permanent changes in anatomic structure or function as well as changes in ADLs, IADLs, roles, relationships, and spirituality.
- State the name, dose, side effects, frequency, and schedule for all medications.
- Identify interventions and strategies (e.g., durable medical equipment, oxygen, and adaptive equipment) used in adapting to any permanent changes in structure or function.
- Describe ongoing postoperative therapeutic regimen, including diet and activities to perform (e.g., walking and breathing exercises) and to limit or avoid (e.g., lifting weights, driving a car, and contact sports).
  - Alternate walking and other activities with frequent rest periods, expecting weakness and fatigue for the first 3 weeks.
  - Walk at a moderate pace, gradually and persistently extending walking time and distance.
  - Perform arm and shoulder exercises as prescribed.
  - Perform breathing exercises several times daily for the first few weeks at home.
  - Avoid lifting >20 lb until complete healing has taken place; the chest muscles and incision may be weaker than normal for 3 to 6 months after surgery.
  - Use local heat and oral analgesia to relieve intercostal pain.
  - Immediately stop any activity that causes undue fatigue, increased shortness of breath, or chest pain.
  - Avoid bronchial irritants (smoke, fumes, air pollution, aerosol sprays).
  - Avoid others with known colds or lung infections.
- Describe signs and symptoms of complications (e.g., increased shortness of breath, fever, restlessness, mental status changes, change in rate or pattern of respiration, increased pain, or bleeding from incision).
- Relate how to reach primary provider with questions or complications.
- State time and date of follow-up appointments.
- Obtain an annual influenza vaccine, and discuss vaccination against pneumonia with the primary provider.
- State understanding of community resources and referrals (if any).
- Identify the need for health promotion (e.g., weight reduction, smoking cessation, and stress management), disease prevention and screening activities

Resources

See Chapter 20, Chart 20-7 for additional information on oxygen therapy at home and Chart 19-23 for additional information on performing arm and shoulder exercises.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Chemotherapy

Chemotherapy is used to alter tumor growth patterns, to treat distant metastases or small cell cancer of the lung, and as an adjunct to surgery or radiation therapy. Chemotherapy may provide relief, especially of pain, but it does not usually cure the disease or prolong life to any great degree. Chemotherapy is also accompanied by side effects. It is valuable in reducing pressure symptoms of lung cancer and in treating brain, spinal cord, and pericardial metastasis (see Chapter 12 for a discussion of chemotherapy for the patient with cancer).

The choice of agent depends on the growth of the tumor cell and the specific phase of the cell cycle that the medication affects. In combination with surgery, chemotherapy may be given before surgery (neoadjuvant therapy) or after surgery (adjuvant therapy). Specific guidelines are available for the treatment of differing stages of NSCLC and SCLC through the NCCN (2020).

Immunotherapy

Advances in immunotherapy have provided additional options for the treatment of advanced NSCLC and SCLC. Immunotherapy drugs referred to as checkpoint inhibitors are indicated for the treatment of unresectable stage III tumors in addition to lung cancers that have metastasized. These agents target programmed cell death proteins such as PD-1 or PD-L1 on T cells that prevent T cells from attacking other cells in the body. By blocking these PD proteins, the T cells are able to mount a better immune response against the tumor cells, more quickly and effectively killing them. Four checkpoint inhibitors are FDA-approved for use with lung cancer. The first three, pembrolizumab, nivolumab, and atezolizumab, are approved for use in metastatic lung cancer (Hellman & West, 2020; Yang, Zhang, & Wang, 2019). In addition, penbrolizumab combined with chemotherapy may be used as a first-line treatment for metastatic NSCLC. Durvalumab is the only agent approved for nonoperable stage III NSCLC (Hellmann & West, 2020). Checkpoint inhibitors are delivered by IV infusion every 2, 3, or 4 weeks over several months or up to 1 year. They are generally well tolerated with few adverse effects, particularly as compared to chemotherapeutic agents. Side effects include fatigue, rashes, and diarrhea (ACS, 2019).

Palliative Care

Palliative care, concurrent with standard oncologic care for lung cancer, should be considered early in the course of illness for any patient with metastatic cancer or high symptom burden. In lung cancer, palliative therapy may include radiation therapy to shrink the tumor to provide pain relief, a variety of bronchoscopic interventions to open a narrowed bronchus or airway, and pain management and other comfort measures. Evaluation and referral for hospice care are important in planning for comfortable and dignified end-of-life care for the patient and family (see Chapter 13 for further discussion).

Complications

A variety of complications may occur as a result of treatment of lung cancer. Surgical resection may result in respiratory failure, particularly if the cardiopulmonary system is compromised before surgery. Surgical complications and prolonged mechanical

ventilation are potential outcomes. Despite advances in improved delivery of radiation therapy, complications may still ensue, including diminished cardiopulmonary function and other complications, such as pulmonary fibrosis, pericarditis, myelitis, and cor pulmonale (Benveniste, Gomez, Brett, et al., 2019). Chemotherapy, particularly in combination with radiation therapy, can cause pneumonitis. Pulmonary toxicity is a potential side effect of chemotherapy.

Nursing Management

Nursing care of patients with lung cancer is similar to that for other patients with cancer (see Chapter 12, Chart 12-6) and addresses the physiologic and psychological needs of the patient. The physiologic problems are primarily due to the respiratory manifestations of the disease. Nursing care includes strategies to ensure relief of pain and discomfort and to prevent complications.

Managing Symptoms

The nurse educates the patient and family about the potential side effects of the specific treatment and strategies to manage them. Strategies for managing such symptoms as dyspnea, fatigue, nausea and vomiting, and anorexia help the patient and family cope with therapeutic measures.

Relieving Breathing Problems

Airway clearance techniques are key to maintaining airway patency through the removal of excess secretions. This may be accomplished through deep-breathing exercises, chest physiotherapy, directed cough, suctioning, and in some instances bronchoscopy. Bronchodilator medications may be prescribed to promote bronchial dilation. As the tumor enlarges or spreads, it may compress a bronchus or involve a large area of lung tissue, resulting in an impaired breathing pattern and poor gas exchange. At some stage of the disease, supplemental oxygen will probably be necessary.

Nursing measures focus on decreasing dyspnea by encouraging the patient to assume positions that promote lung expansion and to perform breathing exercises for lung expansion and relaxation. Patient education about energy conservation and airway clearance techniques is also necessary. Many of the techniques used in pulmonary rehabilitation can be applied to patients with lung cancer. Depending on the severity of disease and the patient's wishes, a referral to a pulmonary rehabilitation program may be helpful in managing respiratory symptoms.

Reducing Fatigue

Fatigue is a devastating symptom that affects quality of life in patients with cancer. It is commonly experienced by patients with lung cancer and may be related to the disease itself, the cancer treatment and complications (e.g., anemia), sleep disturbances, pain and discomfort, hypoxemia, poor nutrition, or the psychological ramifications of the disease (e.g., anxiety and depression) (see Chapter 12 for nursing strategies to reduce fatigue).

Providing Psychological Support

Another important part of the nursing care of patients with lung cancer is provision of psychological support and identification of potential resources for the patient and family. Often, the nurse must help the patient and family deal with the following:

- The poor prognosis and relatively rapid progression of this disease
- Informed decision making regarding the possible treatment options
- Methods to maintain the patient's quality of life during the course of this disease
- End-of-life treatment options

Oncology nurses are employed as *nurse navigators* in oncology practice settings to help patients and their families manage and coordinate the many challenging aspects of cancer care. Jeyathevan, Lemonde, and Cooper Brathwaite (2017) studied the effectiveness of the oncology nurse navigator role in helping patients and families deal with the complexities of a diagnosis of lung cancer (see Nursing Research Profile in Chart 19-26).

Gerontologic Considerations

At the time of diagnosis of lung cancer, most patients are older than 65 years and have stage III or IV disease (Midthun, 2019). In older patients, the management of a cancer is complex and challenging. Although age is not a significant prognostic factor for overall survival and response to treatment of either NSCLC or SCLC, older patients have specific needs. The presence of comorbidities and the patient's cognitive, functional, nutritional, and social status are important issues to consider with the patient of advanced age. Depending on the comorbidities and functional status of older adult patients, chemotherapy agents, doses, and cycles may need to be adjusted to maintain quality of life.

Tumors of the Mediastinum

Tumors of the mediastinum include neurogenic tumors, tumors of the thymus, lymphomas, germ cell tumors, cysts, and mesenchymal tumors. These tumors may be malignant or benign. They are usually described in relation to location: anterior, middle, or posterior masses or tumors.

Clinical Manifestations

Nearly all symptoms of mediastinal tumors result from the pressure of the mass against important intrathoracic organs. Symptoms may include cough, wheezing, dyspnea, anterior chest or neck pain, bulging of the chest wall, heart palpitations, angina, other circulatory disturbances, central cyanosis, superior vena cava syndrome (i.e., swelling of the face, neck, and upper extremities), marked distention of the veins of the neck and the chest wall (evidence of the obstruction of large veins of the mediastinum by extravascular compression or intravascular invasion), and dysphagia and weight loss from pressure or invasion into the esophagus (Berry, 2019).

Assessment and Diagnostic Findings

Chest x-rays are the major method used initially to diagnose mediastinal tumors and cysts. A CT scan is the standard diagnostic test for the assessment of the mediastinum and surrounding structures. MRI, as well as PET, may be used in some circumstances (Berry, 2019).

Chart 19-26 **NURSING RESEARCH PROFILE**

The Role of the Oncology Nurse Navigator

Jeyathevan, G., Lemonde, M., & Cooper Brathwaite, A. (2017). The role of oncology nurse navigators in facilitating continuity of care within the diagnostic phase for adult patients with lung cancer. *Canadian Oncology Nursing Journal*, *27*(1), 74–87.

Purpose

An emerging trend in the effective management of cancer care and treatment is the use of nurse navigators. The purpose of this phenomenologic qualitative research study was to explore the effectiveness of the oncology nurse navigator (ONN) in facilitating the care of the patient with lung cancer during the diagnostic period. Through the lens of both the ONN and the patient, the researchers explored the organizational and clinical component of the role and the impact on continuity of care and patient empowerment. This published report focused on continuity of care through the dimensions of informational, management, and relational continuity.

Design

A Bi-Dimensional Framework examining the organization and clinical role of the ONN guided this study. Using a phenomenologic approach, the "lived experience" of the patient and the ONN were explored. Purposive sampling yielded eight participants, four patients, and four ONNs. Criteria for patient participation in the study included: adults 18 years of age and older, symptoms suspicious of lung cancer, English speaking, and at least two prior contacts with the ONN. Criteria for nurse navigator participation in the study included: certification in oncology nursing, completion of courses specific to lung disease, and employed in the lung cancer diagnostic department as a nurse navigator. Semi-structured individual interviews were conducted with each participant; in addition, the ONNs participated in a focus group.

Findings

Five major themes emerged through an iterative process of thematic analysis from the perspective of the patient with lung cancer and the ONN. Themes identified included: patient focused care, needs assessment, shared decision making, accessibility, and eliminating barriers. These themes correspond to the continuity of care related to informational, management, and relational continuity.

Nursing Implications

Little is known about the impact of nurse navigators on the patient experience during the diagnostic and cancer treatment periods. This research provides empirical evidence on the importance of this role throughout the diagnostic period of cancer as perceived by both patients and ONNs. Patient-focused care was enhanced through the provision of timely, personalized information which aided in the patients' understanding of diagnostic tests and subsequent follow-up. Telephone needs assessment proved to be vital as the ONN explored not only medical symptoms and social aspects, but also included an assessment of cultural concerns prior to the patients' first visit to the cancer center. These interactions supported the theme of shared decision making; the participants felt empowered, rather than powerless, as the ONN involved them in their care. Empathy and therapeutic communication were expressed through the theme of accessibility. Participants acknowledged the "professional-personal" connection with the ONN. Through the trusting relationship that was formed, barriers were eliminated, and all aspects of care could be addressed during this phase of care. This research supports best practice standards

for the role of the nurse navigator and provides a framework for continued study in other specialties of care.

Medical Management

If the tumor is malignant and has infiltrated the surrounding tissue and complete surgical removal is not feasible, radiation therapy, chemotherapy, or both are used.

Many mediastinal tumors are benign and operable. The location of the tumor (anterior, middle, or posterior compartment) in the mediastinum dictates the type of incision. The common incision used is a median sternotomy; however, a thoracotomy may be used, depending on the location of the tumor. Additional approaches include a bilateral anterior thoracotomy (clamshell incision) and video-assisted thoracoscopic surgery. The care is the same as for any patient undergoing thoracic surgery. Major complications include hemorrhage, injury to the phrenic or recurrent laryngeal nerve, and infection.

Chest Trauma

Thoracic injuries occurred in over 194,622 patients and accounted for 22.58% of the types of trauma recently recorded in a national trauma database (American College of Surgeons, 2016). Four of the top 10 complications in trauma patients were related to the respiratory system: pneumonia, DVT/PE, unplanned extubation, and acute lung injury/ARDS (American College of Surgeons, 2016). Major chest trauma may occur alone or in combination with multiple other injuries. Chest trauma is classified as either blunt or penetrating. Blunt chest trauma results from sudden compression or positive pressure inflicted to the chest wall. Penetrating trauma occurs when a foreign object penetrates the chest wall.

Blunt Trauma

Overall, blunt thoracic injuries are directly responsible for 20% to 25% of all trauma deaths (Mancini, 2018). Although blunt chest trauma is more common than penetrating trauma, it is often difficult to identify the extent of the damage because the symptoms may be generalized and vague. In addition, patients may not seek immediate medical attention, which may complicate the problem.

Pathophysiology

The most common causes of blunt chest trauma are motor vehicle crashes (trauma from steering wheel, seat belt), falls, and bicycle crashes (trauma from handlebars). Types of blunt chest trauma include chest wall fractures, dislocations, and barotraumas (including diaphragmatic injuries); injuries of the pleura, lungs, and aerodigestive tracts; and blunt injuries of the heart, great arteries, veins, and lymphatics (Mancini,

2018). Injuries to the chest are often life-threatening and result in one or more of the following pathologic states:

- Hypoxemia from disruption of the airway; injury to the lung parenchyma, rib cage, and respiratory musculature; massive hemorrhage; collapsed lung; and pneumothorax
- Hypovolemia from massive fluid loss from the great vessels, cardiac rupture, or hemothorax
- Cardiac failure from cardiac tamponade, cardiac contusion, or increased intrathoracic pressure

These pathologic states frequently result in impaired V./Q. leading to acute kidney injury, hypovolemic shock, and death.

Assessment and Diagnostic Findings

Because time is critical in treating chest trauma, the patient must be assessed immediately to determine the following: time elapsed since injury occurred, mechanism of injury, level of responsiveness, specific injuries, estimated blood loss, recent drug or alcohol use, and prehospital treatment. Initial assessment of thoracic injuries includes assessment of airway obstruction, tension pneumothorax, open pneumothorax, massive hemothorax, flail chest, and cardiac tamponade. These injuries are life-threatening and require immediate treatment. Secondary assessment includes assessment of simple pneumothorax, hemothorax, pulmonary contusion, traumatic aortic rupture, tracheobronchial disruption, esophageal perforation, traumatic diaphragmatic injury, and penetrating wounds to the mediastinum. Although listed as secondary, these injuries may be life-threatening as well.

The physical examination includes inspection of the airway, thorax, neck veins, and breathing difficulty. Specifics include assessing the rate and depth of breathing for abnormalities such as stridor, cyanosis, nasal flaring, the use of accessory muscles, drooling, and overt trauma to the face, mouth, or neck. The chest is assessed for symmetric movement, symmetry of breath sounds, open chest wounds, entrance or exit wounds, impaled objects, tracheal shift, distended neck veins, subcutaneous emphysema, and paradoxical chest wall motion. In addition, the chest wall is assessed for bruising, petechiae, lacerations, and burns. The vital signs and skin color are assessed for signs of shock. The thorax is palpated for tenderness and crepitus, and the position of the trachea is also assessed.

The initial diagnostic workup includes a chest x-ray, CT scan, complete blood count, clotting studies, type and cross-match, electrolytes, oxygen saturation, arterial blood gas analysis, and ECG. The patient is completely undressed to avoid missing additional injuries that may complicate care. Many patients with injuries involving the chest have associated head and abdominal injuries that require attention. Ongoing assessment is essential to monitor the patient's response to treatment and to detect early signs of clinical deterioration.

Medical Management

The goals of treatment are to evaluate the patient's condition and to initiate aggressive resuscitation. An airway is immediately established with oxygen support and, in some

cases, ET intubation and ventilatory support. Reestablishing fluid volume and negative intrapleural pressure and draining intrapleural fluid and blood are essential.

The potential for massive blood loss and exsanguination with blunt or penetrating chest injuries is high because of injury to the great blood vessels. Many patients die at the scene of the injury or are in shock by the time help arrives. Agitation and irrational and combative behavior are signs of decreased oxygen delivery to the cerebral cortex. Strategies to restore and maintain cardiopulmonary function include ensuring an adequate airway and ventilation; stabilizing and reestablishing chest wall integrity; occluding any opening into the chest (open pneumothorax); and draining or removing any air or fluid from the thorax to relieve pneumothorax, hemothorax, or cardiac tamponade. Hypovolemia and low cardiac output must be corrected. Many of these treatment efforts, along with the control of hemorrhage, are carried out simultaneously at the scene of the injury or in the emergency department. Depending on the success of efforts to control the hemorrhage in the emergency department, the patient may be taken immediately to the operating room. Principles of management are essentially those pertaining to care of the postoperative thoracic patient (Urden et al., 2018).

Sternal and Rib Fractures

Sternal fractures are most common in motor vehicle crashes with a direct blow to the sternum via the steering wheel. Rib fractures are the most common type of chest trauma with blunt chest injury (Mancini, 2018). Most rib fractures are benign and are treated conservatively; ribs 4 through 10 are most frequently involved. Fractures of the first three ribs are rare but can result in a high mortality rate because they are associated with laceration of the subclavian artery or vein. Fractures of the lower ribs are associated with injury to the spleen and liver, which may be lacerated by fragmented sections of the rib. Older adult patients with three or more rib fractures have been shown to have a fivefold increased mortality rate and a fourfold increased incidence of pneumonia (Mancini, 2018).

Clinical Manifestations

Patients with sternal fractures have anterior chest pain, overlying tenderness, ecchymosis, crepitus, swelling, and possible chest wall deformity. For patients with rib fractures, clinical manifestations are similar: severe pain, point tenderness, and muscle spasm over the area of the fracture that are aggravated by coughing, deep breathing, and movement. The area around the fracture may be bruised. To reduce the pain, the patient splints the chest by breathing in a shallow manner and avoids sighs, deep breaths, coughing, and movement. This reluctance to move or breathe deeply results in diminished ventilation, atelectasis (collapse of unaerated alveoli), pneumonitis, and hypoxemia. Respiratory insufficiency and failure can be the outcomes of such a cycle.

Assessment and Diagnostic Findings

The patient must be closely evaluated for underlying cardiac injuries. A crackling, grating sound in the thorax (subcutaneous crepitus) may be detected with auscultation. The diagnostic workup may include a chest x-ray, rib films of a specific area, ECG, continuous pulse oximetry, and arterial blood gas analysis.

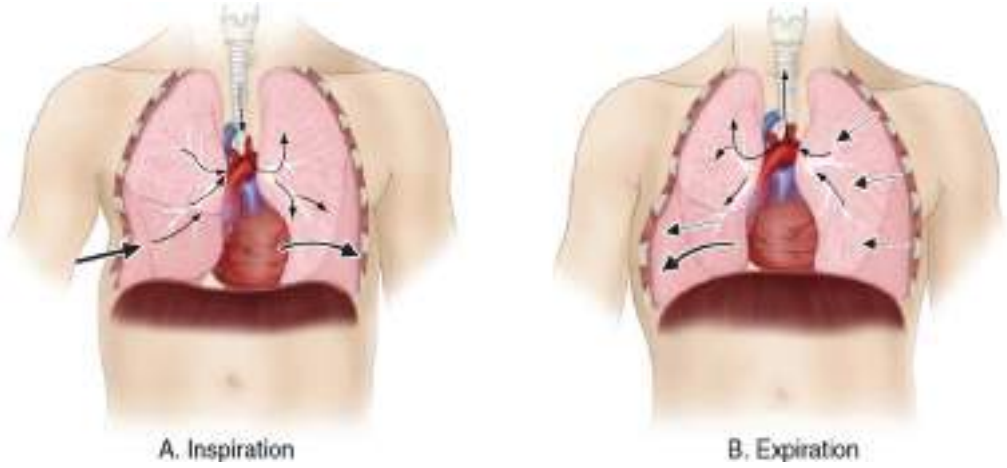


Figure 19-11 • Flail chest is caused by a free-floating segment of rib cage resulting from multiple rib fractures. **A.** Paradoxical movement on inspiration occurs when the flail rib segment is sucked inward and the mediastinal structures shift to the unaffected side. The amount of air drawn into the affected lung is reduced. **B.** On expiration, the flail segment bulges outward and the mediastinal structures shift back to the affected side.

Medical Management

Medical management is directed toward relieving pain, avoiding excessive activity, and treating any associated injuries. Surgical fixation is rarely necessary unless fragments are grossly displaced and pose a potential for further injury.

The goals of treatment of rib fractures are to control pain and to detect and treat the injury. Sedation is used to relieve pain and to allow deep breathing and coughing. Care must be taken to avoid oversedation and suppression of respiratory drive. Alternative strategies to relieve pain include an intercostal nerve block and ice over the fracture site. A chest binder may be used as supportive treatment to provide stability to the chest wall and may decrease pain. The patient is instructed to apply the binder snugly enough to provide support, but not to impair respiratory excursion. Usually, the pain abates in 5 to 7 days, and discomfort can be relieved with epidural analgesia, PCA, or nonopioid analgesia. Most rib fractures heal in 3 to 6 weeks. The patient is monitored closely for signs and symptoms of associated injuries.

Flail Chest

Flail chest is frequently a complication of blunt chest trauma, which may occur from a steering wheel injury, motor vehicle crash involving a pedestrian or cyclist, a significant fall onto the chest, or an assault with a blunt weapon. The incidence of flail chest among patients with chest wall injury is 5% to 13% (Sarani, 2019). It occurs when three or more adjacent ribs (multiple contiguous ribs) are fractured at two or more sites, resulting in free-floating rib segments. It may also result as a combination fracture of ribs and costal cartilages or sternum. As a result, the chest wall loses stability, causing respiratory impairment and usually severe respiratory distress.

Pathophysiology

During inspiration, as the chest expands, the detached part of the rib segment (flail segment) moves in a paradoxical manner (pendelluft movement) in that it is pulled inward during inspiration, reducing the amount of air that can be drawn into the lungs. On expiration, because the intrathoracic pressure exceeds atmospheric pressure, the flail segment bulges outward, impairing the patient's ability to exhale. The mediastinum then shifts back to the affected side (see Fig. 19-11). This paradoxical action results in increased dead space, a reduction in alveolar ventilation, and decreased compliance. Retained airway secretions and atelectasis frequently accompany flail chest. The patient has hypoxemia, and if gas exchange is greatly compromised, respiratory acidosis develops as a result of carbon dioxide retention. Hypotension, inadequate tissue perfusion, and metabolic acidosis often follow as the paradoxical motion of the mediastinum decreases cardiac output.

Medical Management

As with rib fracture, treatment of flail chest is usually supportive. Management includes providing ventilatory support, clearing secretions from the lungs, and controlling pain. Specific management depends on the degree of respiratory dysfunction. If only a small segment of the chest is involved, the objectives are to clear the airway through positioning, coughing, deep breathing, and suctioning to aid in the expansion of the lung, and to relieve pain by intercostal nerve blocks, high thoracic epidural blocks, or cautious use of IV opioids.

For mild-to-moderate flail chest injuries, the underlying pulmonary contusion is treated by monitoring fluid intake and appropriate fluid replacement while relieving chest pain. Pulmonary physiotherapy focusing on lung volume expansion and secretion management techniques is performed. The patient is closely monitored for further respiratory compromise.

For severe flail chest injuries, ET intubation and mechanical ventilation are required to provide internal pneumatic stabilization of the flail chest and to correct abnormalities in gas exchange. This helps to treat the underlying pulmonary contusion, serves to stabilize the thoracic cage to allow the fractures to heal, and improves alveolar ventilation and intrathoracic volume by decreasing the work of breathing. This treatment modality requires ET intubation and mechanical ventilator support. Differing modes of ventilation are used depending on the patient's underlying disease and specific needs.

Rib-specific plating systems may be used for three or more rib fractures or flail chest in order to achieve chest wall stabilization (CWS). These systems are inserted internally in the operating room, preferably within the first 72 hours of injury (see Fig. 19-12). The benefits of their use include decreased bleeding, less inflammation, and reduced chest wall deformities. Contraindications for CWS include traumatic brain injury and unstable spine fracture. With coexisting pulmonary contusion the overall efficacy of CWS remains controversial (Milanez de Campos & White, 2018).

Figure 19-12 • Chest wall stabilization (CWS) plating system provides chest wall stability for multiple fractures or a flail chest. Reproduced from Moya, M., Nirula, R., & Biffl, W. (2017). Rib fixation: Who, What, When? *Trauma Surgery & Acute Care Open*, *2*(1):e000059. Copyright © The American Association for the Surgery of Trauma with permission from BMJ Publishing Group Ltd. doi:10.1136/tsaco-2016-000059.

Regardless of the type of treatment, the patient is carefully monitored by serial chest x-rays, arterial blood gas analysis, pulse oximetry, and bedside pulmonary function monitoring. Pain management is key to successful treatment. PCA, intercostal nerve blocks, epidural analgesia, and intrapleural administration of opioids may be used to relieve or manage thoracic pain.

Pulmonary Contusion

Pulmonary contusion is a common thoracic injury and is frequently associated with flail chest. It is defined as damage to the lung tissues resulting in hemorrhage and localized edema. It is associated with chest trauma when there is rapid compression and decompression to the chest wall (i.e., blunt trauma). Pulmonary contusion represents a spectrum of lung injury characterized by the development of infiltrates and various degrees of respiratory dysfunction and sometimes respiratory failure. It is often cited as the most common potentially life-threatening chest injury; however, mortality is often attributed to other associated injuries. Pulmonary contusion may not be evident initially on examination but develops in the posttraumatic period; it may involve a small portion of one lung, a massive section of a lung, one entire lung, or both lungs. Depending on the extent of injury, this type of trauma may be associated with a mortality rate greater than 50% (Mancini, 2018).

Pathophysiology

The primary pathologic defect is an abnormal accumulation of fluid in the interstitial and intra-alveolar spaces. It is thought that injury to the lung parenchyma and its capillary network results in a leakage of serum protein and plasma. The leaking serum protein exerts an osmotic pressure that enhances loss of fluid from the capillaries. Blood, edema, and cellular debris (from cellular response to injury) enter the lung and accumulate in the bronchioles and alveoli, where they interfere with gas exchange. An increase in pulmonary vascular resistance and pulmonary artery pressure occurs. The patient has hypoxemia and carbon dioxide retention.

Clinical Manifestations

Pulmonary contusion may be mild, moderate, or severe. The clinical manifestations vary from decreased breath sounds, tachypnea, tachycardia, chest pain, hypoxemia, and blood-tinged secretions to more severe tachypnea, tachycardia, crackles, frank bleeding, severe hypoxemia (cyanosis), and respiratory acidosis. Changes in sensorium, including increased agitation or combative irrational behavior, may be signs of hypoxemia.

In addition, patients with moderate pulmonary contusion have a large amount of mucus, serum, and frank blood in the tracheobronchial tree; patients often have a constant cough but cannot clear the secretions. Patients with severe pulmonary contusion have signs and symptoms that mirror ARDS, which may include central cyanosis; agitation; combativeness; and productive cough with frothy, bloody secretions.

Assessment and Diagnostic Findings

The efficiency of gas exchange is determined by pulse oximetry and arterial blood gas measurements. Pulse oximetry is also used to measure oxygen saturation continuously. The initial chest x-ray may show no changes; changes may not appear for 1 or 2 days after the injury and appear as pulmonary infiltrates on chest x-ray.

Medical Management

Treatment priorities include maintaining the airway, providing adequate oxygenation, and controlling pain. In mild pulmonary contusion, adequate hydration via IV fluids and oral intake is important to mobilize secretions. However, fluid intake must be closely monitored to avoid hypervolemia. Volume expansion techniques, postural drainage, physiotherapy including coughing, and ET suctioning are used to remove the secretions. Pain is managed by intercostal nerve blocks or by opioids via PCA or other methods. Usually, antimicrobial therapy is given because the damaged lung is susceptible to infection. Supplemental oxygen is usually given by mask or cannula for 24 to 36 hours.

In patients with moderate pulmonary contusion, bronchoscopy may be required to remove secretions. Intubation and mechanical ventilation with PEEP may also be necessary to maintain the pressure and keep the lungs inflated. A nasogastric tube is inserted to relieve gastrointestinal distention.

In patients with severe contusion, who may develop respiratory failure, aggressive treatment with ET intubation and ventilatory support, diuretics, and fluid restriction

may be necessary. Antimicrobial medications may be prescribed for the treatment of pulmonary infection. This is a common complication of pulmonary contusion (especially pneumonia in the contused segment) because the fluid and blood that extravasate into the alveolar and interstitial spaces serve as an excellent culture medium.

Penetrating Trauma

Any organ or structure within the chest is potentially susceptible to traumatic penetration. These organs include the chest wall, lung and pleura, tracheobronchial system, esophagus, diaphragm, and major thoracic blood vessels, as well as heart and other mediastinal structures. The clinical consequence of penetrating trauma to the chest depends on the mechanism of injury, location, associated injuries, and underlying illnesses (Shahani, 2017). Common injuries include pneumothorax and cardiac tamponade.

Medical Management

The objective of immediate management is to restore and maintain cardiopulmonary function. After an adequate airway is ensured and ventilation is established, examination for shock and intrathoracic and intra-abdominal injuries is necessary. The patient is undressed completely so that additional injuries are not missed (see Chapter 67 for discussion of primary and secondary survey). There is a high risk of associated intra-abdominal injuries with stab wounds below the level of the fifth anterior intercostal space. Death can result from exsanguinating hemorrhage or intra-abdominal sepsis.

The diagnostic workup includes a chest x-ray, chemistry profile, arterial blood gas analysis, pulse oximetry, and ECG. The patient's blood is typed and cross-matched in case blood transfusion is required. After the status of the peripheral pulses is assessed, a large-bore IV line is inserted. An indwelling catheter is inserted to monitor urinary output. A nasogastric tube is inserted and connected to low suction to prevent aspiration, minimize leakage of abdominal contents, and decompress the gastrointestinal tract.

Hemorrhagic shock is treated simultaneously with colloid solutions, crystalloids, or blood, as indicated by the patient's condition. Diagnostic procedures are carried out as dictated by the needs of the patient (e.g., CT scans of chest or abdomen, flat plate x-ray of the abdomen) (see Chapter 11).

A chest tube is inserted into the pleural space in most patients with penetrating wounds of the chest to achieve rapid and continuing re-expansion of the lungs. The insertion of the chest tube frequently results in a complete evacuation of the blood and air. The chest tube also allows early recognition of continuing intrathoracic bleeding, which would make surgical exploration necessary. If the patient has a penetrating wound of the heart or great vessels, the esophagus, or the tracheobronchial tree, surgical intervention is required.

Pneumothorax

Pneumothorax occurs when the parietal or visceral pleura is breached and the pleural space is exposed to positive atmospheric pressure. Normally, the pressure in the pleural space is negative or subatmospheric; this negative pressure is required to maintain lung inflation. When either pleura is breached, air enters the pleural space, and the lung or a portion of it collapses.

Types of Pneumothorax

Types of pneumothorax include simple, traumatic, and tension pneumothorax.

Simple Pneumothorax

A simple, or spontaneous, pneumothorax occurs when air enters the pleural space through a breach of either the parietal or visceral pleura. Most commonly, this occurs as air enters the pleural space through the rupture of a bleb or a bronchopleural fistula. A spontaneous pneumothorax may occur in an apparently healthy person in the absence of trauma due to rupture of an air-filled bleb, or blister, on the surface of the lung, allowing air from the airways to enter the pleural cavity. It may be associated with diffuse interstitial lung disease and severe emphysema.

Traumatic Pneumothorax

A traumatic pneumothorax occurs when air escapes from a laceration in the lung itself and enters the pleural space or from a wound in the chest wall. It may result from blunt trauma (e.g., rib fractures), penetrating chest or abdominal trauma (e.g., stab wounds or gunshot wounds), or diaphragmatic tears. Traumatic pneumothorax may occur during invasive thoracic procedures (i.e., thoracentesis, transbronchial lung biopsy, and insertion of a subclavian line) in which the pleura is inadvertently punctured, or with barotrauma from mechanical ventilation.

A traumatic pneumothorax resulting from major injury to the chest is often accompanied by hemothorax (collection of blood in the pleural space resulting from torn intercostal vessels, lacerations of the great vessels, or lacerations of the lungs). Hemopneumothorax (both blood and air in the chest cavity) is also common after major trauma. Chest surgery can be classified as a traumatic pneumothorax as a result of the entry into the pleural space and the accumulation of air and fluid in the pleural space.

Open pneumothorax is one form of traumatic pneumothorax. It occurs when a wound in the chest wall is large enough to allow air to pass freely in and out of the thoracic cavity with each attempted respiration. Because the rush of air through the wound in the chest wall produces a sucking sound, such injuries are termed *sucking chest wounds.* In such patients, not only does the lung collapse, but the structures of the mediastinum (heart and great vessels) also shift toward the uninjured side with each inspiration and in the opposite direction with expiration. This is termed *mediastinal flutter* or *swing,* and it produces serious circulatory problems.

Quality and Safety Nursing Alert

Traumatic open pneumothorax calls for emergency interventions. Stopping the flow of air through the opening in the chest wall is a lifesaving measure.

Tension Pneumothorax

A **tension pneumothorax** occurs when air is drawn into the pleural space from a lacerated lung or through a small opening or wound in the chest wall. It may be a complication of other types of pneumothorax. In contrast to open pneumothorax, the air that enters the chest cavity with each inspiration is trapped; it cannot be expelled during expiration through the air passages or the opening in the chest wall. In effect, a one-way valve or ball valve mechanism occurs where air enters the pleural space but cannot escape. With each breath, tension (positive pressure) is increased within the affected pleural space. This causes the lung to collapse and the heart, the great vessels, and the trachea to shift toward the unaffected side of the chest (mediastinal shift). Both respiration and circulatory function are compromised because of the increased intrathoracic pressure, which decreases venous return to the heart, causing decreased cardiac output and impairment of peripheral circulation. In extreme cases, the pulse may be undetectable—this is known as pulseless electrical activity.

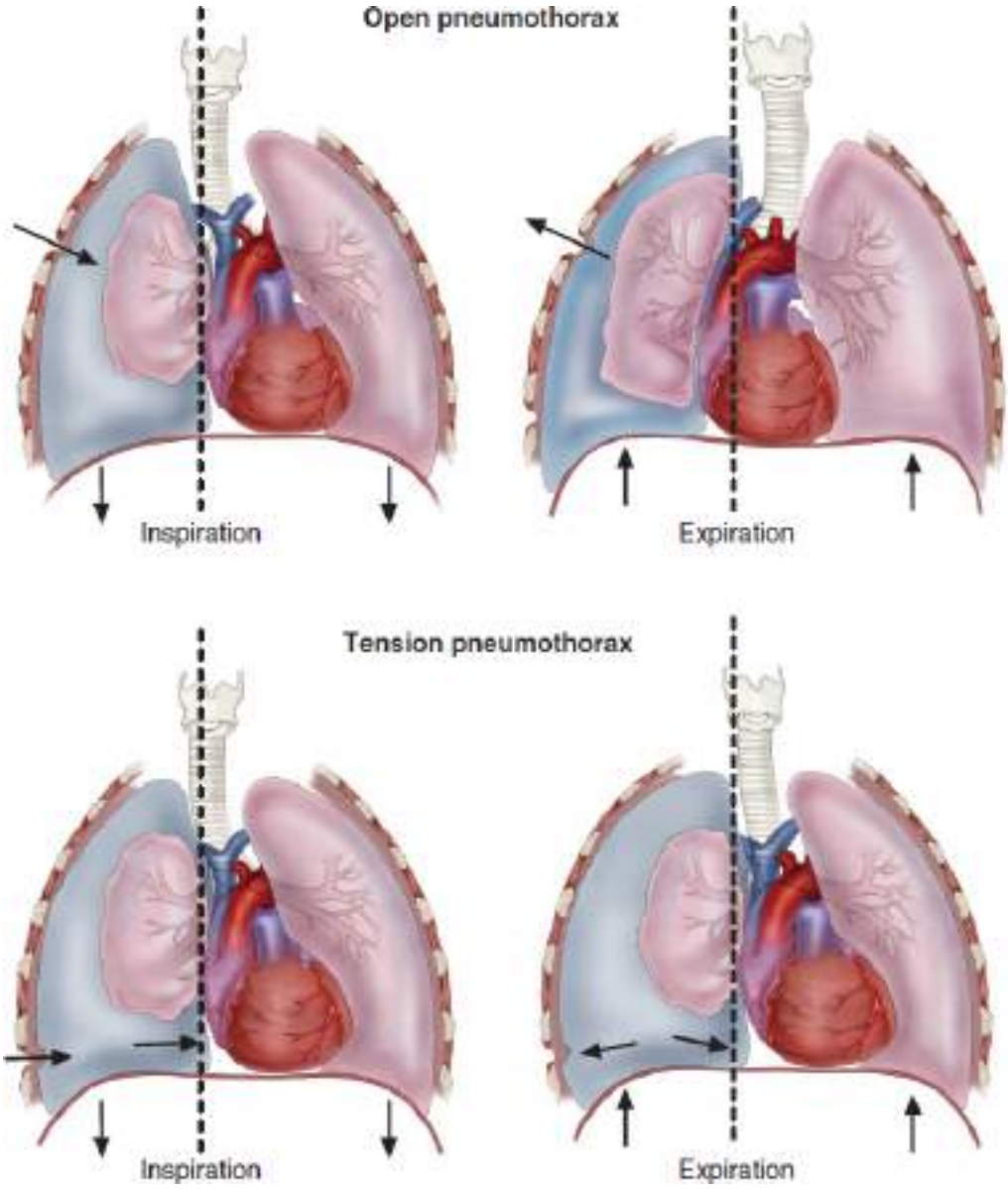


Figure 19-13 • Open pneumothorax (**top**) and tension pneumothorax (**bottom**). In open pneumothorax, air enters the chest during inspiration and exits during expiration. A slight shift of the affected lung may occur because of a decrease in pressure as air moves out of the chest. In tension pneumothorax, air enters but cannot leave the chest. As the pressure increases, the heart and great vessels are compressed and the mediastinal structures are shifted toward the opposite side of the chest. The trachea is pushed from its normal midline position toward the opposite side of the chest, and the unaffected lung is compressed.

Clinical Manifestations

The signs and symptoms associated with pneumothorax depend on its size and cause. Pain is usually sudden and may be pleuritic. The patient may have only minimal respiratory distress with slight chest discomfort and tachypnea with a small simple or uncomplicated pneumothorax. If the pneumothorax is large and the lung collapses totally, acute respiratory distress occurs. The patient is anxious, has dyspnea and air

hunger, has increased use of the accessory muscles, and may develop central cyanosis from severe hypoxemia.

In assessing the chest for any type of pneumothorax, the nurse assesses tracheal alignment, expansion of the chest, breath sounds, and percussion of the chest. In a simple pneumothorax, the trachea is midline, expansion of the chest is decreased, breath sounds may be diminished or absent, and percussion of the chest may reveal normal sounds or hyperresonance depending on the size of the pneumothorax. In a tension pneumothorax, the trachea is shifted away from the affected side, chest expansion may be decreased or fixed in a hyperexpansion state, breath sounds are diminished or absent, and percussion to the affected side is hyperresonant. The clinical picture is one of air hunger, agitation, increasing hypoxemia, central cyanosis, hypotension, tachycardia, and profuse diaphoresis. Figure 19-13 compares open and tension pneumothorax.

Medical Management

Medical management of pneumothorax depends on its cause and severity. The goal of treatment is to evacuate the air or blood from the pleural space. A small chest tube (28 Fr) is inserted near the second intercostal space; this space is used because it is the thinnest part of the chest wall, minimizes the danger of contacting the thoracic nerve, and leaves a less visible scar. If a patient also has a hemothorax, a large-diameter chest tube (32 Fr or greater) is inserted, usually in the fourth or fifth intercostal space at the midaxillary line. The tube is directed posteriorly to drain the fluid and air. Once the chest tube or tubes are inserted and suction is applied (usually to 20 mm Hg suction), effective decompression of the pleural cavity (drainage of blood or air) occurs.

If an excessive amount of blood enters the chest tube in a relatively short period, an autotransfusion may be needed. This technique involves taking the patient's own blood that has been drained from the chest, filtering it, and then transfusing it back into the vascular system.

In such an emergency, anything may be used that is large enough to fill the chest wound—a towel, a handkerchief, or the heel of the hand. If conscious, the patient is instructed to inhale and strain against a closed glottis. This action assists in re-expanding the lung and ejecting the air from the thorax. In the hospital, the opening is plugged by sealing it with gauze impregnated with petrolatum. A pressure dressing is applied. Usually, a chest tube connected to water-seal drainage is inserted to remove air and fluid. Antibiotics usually are prescribed to combat infection from contamination.

The severity of open pneumothorax depends on the amount and rate of thoracic bleeding and the amount of air in the pleural space. The pleural cavity can be decompressed by thoracentesis or by chest tube drainage of the blood or air. The lung is then able to re-expand and resume the function of gas exchange. As a rule of thumb, thoracotomy is performed if more than 1500 mL of blood is aspirated initially by thoracentesis (or is the initial chest tube output) or if chest tube output continues at greater than 200 mL/h (Shahani, 2017). The urgency with which the blood must be removed is determined by the degree of respiratory compromise. An emergency thoracotomy may also be performed in the emergency department if a cardiovascular injury secondary to chest or penetrating trauma is suspected. The patient with a possible tension pneumothorax should immediately be given a high concentration of supplemental oxygen to treat the hypoxemia, and pulse oximetry should be used to

monitor oxygen saturation. In an emergency situation, a tension pneumothorax can be decompressed or quickly converted to a simple pneumothorax by inserting a large-bore needle (14 gauge) at the second intercostal space, midclavicular line on the affected side. This relieves the pressure and vents the positive pressure to the external environment. A chest tube is then inserted and connected to suction to remove the remaining air and fluid, reestablish the negative pressure, and re-expand the lung. If the lung re-expands and air leakage from the lung parenchyma stops, further drainage may be unnecessary. If a prolonged air leak continues despite chest tube drainage to underwater seal, surgery may be necessary to close the leak.

Chest Drainage

Chest tubes and a closed drainage system are used to re-expand the involved lung and to remove excess air, fluid, and blood, and may be used in patients who have had a thoracotomy (see previous discussion). Chest drainage systems also are frequently indicated in the treatment of spontaneous pneumothorax and trauma resulting in pneumothorax. Table 19-8 describes and compares the main features of these systems.

For the procedural guidelines for setting up and managing chest drainage systems, go to thepoint.lww.com/Brunner15e.

The normal breathing mechanism operates on the principle of negative pressure. The pressure in the chest cavity normally is lower than the pressure of the atmosphere, causing air to move into the lungs during inspiration. Whenever the chest is opened, there is a loss of negative pressure, which results in collapse of the lung. The collection of air, fluid, or other substances in the chest can compromise cardiopulmonary function and can also cause the lung to collapse. Pathologic substances that can collect in the pleural space include fibrin or clotted blood, liquids (serous fluids, blood, pus, chyle), and gases (air from the lung, tracheobronchial tree, or esophagus).

Chest tubes may be inserted to drain fluid or air from any of the three compartments of the thorax (the right and left pleural spaces and the mediastinum). The pleural space, located between the visceral and parietal pleura, normally contains 20 mL or less of fluid, which helps lubricate the visceral and parietal pleura (Norris, 2019).

There are two types of chest tubes: small-bore and large-bore catheters. Small-bore catheters (7 Fr to 12 Fr) have a one-way valve apparatus to prevent air from moving back into the chest. They can be inserted through a small skin incision. Large-bore catheters, which range in size up to 40 Fr, are usually connected to a chest drainage system to collect any pleural fluid and monitor for air leaks. After the chest tube is positioned, it is sutured to the skin and connected to a drainage apparatus to remove the residual air and fluid from the pleural or mediastinal space. This results in the re-expansion of remaining lung tissue.

TABLE 19-8 Comparison of Chest Drainage Systems[a]

Types of Chest Drainage Systems	Description	Comments
Traditional Water Seal		
Also referred to as wet suction	Has three chambers: a collection chamber, water-seal chamber (middle chamber), and wet suction control chamber	Requires that sterile fluid be instilled into water seal and suction chambers Has positive- and negative-pressure release valves Intermittent bubbling indicates that the system is functioning properly. Additional suction can be added by connecting system to a suction source.
Dry Suction Water Seal		
Also referred to as dry suction	Has three chambers: a collection chamber, water-seal chamber (middle chamber), and suction regulator dial	Requires that sterile fluid be instilled in water-seal chamber at 2-cm level No fluid-filled suction chamber Suction pressure is set with a suction regulator dial. Has positive- and negative-pressure release valves Has an indicator to signify that the suction pressure is adequate Quieter than traditional water-seal systems
Dry Suction		
Also referred to as one-way valve system	Has a one-way mechanical valve that allows air to leave the chest and prevents air from moving back into the chest	No need to fill suction chamber with fluid; thus, can be set up quickly in an emergency Works even if knocked over, making it ideal for patients who are ambulatory

[a]If no fluid drainage is expected, a drainage collection device may not be needed.

Chest Drainage Systems

Chest drainage systems have a suction source, a collection chamber for pleural drainage, and a mechanism to prevent air from reentering the chest with inhalation (see Fig. 19-14). Various types of chest drainage systems are available for use in the removal of air and fluid from the pleural space and re-expansion of the lungs. Chest drainage systems come with either wet (water seal) or dry suction control. In wet suction systems, the amount of suction is determined by the amount of water instilled in the suction chamber. The amount of bubbling in the suction chamber indicates the strength of the suction. Wet systems use a water seal to prevent air from moving back into the chest on inspiration. Dry systems use a one-way valve and may have a suction

control dial in place of the water. Both systems can operate by gravity drainage, without a suction source.

Figure 19-14 • Chest drainage systems. **A.** The Atrium Ocean is an example of a water-seal chest drain system composed of a drainage chamber and water-seal chamber. The suction control is determined by the height of the water column in that chamber (usually 20 cm). *A,* suction control chamber; *B,* water-seal chamber; *C,* air leak zone; *D,* collection chamber. **B.** The Atrium Oasis is an example of a dry suction water-seal system that uses a mechanical regulator for vacuum control, a water-seal

chamber, and a drainage chamber. *A,* dry suction regulator; *B,* water-seal chamber; *C,* air leak monitor; *D,* collection chamber; *E,* suction monitor bellows. Photos used with permission from Atrium Medical Corporation, Hudson, NH.

Quality and Safety Nursing Alert

When the wall vacuum is turned off, the drainage system must be open to the atmosphere so that intrapleural air can escape from the system. This can be done by detaching the tubing from the suction port to provide a vent.

Water-Seal Systems

The traditional water-seal system (or wet suction) for chest drainage has three chambers: a collection chamber, a water-seal chamber, and a wet suction control chamber. The collection chamber acts as a reservoir for fluid draining from the chest tube. It is graduated to permit easy measurement of drainage. Suction may be added to create negative pressure and promote drainage of fluid and removal of air. The suction control chamber regulates the amount of negative pressure applied to the chest. The amount of suction is determined by the water level. It is usually set at 20 cm H_2O; adding more fluid results in more suction. After the suction is turned on, bubbling appears in the suction chamber. A positive-pressure valve is located at the top of the suction chamber that automatically opens with increases in positive pressure within the system. Air is automatically released through a positive-pressure relief valve if the suction tubing is inadvertently clamped or kinked.

The water-seal chamber has a one-way valve or water seal that prevents air from moving back into the chest when the patient inhales. There is an increase in the water level with inspiration and a return to the baseline level during exhalation; this is referred to as tidaling. Intermittent bubbling in the water-seal chamber is normal, but continuous bubbling can indicate an air leak. Bubbling and tidaling do not occur when the tube is placed in the mediastinal space; however, fluid may pulsate with the patient's heartbeat. If the chest tube is connected to gravity drainage only, suction is not used. The pressure is equal to the water seal only. Two-chamber chest drainage systems (water-seal chamber and collection chamber) are available for use with patients who need only gravity drainage.

The water level in the water-seal chamber reflects the negative pressure present in the intrathoracic cavity. A rise in the water level indicates negative pressure in the pleural or mediastinal space. Excessive negative pressure can cause trauma to tissue. Most chest drainage systems have an automatic means to prevent excessive negative pressure. By pressing and holding a manual high-negativity vent (usually located on the top of the chest drainage system) until the water level in the water-seal chamber returns to the 2-cm mark, excessive negative pressure is avoided, preventing damage to tissue.

Quality and Safety Nursing Alert

If the chest tube and drainage system become disconnected, air can enter the pleural space, producing a pneumothorax. To prevent pneumothorax if the chest tube is inadvertently disconnected from the drainage system, a temporary water seal can be established by immersing the chest tube's open end in a bottle of sterile water.

Dry Suction Water-Seal Systems

Dry suction water-seal systems, also referred to as dry suction, have a collection chamber for drainage, a water-seal chamber, and a dry suction control regulator. The water-seal chamber is filled with water to the 2-cm level. Bubbling in this area can indicate an air leak. The dry suction control regulator provides a dial that conveniently regulates vacuum to the chest drain. The system does not contain a suction control chamber filled with water. Without a water-filled suction chamber, the machine is quieter. However, if the container is knocked over, the water seal may be lost.

Once the tube is connected to the suction source, the regulator dial allows the desired level of suction to be set; the suction is increased until an indicator appears. The indicator has the same function as the bubbling in the traditional water-seal system—that is, it indicates that the vacuum is adequate to maintain the desired level of suction. Some drainage systems use a bellows (a chamber that can be expanded or contracted) or an orange-colored float device as an indicator of when the suction control regulator is set.

When the water in the water seal rises above the 2-cm level, intrathoracic pressure increases. Dry suction water-seal systems have a manual high-negativity vent located on top of the drain. The manual high-negativity vent is pressed until the indicator appears (either a float device or bellows) and the water level in the water seal returns to the desired level, indicating that the intrathoracic pressure is decreased.

Quality and Safety Nursing Alert

The manual vent should not be used to lower the water level in the water seal when the patient is on gravity drainage (no suction) because intrathoracic pressure is equal to the pressure in the water seal.

Dry Suction Systems with a One-Way Valve

A third type of chest drainage system is dry suction with a one-way mechanical valve. This system has a collection chamber, a one-way mechanical valve, and a dry suction control chamber. The valve permits air and fluid to leave the chest but prevents their movement back into the pleural space. This model lacks a water-seal chamber and therefore can be set up quickly in emergency situations, and the dry control drain still works even if it is knocked over. This makes the dry suction systems useful for the patient who is ambulating or being transported. However, without the water-seal chamber, there is no way to tell by inspection whether the pressure in the chest has changed, even though an air leak indicator is present so that the system can be checked. If an air leak is suspected, 30 mL of water is injected into the air leak indicator or the container is tipped so that fluid enters the air leak detection chamber. Bubbles will appear if a leak is present.

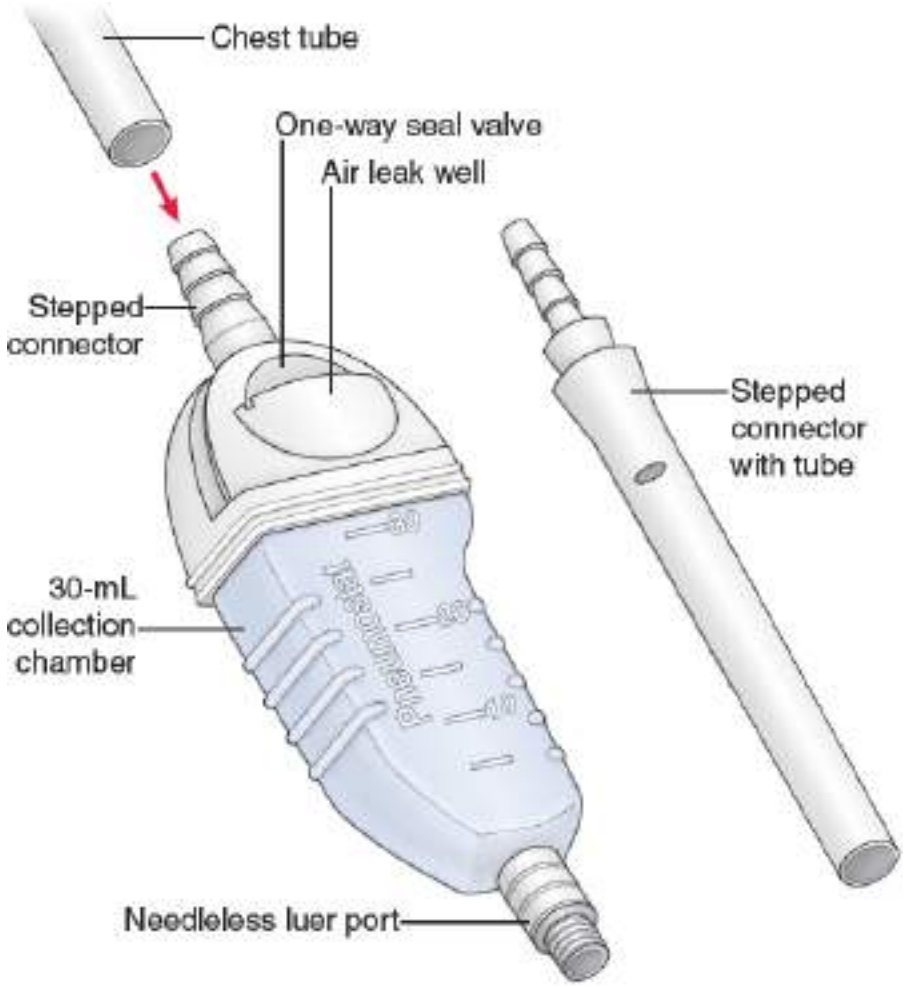


Figure 19-15 • One-way (Heimlich) valve, a disposable, single-use chest drainage system with 30-mL collection volume. Used when minimal volume of chest drainage is expected.

If the chest tube has been inserted to re-expand a lung after pneumothorax, or if very little fluid drainage is expected, a one-way valve (Heimlich valve) may be connected to the chest tube. This valve may be attached to a collection bag (see Fig. 19-15) or covered with a sterile dressing if no drainage is expected.

Cardiac Tamponade

Cardiac tamponade is compression of the heart resulting from fluid or blood within the pericardial sac. It usually is caused by blunt or penetrating trauma to the chest. A penetrating wound of the heart is associated with a high mortality rate. Cardiac tamponade also may follow diagnostic cardiac catheterization, angiographic procedures, and pacemaker insertion, which can produce perforations of the heart and great vessels. Pericardial effusion with fluid compressing the heart also may develop from metastases to the pericardium from malignant tumors of the breast, lung, or mediastinum and may occur with lymphomas and leukemias, kidney injury, TB, and high-dose radiation to the chest (see Chapter 25 for a detailed discussion of cardiac tamponade).

Subcutaneous Emphysema

No matter what kind of chest trauma a patient has, when the lung or the air passages are injured, air may enter the tissue planes and pass for some distance under the skin (e.g., neck and chest). The tissues give a crackling sensation when palpated, and the subcutaneous air produces an alarming appearance as the face, neck, body, and scrotum become misshapen by subcutaneous air. Subcutaneous emphysema is of itself usually not a serious complication. The subcutaneous air is spontaneously absorbed if the underlying air leak is treated or stops spontaneously. In severe cases in which there is widespread subcutaneous emphysema, a tracheostomy is indicated if airway patency is threatened by pressure of the trapped air on the trachea.

CRITICAL THINKING EXERCISES

1 ipc An 84-year-old male is brought to the ED by his daughter with reports of increasing shortness of breath over the past 2 days. You begin your assessment and note that the patient's vital signs include a BP of 110/72 mm Hg, heart rate of 92 bpm, RR of 26/min, and temperature is 38°C (100.4°F). The patient has marked inspiratory and expiratory wheezes that are audible upon auscultation. Oxygen saturation is 92% on room air. The patient denies chest pain; however, he admits to general fatigue, shortness of breath with exertion, and a moist unproductive cough. The daughter explains he resides at home with her and is wheelchair dependent. His past medical history includes an occipital stroke, open reduction internal fixation (ORIF) of right and left hip following fractures, bilateral pulmonary emboli, and paroxysmal atrial fibrillation. The patient's daughter tells you that he has difficulty with dentition with frequent episodes of coughing while eating. The patient admits he stopped taking his prescribed warfarin 6 months ago since he experienced several falls. What are the potential causes of his respiratory problem and what nursing interventions are important? What interdisciplinary team members warrant consultation in the care of the patient?

2 pq A 26-year-old male arrives via Emergency Medical Services (EMS) to the ED following a motor vehicle crash (MVC). The patient is awake and alert; however, he complains of sharp pain in his chest that extends to his back, neck, and shoulders. You begin your assessment and note that the patient's vital signs include a BP of 90/42 mm Hg, heart rate of 101 bpm, and RR of 32/min. He is pale and dyspneic with an oxygen saturation of 89% on 4 L of O_2 via nasal cannula. Inspection of the chest wall reveals areas of ecchymoses over the right shoulder and right anterior chest wall. The emergency medical technician (EMT) reports the patient was the sole driver of the automobile and bystanders stated the driver swerved to avoid a deer and hit a telephone pole. The patient was wearing a seatbelt; however, the air bags did not deploy. Auscultation of the chest reveals an absence of lung sounds on the right side with diminished lung sounds on the left side. What are the possible respiratory conditions associated with the clinical presentation of this patient? Describe your priorities of care.

3 ebp An 18-year-old female is admitted to the ICU from the ED with a diagnosis of acute respiratory failure. She is endotracheally intubated and placed on mechanical ventilation. Her past medical history includes a fractured left ulnar at the age of 10 but is otherwise unremarkable. She denies drug use; however, she admits to use of e-cigarettes since the 10th grade. The intensivist suspects EVALI. Forty-eight hours following intubation, diffuse hazy opacities are noted on chest x-ray throughout all lung fields. What evidence is available associating the use of electronic nicotine delivery systems (ENDS) with acute lung injury? What strategies should you implement to prevent ventilator-associated pneumonia (VAP) in this patient? What is the evidence base for the strategies that you consider? How would you evaluate the strength of the evidence?

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*Asterisk indicates nursing research.
**Double asterisk indicates classic references.

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Resources

Agency for Healthcare Research and Quality (AHRQ), ahrq.gov
American Association for Respiratory Care (AARC), aarc.org
American Cancer Society, cancer.org
American College of Chest Physicians (ACCP), chestnet.org
American Lung Association, lung.org
American Thoracic Society (ATS), thoracic.org
Foundation for Sarcoidosis Research, www.stopsarcoidosis.org
National Cancer Institute (NCI), cancer.gov
Occupational Safety and Health Administration (OSHA), osha.gov
Pulmonary Hypertension Association (PHA), phassociation.org
Respiratory Nursing Society (RNS), respiratorynursingsociety.org

20 Management of Patients with Chronic Pulmonary Disease

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the pathophysiology, clinical manifestations, treatment, and medical and nursing management of chronic pulmonary diseases, including chronic obstructive pulmonary disease, bronchiectasis, asthma, and cystic fibrosis.
2. Discuss the major risk factors for developing chronic obstructive pulmonary disease and nursing interventions to minimize or prevent these risk factors.
3. Use the nursing process as a framework for care of the patient with chronic obstructive pulmonary disease.
4. Develop an education plan for patients with chronic obstructive pulmonary disease.
5. Discuss nursing management of and patient education and transitions in care considerations for patients receiving oxygen therapy.
6. Describe asthma self-management strategies.

NURSING CONCEPTS

Oxygenation

GLOSSARY

air trapping: incomplete emptying of alveoli during expiration due to loss of lung tissue elasticity (emphysema), bronchospasm (asthma), or airway obstruction

alpha$_1$-antitrypsin deficiency: genetic disorder resulting from deficiency of alpha$_1$-antitrypsin, a protective agent for the lung; increases patient's risk for developing panacinar emphysema even in the absence of smoking

asthma: a heterogeneous disease, usually characterized by chronic airway inflammation; defined by history of symptoms such as wheeze, shortness of breath, chest tightness, and cough that vary over time and in intensity

bronchiectasis: chronic, irreversible dilation of the bronchi and bronchioles that results from the destruction of muscles and elastic connective tissue; dilated airways become saccular and are a medium for chronic infection

chest percussion: manually cupping hands over the chest wall and using vibration to mobilize secretions by mechanically dislodging viscous or adherent secretions in the lungs

chest physiotherapy (CPT): therapy used to remove bronchial secretions, improve ventilation, and increase the efficiency of the respiratory muscles; types include postural drainage, chest percussion, and vibration, and breathing retraining

chronic bronchitis: a disease of the airways defined as the presence of cough and sputum production for at least a combined total of 3 months in each of 2 consecutive years

chronic obstructive pulmonary disease (COPD): disease state characterized by airflow limitation that is not fully reversible; sometimes referred to as chronic airway obstruction or chronic obstructive lung disease

desaturate: a precipitous drop in the saturation of hemoglobin with oxygen

dry-powder inhaler (DPI): a compact, portable inspiratory flow–driven inhaler that delivers dry-powder medications into the patient's lungs

emphysema: a disease of the airways characterized by destruction of the walls of overdistended alveoli

flutter valve: portable handheld mucous clearance device; consisting of a tube with an oscillating steel ball inside; upon expiration, high-frequency oscillations facilitate mucous expectoration

fraction of inspired oxygen (FiO_2): concentration of oxygen delivered (e.g., 1.0 equals to 100% oxygen)

hypoxemia: decrease in arterial oxygen tension in the blood

hypoxia: decrease in oxygen supply to the tissues and cells

polycythemia: increase in the red blood cell concentration in the blood; in COPD, the body attempts to improve oxygen-carrying capacity by producing increasing amounts of red blood cells

postural drainage: positioning the patient to allow drainage from all lobes of the lungs and airways

pressurized metered-dose inhaler (pMDI): a compact, portable patient-activated pressurized medication canister that provides aerosolized medication that the patient inhales into the lungs

small-volume nebulizer (SVN): a handheld generator-driven medication delivery system that provides aerosolized liquid medication that the patient inhales into the lungs

spirometry: pulmonary function tests that measure specific lung volumes (e.g., FEV_1, FVC) and rates (e.g., $FEF_{25\%–75\%}$); may be measured before and after bronchodilator administration

vibration: a type of massage given by quickly tapping the chest with the fingertips or alternating the fingers in a rhythmic manner, or by using a mechanical device to assist in mobilizing lung secretions

Chronic pulmonary disorders are a leading cause of morbidity and mortality in the United States. Nurses care for patients with chronic pulmonary disease across the spectrum of care, from outpatient and home care to emergency department (ED), critical care, and hospice settings. To care for these patients, nurses not only need to have astute assessment and clinical management skills, but they also need knowledge of how these disorders can affect quality of life. In addition, the nurse's knowledge of palliative and end-of-life care is important for applicable patients. Patient and family education is an important nursing intervention to enhance self-management in patients with any chronic pulmonary disorder.

Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) is a preventable and treatable slowly progressive respiratory disease of airflow obstruction involving the airways, pulmonary parenchyma, or both (Global Initiative for Chronic Obstructive Lung Disease [GOLD], 2019). The parenchyma includes any form of lung tissue, including bronchioles, bronchi, blood vessels, interstitium, and alveoli. The airflow limitation or obstruction in COPD is not fully reversible. Most patients with COPD present with overlapping signs and symptoms of emphysema and chronic bronchitis, which are two distinct disease processes.

COPD may include diseases that cause airflow obstruction (e.g., emphysema, chronic bronchitis) or any combination of these disorders. Other

diseases such as cystic fibrosis (CF), bronchiectasis, and asthma are classified as chronic pulmonary disorders. Asthma is considered a distinct, separate disorder and is classified as an abnormal airway condition characterized primarily by reversible inflammation. COPD can coexist with asthma. Both of these diseases have the same major symptoms; however, symptoms are generally more variable in asthma than in COPD. This chapter discusses COPD as a disease and describes chronic bronchitis and emphysema as distinct disease states, providing a foundation for understanding the pathophysiology of COPD. Bronchiectasis, asthma, and CF are discussed separately.

While COPD and lower respiratory diseases are the fourth leading cause of death for people of all ages in the United States, they are the third leading cause of death for people ages 65 and over (Centers for Disease Control and Prevention [CDC], 2018a). In 2016, approximately 154,596 Americans died from COPD and lower respiratory diseases (CDC, 2017a). The CDC (2018b) reports that over 16 million Americans live with COPD. This number does not account for the millions of Americans who have COPD but are not diagnosed. Although the rate of hospitalizations for COPD is slowly decreasing, the Agency for Healthcare Research and Quality (AHRQ) reported in 2016 that there were still 501,849 hospitalizations that had COPD as a primary diagnosis (AHRQ, 2016). The cost of individual hospital admissions for patients with COPD is approximately $6245 more per year than admissions for patients without COPD. COPD's economic burden goes beyond the direct medical costs. Patients with COPD were 60% more likely to call in sick to work and 2.6 times more likely to incur short-term disability than patients without COPD (Patel, Coutinho, Lunacsek, et al., 2018).

Pathophysiology

People with COPD commonly become symptomatic during the middle adult years, and the incidence of the disease increases with age. Although certain aspects of lung function normally decrease with age—for example, vital capacity and forced expiratory volume in 1 second (FEV_1)—COPD accentuates and accelerates these physiologic changes as described later. In COPD, the airflow limitation is both progressive and associated with the lungs' abnormal inflammatory response to noxious particles or gases. The inflammatory response occurs throughout the proximal and peripheral airways, lung parenchyma, and pulmonary vasculature (GOLD, 2019). Because of the chronic inflammation and the body's attempts to repair it, changes and narrowing occur in the airways. In the proximal airways (trachea and bronchi greater than 2 mm in diameter), changes include increased numbers of goblet cells and enlarged submucosal glands, both of which lead to hypersecretion of mucus. In the peripheral airways (bronchioles less than 2 mm diameter),

inflammation causes thickening of the airway wall, peribronchial fibrosis, exudate in the airway, and overall airway narrowing (obstructive bronchiolitis). Over time, this ongoing injury-and-repair process causes scar tissue formation and narrowing of the airway lumen (GOLD, 2019). Inflammatory and structural changes also occur in the lung parenchyma (respiratory bronchioles and alveoli). Alveolar wall destruction leads to loss of alveolar attachments and a decrease in elastic recoil. Finally, the chronic inflammatory process affects the pulmonary vasculature and causes thickening of the lining of the vessel and hypertrophy of smooth muscle, which may lead to pulmonary hypertension (GOLD, 2019).

Processes related to imbalances of substances (proteinases and antiproteinases) in the lung may also contribute to airflow limitation. When activated by chronic inflammation, proteinases and other substances may be released, damaging the parenchyma of the lung. These parenchymal changes may also occur as a consequence of inflammation or environmental or genetic factors (e.g., alpha$_1$-antitrypsin deficiency).

Chronic Bronchitis

Chronic bronchitis, a disease of the airways, is defined as the presence of cough and sputum production for at least 3 months in each of 2 consecutive years. Although *chronic bronchitis* is a clinically and epidemiologically useful term, it does not reflect the major impact of airflow limitation on morbidity and mortality in COPD (GOLD, 2019). In many cases, smoke or other environmental pollutants irritate the airways, resulting in inflammation and hypersecretion of mucus. Constant irritation causes the mucus-secreting glands and goblet cells to increase in number, leading to increased mucus production. Mucus plugging of the airway reduces ciliary function. Bronchial walls also become thickened, further narrowing the bronchial lumen (Fig. 20-1). Alveoli adjacent to the bronchioles may become damaged and fibrosed, resulting in altered function of the alveolar macrophages. This is significant because the macrophages play an important role in destroying foreign particles, including bacteria. As a result, the patient becomes more susceptible to respiratory infection. A wide range of viral, bacterial, and mycoplasma infections can produce acute episodes of bronchitis. Exacerbations of chronic bronchitis are most likely to occur during the winter when viral and bacterial infections are more prevalent.

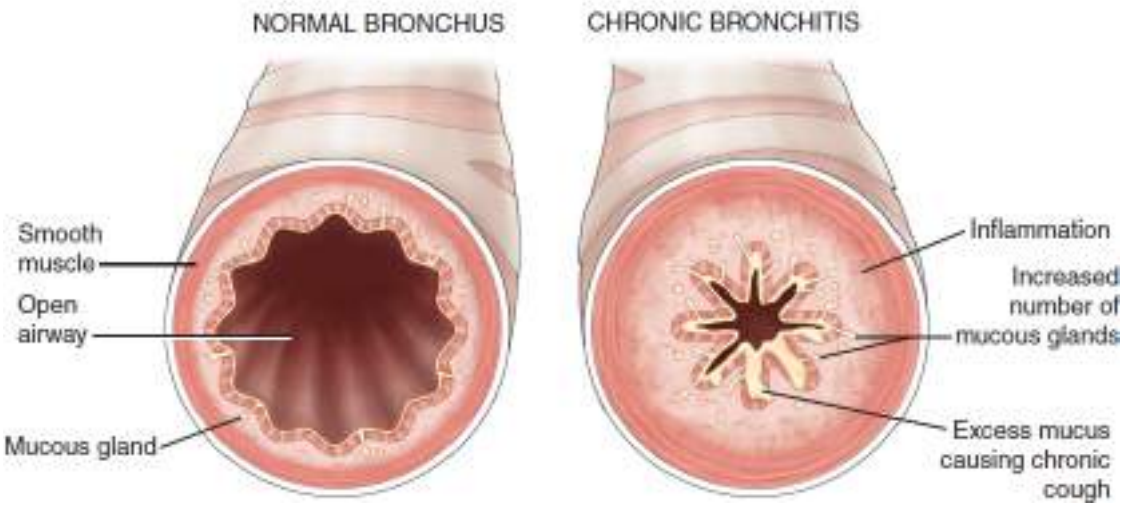


Figure 20-1 • Pathophysiology of chronic bronchitis as compared to a normal bronchus. The bronchus in chronic bronchitis is narrowed and has impaired airflow due to multiple mechanisms: inflammation, excess mucus production, and potential smooth muscle constriction (bronchospasm).

Emphysema

In **emphysema,** impaired oxygen and carbon dioxide exchange results from destruction of the walls of overdistended alveoli. *Emphysema* is a pathologic term that describes an abnormal distention of the airspaces beyond the terminal bronchioles and destruction of the walls of the alveoli (GOLD, 2019; Han, Dransfield, & Martinez, 2018). In addition, a chronic inflammatory response may induce disruption of the parenchymal tissues. This end-stage process progresses slowly for many years. As the walls of the alveoli are destroyed (a process accelerated by recurrent infections), the alveolar surface area in direct contact with the pulmonary capillaries continually decreases. This causes an increase in dead space (lung area where no gas exchange can occur) and impaired oxygen diffusion, which leads to hypoxemia. In the later stages of disease, carbon dioxide elimination is impaired, resulting in hypercapnia (increased carbon dioxide tension in arterial blood) leading to respiratory acidosis. As the alveolar walls continue to break down, the pulmonary capillary bed is reduced in size. Consequently, resistance to pulmonary blood flow is increased, forcing the right ventricle to maintain a higher blood pressure in the pulmonary artery. Hypoxemia may further increase pulmonary artery pressures (pulmonary hypertension). Cor pulmonale, one of the complications of emphysema, is right-sided heart failure brought on by long-term high blood pressure in the pulmonary arteries. This high pressure in the pulmonary arteries and right ventricle lead to back up of blood in the venous

system, resulting in dependent edema, distended neck veins, or pain in the region of the liver (see Chapter 25 for further discussion).

There are two main types of emphysema, based on the changes taking place in the lung (Fig. 20-2). Both types may occur in the same patient. In the panlobular (panacinar) type of emphysema, there is destruction of the respiratory bronchiole, alveolar duct, and alveolus. All airspaces within the lobule are essentially enlarged, but there is little inflammatory disease. A hyperinflated (hyperexpanded) chest, marked dyspnea on exertion, and weight loss typically occur. To move air into and out of the lungs, negative pressure is required during inspiration, and an adequate level of positive pressure must be attained and maintained during expiration. Instead of being an involuntary passive act, expiration becomes active and requires muscular effort.

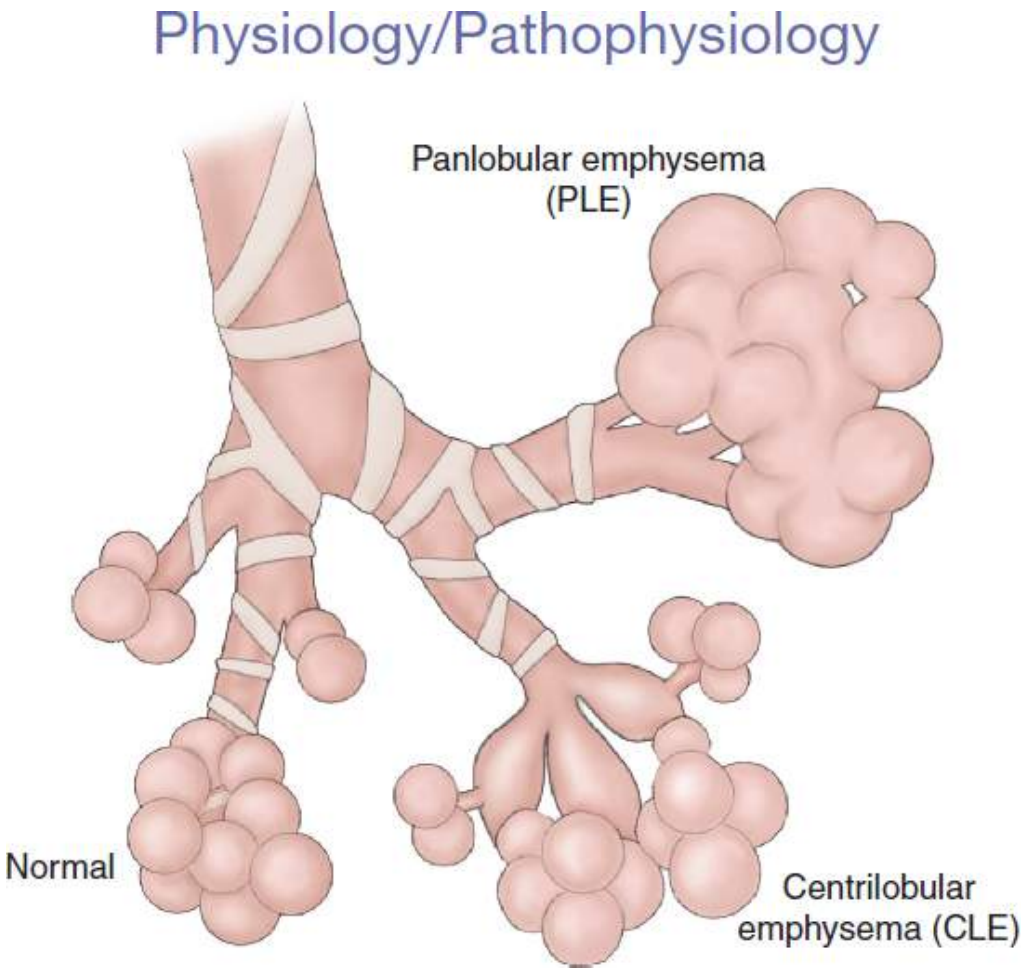


Figure 20-2 • Changes in alveolar structure in centrilobular and panlobular emphysema. In panlobular emphysema, the bronchioles, alveolar ducts, and alveoli are destroyed, and the airspaces within the lobule are enlarged. In centrilobular emphysema, the pathologic changes occur in the lobule, whereas the peripheral portions of the acinus are preserved.

In the centrilobular (centroacinar) form, pathologic changes take place mainly in the center of the secondary lobule, preserving the peripheral portions of the acinus (i.e., the terminal airway unit where gas exchange occurs). Frequently, there is a derangement of ventilation–perfusion ratios, producing chronic hypoxemia, hypercapnia, **polycythemia** (i.e., an increase in red blood cells), and episodes of right-sided heart failure. This leads to central cyanosis and respiratory failure. The patient also develops peripheral edema.

Risk Factors

Risk factors for COPD include environmental exposures and host factors (Chart 20-1). The most important environmental risk factor for COPD worldwide is cigarette smoking. A dose–response relationship exists between the intensity of smoking (pack-year history) and the decline in pulmonary function. Other environmental risk factors include smoking other types of tobacco (e.g., pipes, cigars) and marijuana. Secondhand smoke also contributes to respiratory symptoms and COPD (GOLD, 2019). Smoking depresses the activity of scavenger cells and affects the respiratory tract's ciliary cleansing mechanism, which keeps breathing passages free of inhaled irritants, bacteria, and other foreign matter. When smoking damages this cleansing mechanism, airflow is obstructed and air becomes trapped behind the obstruction. The alveoli greatly distend, which diminishes lung capacity. Smoking also irritates the goblet cells and mucous glands, causing an increased accumulation of mucus, which in turn produces more irritation, infection, and damage to the lung (U.S. Department of Health & Human Services [HHS], 2014). In addition, carbon monoxide (a by-product of smoking) combines with hemoglobin to form carboxyhemoglobin. Hemoglobin that is bound by carboxyhemoglobin cannot carry oxygen efficiently. Cigarette smoking is the best studied COPD risk factor; however, it is not the only risk factor and studies have demonstrated nonsmokers may also develop chronic airflow obstruction.

Chart 20-1 **RISK FACTORS**

Chronic Obstructive Pulmonary Disease

- Exposure to tobacco smoke accounts for an estimated 80–90% of cases of chronic obstructive pulmonary disease
- Secondhand smoke
- Increased age
- Occupational exposure—dust, chemicals
- Indoor and outdoor air pollution
- Genetic abnormalities, including a deficiency of alpha$_1$-antitrypsin, an enzyme inhibitor that normally counteracts the destruction of lung tissue by certain other enzymes

Adapted from Global Initiative for Chronic Obstructive Lung Disease (GOLD). (2019). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. Retrieved on 6/23/2019 at: www.goldcopd.org/wp-content/uploads/2018/11/GOLD-2019-v1.7-FINAL-14Nov2018-WMS.pdf

Other environmental risk factors for COPD include prolonged and intense exposure to occupational dusts and chemicals, indoor air pollution, and outdoor air pollution (GOLD, 2019). Recent studies indicate that the use of electronic nicotine delivery systems (ENDS; e.g., e-cigarettes, e-pens, e-pipes, e-hookahs, e-cigars) could increase the risk for developing COPD, but additional research is needed to better understand how their use causes changes similar to COPD in the lungs (Canistro, Vivarelli, Cirillo, et al., 2017; Evans, Burton, & Schwartz, 2018; Larcombe, Janka, Mullins, et al., 2017). Smoke from ENDS has been shown to trigger lung changes (i.e., airway hyperreactivity and lung tissue destruction) that are normally associated with the development of COPD (Garcia-Arcos, Geraghty, Baumlin, et al., 2016). Further research demonstrated that different flavored e-cigarette fluids, aerosols, and solvents can produce different patterns of cytotoxicity (Behar, Wang, & Talbot, 2018). The Surgeon General reported that more than one third of adults ages 18 to 24 years of age had tried e-cigarettes (HHS, 2016). Young adults who have used e-cigarettes report being attracted to them due to perceptions of low harm, the flavorings/tastes of the product, and curiosity (HHS, 2016).

Host risk factors include a person's genetic makeup. One well-documented genetic risk factor is a deficiency of alpha$_1$-antitrypsin, an enzyme inhibitor that protects the lung parenchyma from injury. This deficiency may lead to lung and liver disease. Worldwide, **alpha$_1$-antitrypsin deficiency** impacts between 1/1500 and 1/3000 people with European ancestry (U.S. National Library of Medicine [NLM], 2019). This genetic risk is uncommon in people of Asian descent (NLM, 2019). Approximately 2% of people with COPD have been diagnosed with this deficiency (Stoller, Barnes, & Hollingsworth, 2018).

This deficiency predisposes young people to rapid development of lobular emphysema, even in the absence of smoking. Among Caucasians, alpha$_1$-antitrypsin deficiency is one of the most common genetically linked lethal diseases. COPD may also result from gene–environment interactions (GOLD, 2019). People who are genetically susceptible are sensitive to environmental factors (e.g., smoking, air pollution, infectious agents, allergens) and eventually develop chronic obstructive symptoms. Carriers must be identified so that they can modify environmental risk factors to delay or prevent overt symptoms of disease. Genetic counseling should be offered. Alpha-protease inhibitor replacement therapy, which slows the progression of the disease, is available for patients with this genetic defect and for those with severe disease. However, this infusion therapy is costly and is required on an ongoing basis.

Other genetic risk factors may predispose a patient to COPD. Work is ongoing to identify specific variants of genes hypothesized to be involved in the development of COPD. These may include specific phenotypes to several chromosomal regions in families with multiple members developing early-onset COPD (see Chapter 17, Chart 17-8).

Age is often identified as a risk factor for COPD, but it is unclear whether healthy aging is an independent risk or whether the risk is related to cumulative exposures to risks over time (GOLD, 2019). There is a strong inverse relationship between COPD and lower socioeconomic status. However, perhaps it is not the lower socioeconomic status but how the socioeconomic status places the person at risk for increased patterns of exposure (indoor and outdoor pollutants, crowding, poor nutrition, infections, and increased smoking).

Clinical Manifestations

Although the natural history of COPD is variable, it is generally a progressive disease characterized by three primary symptoms: chronic cough, sputum production, and dyspnea (GOLD, 2019). These symptoms often worsen over time. Chronic cough and sputum production often precede the development of airflow limitation by many years. However, not all people with cough and sputum production develop COPD. The cough may be intermittent and may be unproductive in some patients (GOLD, 2019). Dyspnea may be severe and interfere with the patient's activities and quality of life. It is usually progressive, worse with exercise, and persistent. As COPD progresses, dyspnea may occur at rest. Weight loss is common, because dyspnea interferes with eating and the work of breathing is energy depleting. As the work of breathing increases over time, the accessory muscles are recruited in an effort to breathe. Patients with COPD are at risk for respiratory insufficiency and respiratory infections or COPD exacerbation, which in turn increase the risk of acute and chronic respiratory failure.

In patients with COPD who have a primary emphysematous component, chronic hyperinflation leads to the "barrel chest" thorax configuration. This configuration results from a more fixed position of the ribs in the inspiratory position (due to hyperinflation) and from loss of lung elasticity (Fig. 20-3). Retraction of the supraclavicular fossae occurs on inspiration, causing the shoulders to heave upward (Fig. 20-4). In advanced emphysema, the abdominal muscles may also contract on inspiration.

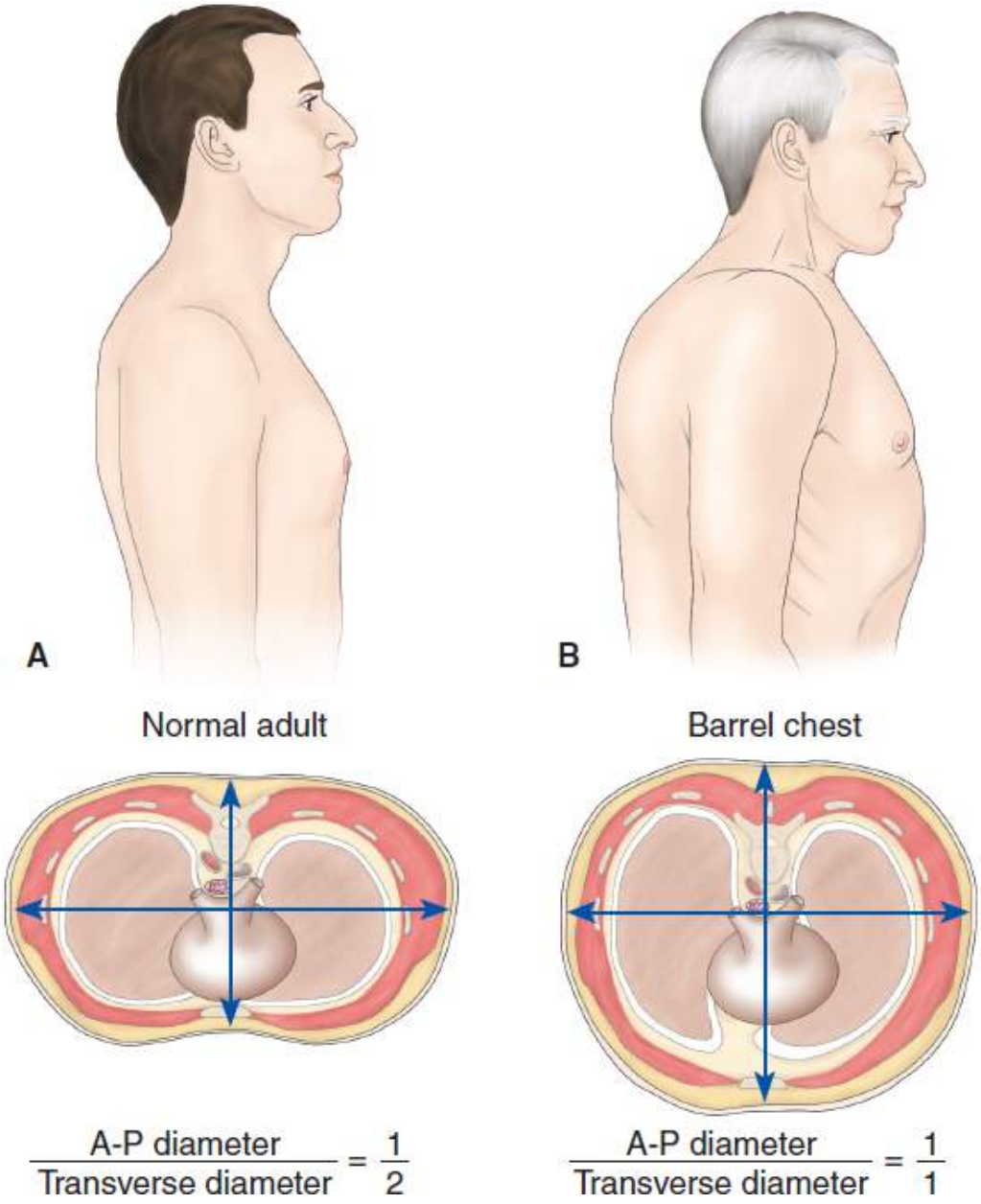


Figure 20-3 • Characteristics of normal chest wall and chest wall in emphysema. **A.** The normal chest wall and its cross-section. **B.** The barrel-shaped chest of emphysema and its cross-section.

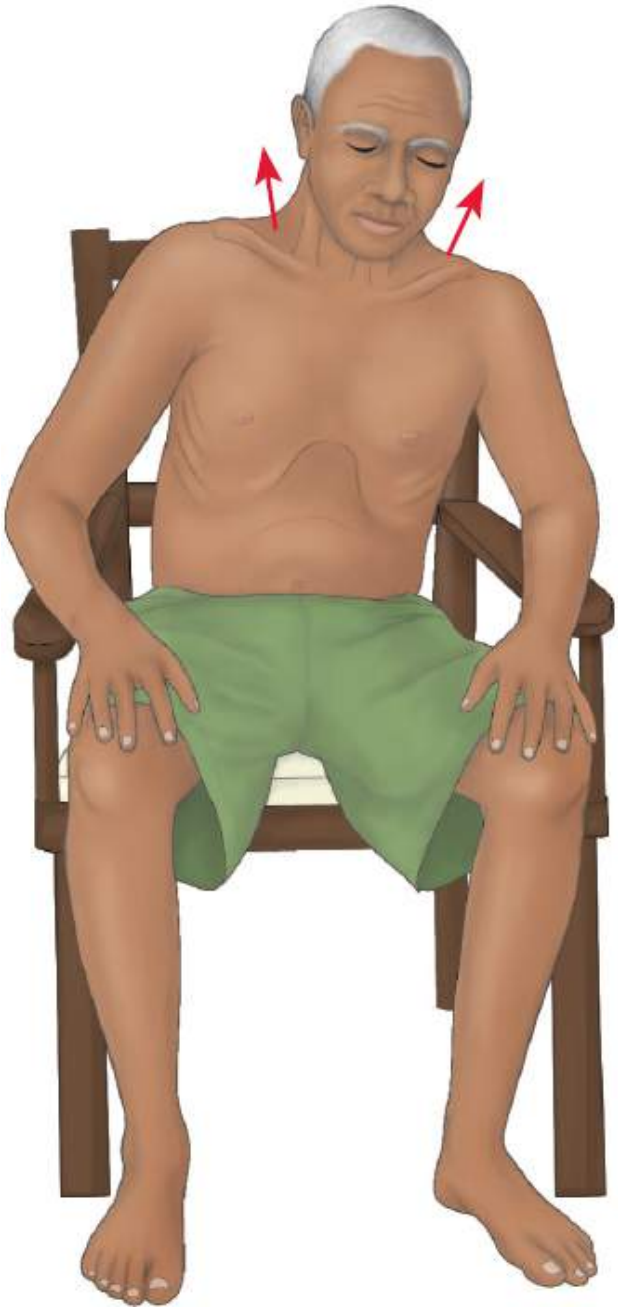


Figure 20-4 • Typical posture of a person with chronic obstructive pulmonary disease—primarily emphysema. The person tends to lean forward and uses the accessory muscles of respiration to breathe, forcing the shoulder girdle upward and causing the supraclavicular fossae to retract on inspiration.

There are systemic or extrapulmonary manifestations of COPD. These include musculoskeletal wasting (see Chapter 4 for discussion of nutrition assessment and Chapters 39 and 40 for discussion of nutrition therapy), metabolic disturbances, and depression (a frequent comorbidity that accompanies chronic debilitating illnesses). These clinical manifestations beyond the lungs must also be assessed and treated in order to decrease the

morbidity and improve the quality of life of the patient with COPD. For example, research has indicated that depression, metabolic syndrome, and diabetes are frequent comorbidities of COPD (Raherison, Ouaalaya, Bernady, et al., 2018). It is speculated that measures to promote healthy eating and activity that may ameliorate metabolic syndrome, diabetes, and depression may also deter the development of COPD.

Assessment and Diagnostic Findings

The nurse obtains a thorough health history from patients with known or potential COPD. Chart 20-2 lists the key factors to assess for patients with known or suspected COPD. Pulmonary function studies are used to help confirm the diagnosis of COPD, determine disease severity, and monitor disease progression. **Spirometry** is used to evaluate airflow obstruction, which is determined by the ratio of FEV_1 to forced vital capacity (FVC). Spirometric results are expressed as an absolute volume and as a percentage of the predicted value using appropriate normal values for gender, age, and height. With obstruction, the patient either has difficulty exhaling or cannot forcibly exhale air from the lungs, reducing the FEV_1. Spirometry is also used to determine reversibility of obstruction after the use of bronchodilators (GOLD, 2019). Spirometry is initially performed, the patient is given an inhaled bronchodilator treatment according to a standard protocol, and then spirometry is repeated. The patient demonstrates a degree of reversibility if the pulmonary function values improve after administration of the bronchodilator.

Chart 20-2 **ASSESSMENT**

Assessing Patients with Chronic Obstructive Pulmonary Disease

Health History

- Has the patient been exposed to risk factors (see Chart 20-1)? If so, inquire about types, intensity, and duration of exposure; for instance:
  - How much exposure has the patient had to secondhand smoke?
  - Is there occupational exposure to smoke or other pollutants?
- Does the patient have a past medical history of respiratory diseases/problems, including asthma, allergy, sinusitis, nasal polyps, or respiratory infections?
- Does the patient have a family history of chronic obstructive pulmonary disease or other chronic respiratory diseases?
- How long has the patient had respiratory difficulty?
- What is the pattern of symptom development?
- Does exertion increase the dyspnea? What type of exertion?
- What are the limits of the patient's tolerance for exercise?
- At what times during the day does the patient complain most of fatigue and shortness of breath?
- Does the patient describe any discomfort or pain in any part of the body? If so, where does it occur, how intense is this pain, when does it occur, and does it interfere with activities of daily living? Is there any intervention that helps to alleviate the pain or discomfort?
- Which eating and sleeping habits have been affected?
- What is the impact of respiratory disease on quality of life?
- What does the patient know about the disease and their condition?
- What is the patient's smoking history?
- Does the patient have a history of using electronic nicotine delivery systems (ENDS) (e.g., vaping, e-cigarettes, e-pens, e-pipes, e-hookah, e-cigars)?
- What are the triggering events (e.g., exertion, strong odors, dust, exposure to animals)?
- Does the patient have a history of exacerbations or previous hospitalizations for respiratory problems?
- Are comorbidities present?
- How appropriate are current medical treatments?
- Does the patient have available social and family support?
- What is the potential for reducing risk factors (e.g., smoking cessation)?

Physical Assessment

- What position does the patient assume during the interview?
- What are the pulse and the respiratory rates?
- What is the character of respirations? Even and without effort? Other?

- Can the patient complete a sentence without having to take a breath?
- Does the patient contract the abdominal muscles during inspiration?
- Does the patient use accessory muscles of the shoulders and neck when breathing?
- Does the patient take a long time to exhale (prolonged expiration)?
- Is central cyanosis evident?
- Are the patient's neck veins distended?
- Does the patient have peripheral edema?
- Is the patient coughing?
- What are the color, amount, and consistency of the sputum?
- Is clubbing of the fingers present?
- What types of breath sounds (i.e., clear, diminished or distant, crackles, wheezes) are heard? Describe and document findings and locations.
- Are there any sensory deficits?
- Is there short- or long-term memory impairment?
- Is there increasing stupor?
- Is the patient apprehensive?

Arterial blood gas measurements may also be obtained to assess baseline oxygenation and gas exchange and are especially important in advanced COPD. A chest x-ray may be obtained to exclude alternative diagnoses. A computed tomography (CT) chest scan is not routinely obtained in the diagnosis of COPD, but a high-resolution CT scan may help in the differential diagnosis. Screening for $alpha_1$-antitrypsin deficiency is suggested for all adults who are symptomatic, especially for patients younger than 45 years. Screening in young adults is important for those with a family history of COPD, particularly if they have a family history of blood relatives with $alpha_1$-antitrypsin deficiency or COPD that is primarily emphysematous in nature (Han et al., 2018).

COPD is classified into four grades depending on the severity measured by pulmonary function tests, as shown in Table 20-1 (GOLD, 2019). However, pulmonary function is not the only way to assess or classify COPD; pulmonary function is evaluated in conjunction with symptoms, health status impairment with COPD, and the potential for exacerbations. Factors that determine the clinical course and survival of patients with COPD include history of cigarette smoking, exposure to secondhand smoke, age, rate of decline of FEV_1, hypoxemia, pulmonary artery pressure, resting heart rate, weight loss, reversibility of airflow obstruction, and comorbidities.

In diagnosing COPD, several differential diagnoses must be ruled out. The primary differential diagnosis is asthma. It may be difficult to differentiate between a patient with COPD and one with chronic asthma. Other diseases

that must be considered in the differential diagnosis include heart failure, bronchiectasis, tuberculosis, obliterative bronchiolitis, and diffuse panbronchiolitis (GOLD, 2019). Key factors in determining the diagnosis are the patient's history, severity of symptoms, and responsiveness to bronchodilators.

TABLE 20-1 Grades of Chronic Obstructive Pulmonary Disease

Grade	Severity	Pulmonary Function
Grade I	Mild	FEV_1/FVC <70% FEV_1 ≥80% predicted
Grade II	Moderate	FEV_1/FVC <70% FEV_1 50–79% predicted
Grade III	Severe	FEV_1/FVC <70% FEV_1 30–49% predicted
Grade IV	Very severe	FEV_1/FVC <70% FEV_1 <30% predicted

FEV_1, forced expiratory volume in 1 s; FVC, forced vital capacity.

Adapted from Global Initiative for Chronic Obstructive Lung Disease (GOLD). (2019). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. Retrieved on 06/23/2019 at: www.goldcopd.org/wp-content/uploads/2018/11/GOLD-2019-v1.7-FINAL-14Nov2018-WMS.pdf

Complications

Respiratory insufficiency and failure are major life-threatening complications of COPD. The acuity of the onset and the severity of respiratory failure depend on baseline pulmonary function, pulse oximetry or arterial blood gas values, comorbid conditions, and the severity of other complications of COPD. Respiratory insufficiency and failure may be chronic (with severe COPD) or acute (with severe bronchospasm or pneumonia in a patient with severe COPD). Acute respiratory insufficiency and failure may necessitate ventilatory support until other acute complications, such as infection, can be treated. (See Chapter 19 for the management of the patient requiring ventilatory support.) Other complications of COPD include pneumonia, chronic atelectasis, pneumothorax, and pulmonary arterial hypertension (cor pulmonale).

Medical Management

Therapeutic strategies for the patient with COPD include promoting smoking cessation as appropriate, providing supplemental oxygen therapy as indicated, prescribing medications, and managing exacerbations. Some patients may

benefit from surgical interventions; whereas others with advanced COPD may benefit from palliative care.

Risk Reduction

For patients with stable disease, treatment aims to reduce risk and symptoms. The major risk factor associated with COPD is environmental exposure and it is modifiable. The most important environmental exposure is smoking. In 2017, over 34 million people in the United States reported that they were active smokers (CDC, 2018b). Smoking kills more than 480,000 people each year and costs the nation more than $300 billion in health care expenses and lost productivity annually (CDC, 2019a; CDC, 2019b). Smoking cessation is the single most cost-effective intervention to reduce the risk of developing COPD and to stop its progression (GOLD, 2019). However, smoking cessation is difficult to achieve and even more difficult to sustain in the long term. Factors associated with continued smoking vary among patients and may include the strength of the nicotine addiction, continued exposure to smoking-associated stimuli (at work or in social settings), stress, depression, and habit.

Because multiple factors are associated with continued smoking, successful cessation often requires multiple strategies. Health care providers should promote cessation by explaining the risks of smoking and personalizing the "at-risk" message to the patient. After giving a strong warning about smoking, health care providers should work with the patient to set a definite "quit date." Referral to a smoking cessation program may be helpful. Follow-up within 3 to 5 days after the quit date to review progress and to address any problems is associated with an increased rate of success; this should be repeated as needed. Continued reinforcement with a modality that is individualized to the patient and the patient's lifestyle (e.g., telephone calls, texting, e-mail, or clinic visits) is beneficial. Relapses should be analyzed, and the patient and health care provider should jointly identify possible solutions to prevent future backsliding. It is important to emphasize successes rather than failures. Nicotine replacement—a first-line pharmacotherapy that reliably increases long-term smoking abstinence rates—comes in a variety of forms (gum, inhaler, nasal spray, transdermal patch, sublingual tablet, or lozenge). Bupropion SR and nortriptyline, both antidepressants, may also increase long-term quit rates. Other pharmacologic agents include the antihypertensive agent clonidine; however, its side effects limit its use. Varenicline, a nicotinic acetylcholine receptor partial agonist, may assist in smoking cessation (GOLD, 2019). Patients who are not appropriate candidates for such pharmacotherapy include those with medical contraindications, light smokers (fewer than 10 cigarettes per day), pregnant women, and adolescent smokers.

Smoking cessation can begin in a variety of health care settings—outpatient clinic, nursing center, pulmonary rehabilitation center, community, hospital, and in the home. Regardless of the setting, nurses have the opportunity to

educate patients about the risks of smoking and the benefits of smoking cessation. Various materials, resources, and programs developed by several organizations (e.g., AHRQ, CDC, National Cancer Institute, American Lung Association, American Cancer Society) are available to assist with this effort.

General Principles of Oxygen Therapy

Oxygen therapy is the administration of oxygen at a concentration greater than that found in the environmental atmosphere. At sea level, the concentration of oxygen in room air is 21%. The goal of oxygen therapy is to provide adequate transport of oxygen in the blood while decreasing the work of breathing and reducing stress on the myocardium.

Oxygen transport to tissues depends on factors such as cardiac output, arterial oxygen content, concentration of hemoglobin, and metabolic requirements. These factors must be kept in mind when oxygen therapy is considered for use in all patients, regardless of underlying disorders.

Indications

A change in the patient's respiratory rate or pattern may be one of the earliest indicators of the need for oxygen therapy. These changes may result from hypoxemia or hypoxia. **Hypoxemia,** a decrease in the arterial oxygen tension in the blood, is manifested by changes in mental status (progressing through impaired judgment, agitation, disorientation, confusion, lethargy, and coma), dyspnea, increase in blood pressure, changes in heart rate, arrhythmias, central cyanosis (late sign), diaphoresis, and cool extremities. Hypoxemia usually leads to **hypoxia,** a decrease in oxygen supply to the tissues and cells that can also be caused by problems outside the respiratory system. Severe hypoxia can be life-threatening.

The signs and symptoms signaling the need for supplemental oxygen may depend on how suddenly this need develops. With rapidly developing hypoxia, changes occur in the central nervous system because the neurologic centers are very sensitive to oxygen deprivation. The clinical picture may resemble that of alcohol intoxication, with the patient exhibiting lack of coordination and impaired judgment. With long-standing hypoxia (as seen in patients with COPD as well as in patients with chronic heart failure), fatigue, drowsiness, apathy, inattentiveness, and delayed reaction time may occur. The need for oxygen is assessed by arterial blood gas analysis, pulse oximetry, and clinical evaluation.

Complications

Oxygen is a medication, and except in emergency situations it is given only when prescribed by a health care provider. As with other medications, the nurse administers oxygen with caution and carefully assesses its effects on each patient.

In general, a patient with any type of respiratory disorder is given oxygen therapy only to increase the partial pressure of arterial oxygen (PaO_2) back to the patient's normal baseline, which may vary from 60 to 95 mm Hg. In terms of the oxyhemoglobin dissociation curve (see Chapter 17), arterial hemoglobin at these levels is 80% to 98% saturated with oxygen; higher **fraction of inspired oxygen (FiO_2)** flow values add no further significant amounts of oxygen to the red blood cells or plasma. Instead of helping, increased amounts of oxygen may produce toxic effects on the lungs and central nervous system or may depress ventilation, which is a particularly lethal adverse effect in patients with COPD (see later discussion).

It is important to observe for subtle indicators of inadequate oxygenation when oxygen is given by any method. Therefore, the nurse assesses the patient frequently for confusion, restlessness progressing to lethargy, diaphoresis, pallor, tachycardia, tachypnea, and hypertension. Intermittent or continuous pulse oximetry is used to monitor oxygen levels.

Oxygen toxicity may occur when too high concentration of oxygen is given for an extended period (generally longer than 24 hours) (Kacmarek, Stoller, & Heuer, 2017). It is caused by overproduction of oxygen free radicals, which are by-products of cell metabolism. These free radicals then mediate a severe inflammatory response that can severely damage the alveolar capillary membrane leading to pulmonary edema and progressing to cell death. Clinical manifestations of oxygen toxicity causing lung damage are similar to acute respiratory distress syndrome (ARDS) (see Chapter 19).

Signs and symptoms of oxygen toxicity include substernal discomfort, paresthesias, dyspnea, restlessness, fatigue, malaise, progressive respiratory difficulty, refractory hypoxemia, alveolar atelectasis, and alveolar infiltrates evident on chest x-rays.

Using the lowest amount of oxygen needed to maintain an acceptable PaO_2 level and treating the underlying condition aids in the prevention of oxygen toxicity (Kacmarek et al., 2017).

An additional adverse effect of the administration of high concentrations of oxygen (greater than 50%) to patients who are sedated and breathing small tidal volumes of air (volume of air inspired and expired with each breath) is absorption atelectasis. Normally, 79% of room air is comprised of nitrogen. During inhalation, nitrogen, in addition to other gases, fills the alveoli and helps keep the alveoli open. With the administration of high concentrations of oxygen, nitrogen is diluted and replaced with oxygen. Oxygen in the alveoli is absorbed quickly into the bloodstream and not replaced rapidly enough in the alveoli to maintain patency. The alveoli collapse, causing atelectasis (Kacmarek et al., 2017).

Because oxygen supports combustion, there is always a danger of fire when it is used. It is important to post "No Smoking" signs when oxygen is in use. Oxygen therapy equipment is also a potential source of bacterial

contamination; therefore, the nurse (or respiratory therapist) changes the tubing according to infection prevention policy, manufacturer's recommendations, and the type of oxygen delivery equipment.

Gerontologic Considerations

The respiratory system changes throughout the aging process, and it is important for nurses to be aware of these changes when assessing older adult patients who are receiving oxygen therapy. As the respiratory muscles weaken and the large bronchi and alveoli become enlarged, the available surface area of the lungs decreases, resulting in reduced ventilation and respiratory gas exchange. The number of functional cilia is also reduced, decreasing ciliary action and the cough reflex. As a result of osteoporosis and calcification of the costal cartilages, chest wall compliance is decreased. Patients may display increased chest rigidity and respiratory rate and decreased PaO_2 and lung expansion. The older adult is at risk for aspiration and infection related to these changes. In addition, patient education regarding adequate nutrition is essential because appropriate dietary intake can help diminish the excess buildup of carbon dioxide and maintain optimal respiratory functioning (Meiner & Yeager, 2019).

Methods of Oxygen Administration

Oxygen is dispensed from a cylinder or a piped-in system. A reduction gauge is necessary to reduce the pressure to a working level, and a flow meter regulates the flow of oxygen in liters per minute (L/min). When oxygen is used at high flow rates, it should be moistened by passing it through a humidification system to prevent it from drying the mucous membranes of the respiratory tract.

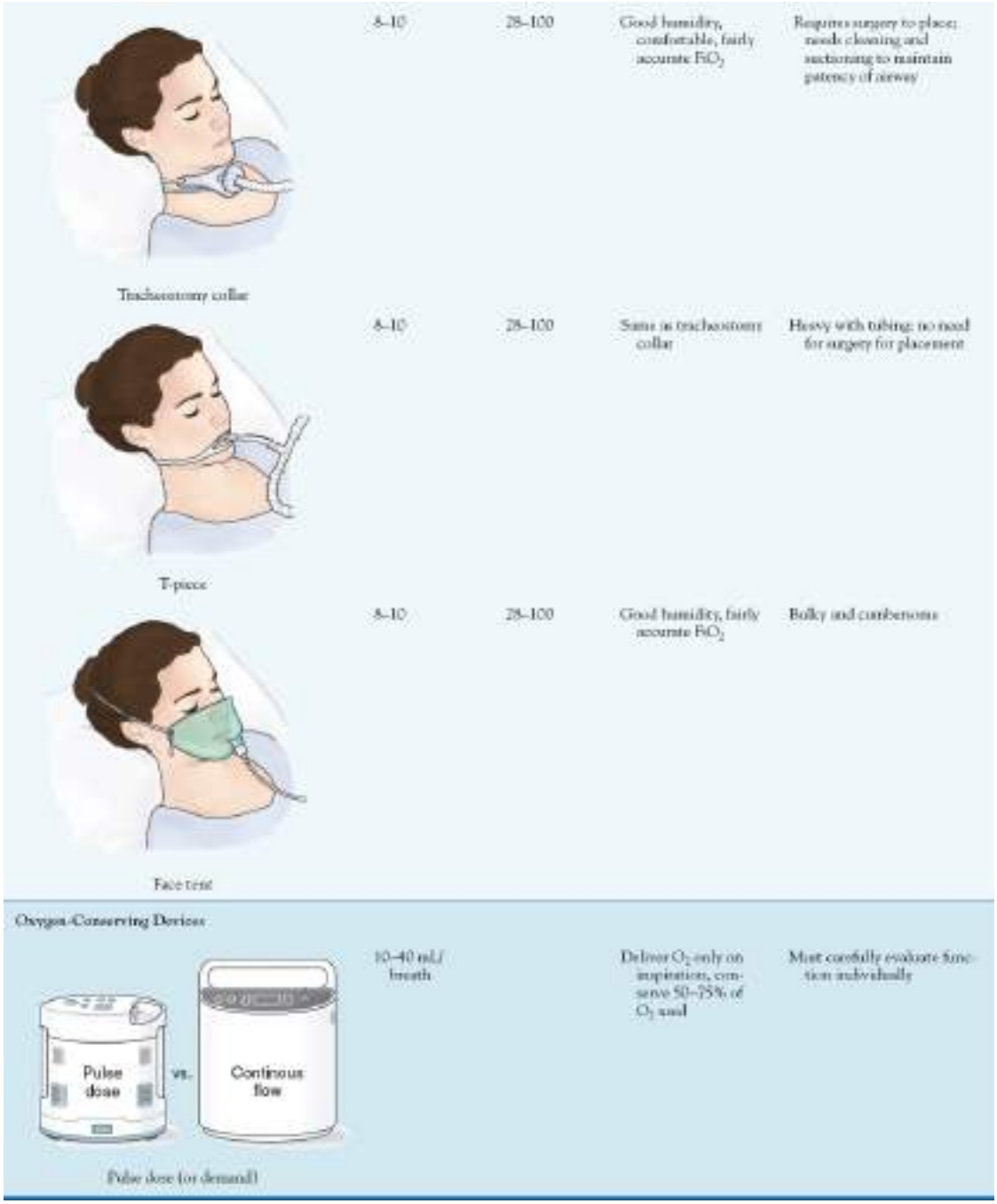
The use of oxygen concentrators is another means of providing varying amounts of oxygen, especially in the home setting. These devices are relatively portable, easy to operate, and cost-effective but require more maintenance than tank or liquid systems. These models can deliver oxygen flows from 1 to 10 L/min and provide an FiO_2 of about 40% (Cairo, 2018).

Many different oxygen devices are used (Table 20-2). The amount of oxygen delivered is expressed as a percentage concentration (e.g., 70%). The appropriate form of oxygen therapy is best determined by arterial blood gas levels (see Chapter 10), which indicate the patient's oxygenation status.

TABLE 20-2 Oxygen Administration Devices

Device	Suggested Flow Rate (L/min)	O_2 Percentage Setting	Advantages	Disadvantages
Low-Flow Systems				
Cannula (nasal and reservoir)	1–2 3–5 6	24–28 32–40 44	Lightweight, comfortable, inexpensive, continuous use with meals and activity	Easily dislodged, from nares, skin breakdown over ears or nares, nasal mucosal and/or pharyngeal mucosal drying, air swallowing, variable FiO_2
Nasal (oropharyngeal) catheter	1–6	24–44	Inexpensive, does not require a tracheostomy	Nasal mucosa irritation; catheter should be changed frequently to alternate nostril
Mask, simple	5–8	40–60	Simple to use, inexpensive	Poorly fitting, variable FiO_2, must remove to eat
Mask, partial rebreathing	8–11	50–75	Moderate O_2 concentration	Warm, poorly fitting, must remove to eat

Mask, nonrebreathing	10–15	80–95	High O_2 concentration	Poorly fitting, must remove to eat
High-Flow Systems				
Mask, Venturi	4–6 6–8	24, 26, 28 30, 35, 40	Provides low levels of supplemental O_2 Precise FiO_2, additional humidity available	Must remove to eat
Tracheostomal oxygen catheter	1/4–4	60–100	More comfortable than other high-flow systems, concealed by clothing, less oxygen liters per minute needed than nasal cannula	Requires frequent and regular cleaning, requires surgical intervention, with associated risk for surgical complications
Mask, aerosol	8–10	28–100	Good humidity, accurate FiO_2	Uncomfortable for some



Oxygen delivery systems are classified as low-flow systems (variable performance) or high-flow systems (fixed performance). Low-flow systems contribute partially to the inspired gas the patient breathes, which means that the patient breathes some room air along with the oxygen. These systems do not provide a constant or precise concentration of inspired oxygen. The amount of inspired oxygen changes as the patient's breathing changes. High-flow systems provide the total inspired air. A specific percentage of oxygen is delivered independent of the patient's breathing. High-flow systems are indicated for patients who require a constant and precise amount of oxygen (Cairo, 2018).

A nasal cannula is used when the patient requires a low to medium concentration of oxygen for which precise accuracy is not essential. This method allows the patient to move about in bed, talk, cough, and eat without interrupting oxygen flow. Although a nasal cannula can deliver up to 6 L/min, flow rates in excess of 4 L/min may lead to swallowing of air or may cause irritation and drying of the nasal and pharyngeal mucosa.

A reservoir cannula stores oxygen in a thin membrane during exhalation. When the patient's inspiration exceeds the flow rate into the cannula, the patient receives additional gas from the reservoir membrane. This reduces oxygen use because the patient can achieve adequate oxygenation with a lower flow rate than what would be used with a nasal cannula. The patient must exhale through the nose to reopen the reservoir. Any condition, such as pursed lipped breathing, that prevents nasal exhalation would limit the effectiveness of the device.

The nasal (oropharyngeal) catheter delivers low to moderate concentrations of oxygen and is rarely used. This method of delivering low-flow oxygen is usually reserved for use in special procedures, such as those that examine the patient's airways and lungs (bronchoscopy). When used during long procedures, the catheter should be changed frequently (e.g., every 8 hours), alternating nostrils to prevent nasal irritation and infection.

When oxygen is given via cannula or catheter, the percentage of oxygen reaching the lungs varies with the depth, rate, and technique of respirations. Anatomic occlusions in the nasal cavity, swollen nasal mucosa, and mouth breathing are examples of conditions that would alter the amount of gas the patient inhales.

Oxygen masks come in several forms. Each is used for different purposes (see Table 20-2). *Simple masks,* low-flow design, are used to administer low to moderate concentrations of oxygen. The body of the mask itself gathers and stores oxygen between breaths. The patient exhales directly through openings or ports in the body of the mask. If oxygen flow ceases, the patient can draw air in through these openings around the mask edges. Although widely used, these masks cannot be used for controlled oxygen concentrations and must be adjusted for proper fit. They should not press too tightly against the skin, because this can cause a sense of claustrophobia as well as skin breakdown; adjustable elastic bands are provided to ensure comfort and security.

Partial rebreathing masks have a reservoir bag that must remain inflated during both inspiration and expiration. The nurse adjusts the oxygen flow to ensure that the bag does not collapse during inhalation. A moderate concentration of oxygen can be delivered because both the mask and the bag serve as reservoirs for oxygen. Oxygen enters the mask through small-bore tubing that connects at the junction of the mask and bag. As the patient inhales, gas is drawn from the mask, from the bag, and potentially from room air through the exhalation ports. As the patient exhales, the first third of the

exhalation fills the reservoir bag. This is mainly dead space and does not participate in gas exchange in the lungs. Therefore, it has a high oxygen concentration. The remainder of the exhaled gas is vented through the exhalation ports. The actual percentage of oxygen delivered is influenced by the patient's ventilatory pattern (Kacmarek et al., 2017).

Nonrebreathing masks are similar in design to partial rebreathing masks except that they have additional valves. A one-way valve located between the reservoir bag and the base of the mask allows gas from the reservoir bag to enter the mask on inhalation but prevents gas in the mask from flowing back into the reservoir bag during exhalation. One-way valves located at the exhalation ports prevent room air from entering the mask during inhalation. They also allow the patient's exhaled gases to exit the mask on exhalation. As with the partial rebreathing mask, it is important to adjust the oxygen flow so that the reservoir bag does not completely collapse on inspiration. In theory, if the nonrebreathing mask fits the patient snugly and both side exhalation ports have one-way valves, it is possible for the patient to receive 100% oxygen, making the nonrebreathing mask a high-flow oxygen system. However, because it is difficult to get an exact fit from the mask on every patient, and some nonrebreathing masks have only one one-way exhalation valves, it is almost impossible to ensure 100% oxygen delivery, making it a low-flow oxygen system.

The *Venturi mask* is the most reliable and accurate method for delivering precise concentrations of oxygen through noninvasive means. The mask is constructed in a way that allows a constant flow of room air blended with a fixed flow of oxygen. It is used primarily for patients with COPD because it can accurately provide appropriate levels of supplemental oxygen, thus avoiding the risk of suppressing the hypoxic drive.

The Venturi mask uses the Bernoulli principle of air entrainment (trapping the air like a vacuum), which provides a high airflow with controlled oxygen enrichment. For each liter of oxygen that passes through a jet orifice, a fixed proportion of room air is entrained. Varying the size of the jet orifice and adjusting the flow of oxygen can deliver a precise volume of oxygen. Excess gas leaves the mask through the two exhalation ports, carrying with it the exhaled carbon dioxide. This method allows a constant oxygen concentration to be inhaled regardless of the depth or rate of respiration.

The mask should fit snugly enough to prevent oxygen from flowing into the patient's eyes. The nurse checks the patient's skin for irritation. It is necessary to remove the mask so that the patient can eat, drink, and take medications, at which time supplemental oxygen is provided through a nasal cannula.

Concept Mastery Alert

Oxygen delivery systems are classified as either low- or high-flow systems. Whereas a low-flow oxygen delivery system may imprecisely deliver high concentrations of oxygen (e.g., up to 100% via a nonrebreathing mask), the Venturi mask, which is a high-flow system, is specifically designed to deliver precise but lower concentrations of oxygen (less than 30% oxygen).

The *transtracheal oxygen catheter* requires minor surgery to insert a catheter through a small incision directly into the trachea. It is indicated for patients with chronic oxygen therapy needs. These catheters are more comfortable, less dependent on breathing patterns, and less obvious than other oxygen delivery methods. Because no oxygen is lost into the surrounding environment, the patient achieves adequate oxygenation at lower rates, making this method less expensive and more efficient.

Other oxygen devices include *aerosol masks, tracheostomy collars* (see Table 20-2), *T-pieces,* and *face tents,* all of which are used with aerosol devices (nebulizers) that can be adjusted for oxygen concentrations from 28% to 100% (0.28 to 1.00). If the gas mixture flow falls below patient demand, room air is pulled in, diluting the concentration. The aerosol mist must be available for the patient during the entire inspiratory phase.

Specific Considerations for the Patient with COPD Receiving Oxygen Therapy

Oxygen therapy can be given as long-term continuous therapy, during exercise, or to prevent acute dyspnea during an exacerbation (see later discussion). The goal of supplemental oxygen therapy in the patient with COPD is to increase the baseline resting partial pressure of arterial oxygen (PaO_2) to at least 60 mm Hg at sea level, which corresponds with an arterial oxygen saturation (SaO_2) of 90% (GOLD, 2019). Long-term oxygen therapy (more than 15 hours per day) has also been shown to improve quality of life, reduce pulmonary arterial pressure and dyspnea, and improve survival (GOLD, 2019). Long-term oxygen therapy is usually introduced in very severe COPD, and indications generally include a PaO_2 of 55 mm Hg or less or SaO_2 at or below 88% (GOLD, 2019). Other indications for long-term oxygen therapy include evidence of tissue hypoxia and organ damage such as cor pulmonale, secondary polycythemia, edema from right-sided heart failure, or impaired mental status (GOLD, 2019). For patients with exercise-induced hypoxemia, oxygen supplementation during exercise may improve dyspnea but will not diminish breathlessness in daily life (GOLD, 2019). Patients who are hypoxemic while awake are likely to be so during sleep. Therefore, nighttime oxygen therapy is recommended as well, and the prescription for oxygen therapy is for continuous, 24-hour use. Intermittent oxygen therapy is indicated for patients who **desaturate** (i.e., experience a precipitous drop in hemoglobin molecule saturation with oxygen) only during activities of daily living, exercise, or sleep.

The main objective in treating patients with hypoxemia and hypercapnia is to give sufficient oxygen to improve oxygenation. Patients with COPD who require oxygen may have respiratory failure that is caused primarily by a ventilation–perfusion mismatch. These patients respond to oxygen therapy and should be treated to keep the resting oxygen saturation at or above 90%, which is associated with a PaO_2 of 60 mm Hg or higher (GOLD, 2019). Nursing assessments of a patient with COPD on supplemental oxygen must include monitoring the respiratory rate and the oxygen saturation as measured by pulse oximetry (SpO_2) so that the patient has an adequate oxygen saturation (90%) on the lowest liter flow of oxygen (GOLD, 2019).

Administering too much oxygen can result in the retention of carbon dioxide. The high O_2 levels can then suppress CO_2 chemoreceptors, which in turn would depress the respiratory drive and disrupt ventilation–perfusion balance (Kacmarek et al., 2017). The resulting increased O_2 tension in the alveoli causes a ventilation–perfusion mismatch that presents as hypercapnia. Monitoring and assessment are essential in the care of patients with COPD on supplemental oxygen due to complications of oxygen supplementation. Although pulse oximetry is helpful in assessing response to oxygen therapy, it does not assess $PaCO_2$ levels. A SaO_2 of 88% or less warrants further evaluation with arterial blood gas analysis (GOLD, 2019). The nurse must evaluate for other factors and medications which could further decrease the respiratory drive—neurologic impairment, fluid and electrolyte issues, and opioids or sedatives.

Quality and Safety Nursing Alert

Oxygen therapy is variable in patients with COPD; its aim in COPD is to achieve an acceptable oxygen level without a fall in the pH (increasing hypercapnia).

Pharmacologic Therapy

Medication regimens used to manage COPD are based on disease severity. For grade I (mild) COPD, a short-acting bronchodilator may be prescribed. For grade II or III (moderate or severe) COPD, a short-acting bronchodilator and regular treatment with one or more long-acting bronchodilators may be used. For grade III or IV (severe or very severe) COPD, medication therapy includes regular treatment with long-acting bronchodilators and/or inhaled corticosteroids (ICSs) for repeated exacerbations.

Bronchodilators

Bronchodilators are key for symptom management in stable COPD (GOLD, 2019). The choice of bronchodilator depends on availability and individual response in terms of symptom relief and side effects. Long-acting bronchodilators are more convenient for patients to use, and combining bronchodilators with different durations of action and different mechanisms may optimize symptom management (GOLD, 2019). Long-acting bronchodilators are typically used for maintenance treatment for long-term symptom control. Short-acting bronchodilators are usually used for acute management of symptomatic flairs. Even patients who do not show a significant response to a short-acting bronchodilator test may benefit symptomatically from long-term bronchodilator treatment.

Bronchodilators relieve bronchospasm by improving expiratory flow through widening of the airways and promoting lung emptying with each breath. These medications alter smooth muscle tone and reduce airway obstruction by allowing increased oxygen distribution throughout the lungs and improving alveolar ventilation. Although regular use of bronchodilators that act primarily on the airway smooth muscle does not modify the decline of function or the prognosis of COPD, their use is central in the management of COPD (GOLD, 2019). These agents can be delivered through a pressurized metered-dose inhaler (pMDI), a dry-powder inhaler (DPI), by a small-volume nebulizer (SVN), or via the oral route in pill or liquid form. Bronchodilators are often given regularly throughout the day as well as on an as-needed basis. They may also be used prophylactically to prevent breathlessness by having the patient use them before participating in or completing an activity, such as eating or walking.

Several devices are available to deliver medication via the inhaled route. These may be categorized as pMDIs, DPIs, or SVNs, as noted previously (Cairo, 2018; Gregory, Elliott, & Dunne, 2013). The choice of an inhaler device will depend on availability, cost, prescribing provider, insurance coverage, and the skills and ability of the patient (GOLD, 2019). Key aspects of each are described in Table 20-3.

Both pMDIs and DPIs are small handheld devices that may be carried in a pocket or purse (Cairo, 2018; D'Urzo, Chapman, Donohue, et al., 2019). Attention to effective drug delivery and training in proper inhaler technique is essential when using a pMDI or DPI. A respiratory therapist is an excellent health care provider to consult on appropriate inhaler technique. **Pressurized metered-dose inhalers (pMDIs)** include conventional pMDIs or breath-actuated pMDIs; these may also feature spacer or valved-holding chambers (VHCs). They are pressurized devices that contain aerosolized powder of medications. A precise amount of medication is released with each activation of the pMDI canister. A spacer or VHC may also be indicated to enhance deposition of the medication in the lung and help the patient coordinate activation of the pMDI with inspiration. Spacers come in several designs, but

all are attached to the pMDI and have a mouthpiece on the opposite end (Fig. 20-5).

All pMDIs are designed so that they require coordination between the patient's inspiration and the mechanics of the inhaler. In contrast, **dry-powder inhalers (DPIs)** (see Fig. 20-5) rely solely on the patient's inspiration for medication delivery. While DPIs still require the user to press a lever or button to dispense the medication, these inhalers do not require the coordination necessary to administer pMDIs.

Because of the significant relationship between poor inhaler technique and lack of symptom control, issues that could affect proper inhaler use must be considered when assessing the effectiveness of these medications (GOLD, 2019). Conditions such as decreased hand–inhalation coordination, insufficient hand strength, and the inability to generate a sufficient inspiratory flow could impair the delivery of the medication, and thus, impair symptom control (D'Urzo et al., 2019). For example, patients with decreased hand–inhalation coordination could fail to exhale prior to administering pMDIs, which would prevent them from inhaling the proper amount of the medication. While DPIs minimize the need for hand–inhalation coordination, patients with severe COPD may not have the ability to generate a sufficient inspiratory flow necessary to deliver the proper dose (D'Urzo et al., 2019).

TABLE 20-3 Aerosol Delivery Devices

Devices/Drugs	Optimal Technique	Therapeutic Issues
Pressurized metered-dose inhaler (pMDI) Beta-2-adrenergic agonists Corticosteroids Anticholinergics	Actuation[a] during a slow (30 L/min or 3–5 s) deep inhalation, followed by 10-s breath-hold	Slow inhalation and coordination of actuation may be difficult for some patients. Patients may incorrectly stop inhalation at actuation. Deposition of 50–80% of actuated dose in the oropharynx. Mouth washing and spitting is effective in reducing the amount of drug swallowed and absorbed systemically
Breath-actuated pMDI Beta-2-adrenergic agonists	Tight seal around mouthpiece and slightly more rapid inhalation than standard pMDI (see above) followed by 10-s breath-hold	May be particularly useful for patients unable to coordinate inhalation and actuation. May also be useful for older patients. Patients may incorrectly stop inhalation at actuation. Cannot be used with currently available spacer/valved-holding chamber (VHC) devices
Spacer or VHC (*Note—this is an accessory to a pMDI*)	Slow (30 L/min or 3–5 s) deep inhalation, followed by 10-s breath-hold immediately following actuation. Actuate only once into spacer/VHC per inhalation. Rinse plastic VHCs once a month with low concentration of liquid household dishwashing detergent (1:5000 or 1–2 drops per cup of water) and let drip dry	Indicated for patients who have difficulty performing adequate pMDI technique. May be bulky. Simple tubes do not obviate coordinating actuation and inhalation. VHCs are preferred. Spacers or VHCs may increase delivery of inhalational corticosteroids to the lungs
Dry-powder inhaler (DPI) Beta-2-adrenergic agonists Corticosteroids Anticholinergics	Rapid (1–2 s) deep inhalation. Minimally effective inspiratory flow is device dependent	Dose is lost if patient exhales through device after actuating. Delivery may be greater or lesser than pMDIs, depending on device and technique. Delivery is more flow dependent in devices with highest internal resistance. Rapid inhalation promotes greater deposition in larger central airways. Mouth washing and spitting are effective in reducing amount of drug swallowed and absorbed systemically
Small-volume nebulizer (SVN) Beta-2-adrenergic agonists	Slow tidal breathing with occasional deep breaths. Tightly fitting facemask for those unable to use mouthpiece	Less dependent on patient's coordination and cooperation. May be expensive, time-consuming, and bulky; output depends on device and operating parameters (fill volume, driving gas flow);

Corticosteroids Anticholinergics	internebulizer and intranebulizer output variances are significant. The use of a facemask reduces delivery to lungs by 50%. Choice of delivery system depends on resources, availability, and clinical judgment of clinician caring for patient. There is potential for infections if device is not cleaned properly

[a]Actuation refers to release of dose of medication with inhalation.

Adapted from Cairo, J. M. (2018). *Mosby's respiratory care equipment* (10th ed.). St. Louis, MO: Elsevier Mosby.

Figure 20-5 • **A.** Examples of pressurized metered-dose inhalers (pMDIs) and spacers and a dry-powder inhaler (DPI). **B.** A pressurized metered-dose inhaler and spacer in use.

The **small-volume nebulizer (SVN)** is a handheld apparatus that is easier to use than a pMDI or a DPI but lacks the convenience of these inhalers as it requires a power source in order to operate. Common SVNs include single-use pneumatic jet nebulizers with reservoir tubes, which are most commonly used in hospitals, and electronic nebulizers, which may be used in the home-based setting (Gregory et al., 2013). SVNs are commonly prescribed when patients are challenged with being able to administer their medications through either a pMDI or a DPI; some reasons why this might happen have been described previously (Cairo, 2018). The SVN may also be a preferred option to other inhalers because the nebulized particles in an SVN are smaller and can better penetrate the airways. Diaphragmatic breathing (see later discussion under "Breathing Retraining") is a helpful technique to prepare for proper use of the SVN.

Several classes of bronchodilators are used that include beta-adrenergic agonists, muscarinic antagonists (anticholinergics) and combination agents. Beta-adrenergic agonists include short-acting beta-2-adrenergic agonists (SABAs) and long-acting beta-2 adrenergic agonists (LABAs). The anticholinergic agents include short-acting muscarinic antagonists (SAMAs) and long-acting muscarinic antagonists (LAMAs) (GOLD, 2018; GOLD, 2019). ICSs may also be combined with bronchodilators. These medications may be used in combination to optimize bronchodilation. LABA bronchodilators are more convenient for patient use as compared to short-acting $beta_2$-agonist bronchodilators. Examples of these medications are described in Table 20-4.

Fixed dose combinations of LABAs and LAMAs have become the foundation for treating COPD (D'Urzo et al., 2019). Combining these classes of medications in one inhaler has synergistic effects, so that the dosages of each medication may be lesser than if they were each administered separately (i.e., as monotherapy), without diminishing their effectiveness (GOLD, 2019). Furthermore, combination therapy is associated with less adverse reactions and promotes proper medication administration by avoiding the use of multiple inhaler devices (GOLD, 2019).

Corticosteroids

Although inhaled and systemic corticosteroids may improve the symptoms of COPD, they do not slow the decline in lung function. A short trial course of oral corticosteroids may be prescribed for patients to determine whether pulmonary function improves and symptoms decrease. Long-term treatment with oral corticosteroids is not recommended in COPD and can cause steroid myopathy, leading to muscle weakness, decreased ability to function, and, in advanced disease, respiratory failure (GOLD, 2019). ICSs are frequently prescribed in COPD.

Treatment of COPD with combination long-term $beta_2$-agonists plus corticosteroids in one inhaler may improve lung function (GOLD, 2018). Examples of these medications include formoterol/budesonide, vilanterol/fluticasone furoate, and salmeterol/fluticasone.

Other Medications

Other pharmacologic treatments that may be used in COPD include $alpha_1$-antitrypsin augmentation therapy, antibiotic agents, mucolytic agents, antitussive agents, vasodilators, and opioids. Vaccines are also effective in that they prevent exacerbations by thwarting respiratory infections. For instance, influenza vaccines can reduce serious illness and death in patients with COPD (GOLD, 2019). It is recommended that people limit their risk through influenza vaccination and smoking cessation. Pneumococcal vaccination also

reduces the incidence of community-acquired pneumonia in the general older adult population (GOLD, 2019).

Management of Exacerbations

An exacerbation of COPD is defined as an event in the natural course of the disease characterized by acute changes (worsening) in the patient's respiratory symptoms beyond the normal day-to-day variations. An exacerbation also leads to change in medication (GOLD, 2019). During an exacerbation, there is increased dyspnea that is a result of amplified hyperinflation and air trapping (GOLD, 2019). Primary causes of an acute exacerbation are usually related to viral infections, particularly human rhinovirus (i.e., the common cold). However, bacterial infections and environmental factors have also been linked to the development of acute exacerbations (GOLD, 2019). Roflumilast may be used as a treatment to reduce the risk of exacerbations in patients with severe COPD associated with chronic bronchitis and a history of exacerbations. Roflumilast is a selective phosphodiesterase-4 (PDE4) inhibitor and is taken as a tablet once daily.

TABLE 20-4 Common Types of Bronchodilator Medications for Chronic Obstructive Pulmonary Disease

	Method of Administration			
Class/Drug	Inhaler[a]	Nebulizer	Oral	Duration of Action[b]
Beta-2–Adrenergic Agonist Agents				
albuterol	X	X	X	SABA
levalbuterol	X	X		SABA
terbutaline	X			SABA
arformoterol	X			LABA
formoterol	X			LABA
salmeterol	X			LABA
indacaterol	X			LABA
olodaterol	X			LABA
Anticholinergic Agents				
ipratropium bromide	X	X		SAMA
tiotropium bromide	X			LAMA
umeclidinium	X			LAMA
Combination Short-Acting Beta-2–Adrenergic Agonist and Anticholinergic Agent				
albuterol/ipratropium	X			SABA/SAMA
Inhaled Corticosteroids (ICSs)				
beclomethasone dipropionate	X	X		
budesonide	X	X		
fluticasone propionate	X	X		
Combination Inhaled Corticosteroids and Long-Acting Beta-2–Adrenergic Agonist				
budesonide/formoterol	X			ICS/LABA
mometasone/formoterol	X			ICS/LABA
fluticasone/salmeterol	X			ICS/LABA
fluticasone furoate/vilanterol	X			ICS/LABA

[a]Inhaler may include pressurized metered-dose inhaler (pMDI) or dry-powder inhaler (DPI).
[b]Short acting, 4–6 h; long acting, 12+ h.
ICS, inhaled corticosteroid; LABA, long-acting beta-2 adrenergic agonist; LAMA, long-acting muscarinic antagonist; SABA, short-acting beta-2 adrenergic agonist; SAMA, short-acting muscarinic antagonist.
Adapted from Global Initiative for Chronic Obstructive Lung Disease (GOLD). (2019). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. Retrieved on 6/25/2019 at: www.goldcopd.org/wp-content/uploads/2018/11/GOLD-2019-v1.7-FINAL-14Nov2018-WMS.pdf

Treatment of an exacerbation requires identifying the primary cause (if possible) and administering the specific treatment. Optimization of bronchodilator medications is first-line therapy and involves identifying the best medication or combinations of medications taken on a regular schedule

for a specific patient. Depending on the signs and symptoms, corticosteroids, antibiotic agents, oxygen therapy, and intensive respiratory interventions may also be used. The GOLD (2019) guidelines provide indications for assessment, hospital admission, and possible critical-care admission for patients with exacerbations of COPD. Indications for hospitalization include marked increase in intensity of symptoms, severe underlying COPD, onset of new physical signs (e.g., the use of accessory muscles, paradoxical chest wall movement, worsening or new onset of central cyanosis, peripheral edema, signs of right heart failure, reduced alertness), failure to respond to initial medical management, older age, and insufficient home support. Patients requiring hospitalization for an exacerbation would exhibit severe dyspnea that does not respond adequately to initial therapy, confusion or lethargy, respiratory muscle fatigue, paradoxical chest wall movement, peripheral edema, worsening or new onset of central cyanosis, persistent or worsening hypoxemia, and the need for noninvasive or invasive assisted mechanical ventilation (GOLD, 2019). The outcome from an exacerbation of COPD is closely related to the development of respiratory acidosis, the presence of significant comorbidities, and the need for noninvasive or invasive positive pressure ventilatory support.

When the patient with an exacerbation of COPD arrives in an ED, the first line of treatment is supplemental oxygen therapy and rapid assessment to determine if the exacerbation is life-threatening (GOLD, 2019). A short-acting inhaled bronchodilator may be used to assess response to treatment. Oral or intravenous (IV) corticosteroids, in addition to bronchodilators, are recommended in the hospital management of a COPD exacerbation. The administration of antibiotics remains controversial, but in general, they should be administered when the patient has three cardinal symptoms of an exacerbation: increase in dyspnea, increase in sputum volume, and sputum purulence (GOLD, 2019).

Surgical Management

Surgical options might be appropriate for patients who do not demonstrate symptom improvement with nonsurgical therapies.

Bullectomy

A bullectomy is a surgical option for select patients with bullous emphysema. Bullae are enlarged airspaces that do not contribute to ventilation but occupy space in the thorax; these areas may be surgically excised. These bullae compress areas of the lung and may impair gas exchange. Bullectomy may help reduce dyspnea and improve lung function. It can be performed via a video-assisted thoracoscope or a limited thoracotomy incision (GOLD, 2019).

Lung Volume Reduction Surgery

Treatment options for patients with advanced or end-stage COPD (grade IV) with a primary emphysematous component are limited, although lung volume reduction surgery is a palliative surgical option. This includes patients with homogenous disease or disease that is focused in one area and not widespread throughout the lungs. Lung volume reduction surgery involves the removal of a portion of the diseased lung parenchyma. This reduces hyperinflation and allows the functional tissue to expand, resulting in improved elastic recoil of the lung and improved chest wall and diaphragmatic mechanics. This type of surgery does not cure the disease but may improve health status, exercise tolerance, and the patient's overall quality of life (GOLD, 2019).

Bronchoscopic lung volume reduction therapies are under investigation in clinical research protocols. These bronchoscopic procedures were developed to collapse areas of emphysematous lung and thus improve aeration of the functional lung tissue. Techniques include endobronchial placement of a one-way valve that allows air and mucus to exit the treated area but does not allow air to reenter. Another technique achieves biologic lung volume reduction through bronchoscopic instillation of nitinol coils into the airway of the hyperinflated lung tissue of patients with advanced emphysema. Because air can no longer enter the airway, the lung tissue beyond the sealed airway collapses over time. Patients receiving this procedure reported increased quality of life. However, there is insufficient evidence to determine the benefit–risk ratios, cost-effectiveness, and possible roles of these procedures in care of the patient with severe emphysema (GOLD, 2019).

Lung Transplantation

Lung transplantation is a viable option for definitive surgical treatment of severe COPD in select patients. It has been shown to improve quality of life and functional capacity in some patients with COPD. Limited not only by the shortage of donor organs, it is also a costly procedure with financial implications for months to years because of complications and the need for costly immunosuppressive medication regimens (GOLD, 2019).

Pulmonary Rehabilitation

Pulmonary rehabilitation, one of the most cost-effective treatment strategies, is a holistic intervention aimed at improving physical and psychological health of patients with COPD (GOLD, 2019). The primary goals of rehabilitation are to reduce symptoms, improve quality of life, and increase physical and emotional participation in everyday activities (GOLD, 2019). The benefits of this therapy include improvement of exercise capacity, reduction in the perceived intensity of breathlessness, improvement in health-related quality of life, reduction in the number of hospitalizations and days in the hospital, and reduction in the anxiety and depression associated with COPD (GOLD, 2019). Pulmonary rehabilitation services are multidisciplinary and include assessment, education,

smoking cessation, physical reconditioning, nutritional counseling, skills training, and psychological support. Patients are taught methods to alleviate symptoms. Breathing exercises, as well as retraining and exercise programs, are used to improve functional status.

Pulmonary rehabilitation is appropriate for most patients with COPD, particularly those with moderate or severe COPD (GOLD, 2019). Optimum benefits are achieved in programs that are 6 to 8 weeks in length (GOLD, 2019). Programs vary in duration and may be conducted in inpatient, outpatient, or home settings. Program selection depends on the patient's physical, functional, and psychosocial status; insurance coverage; availability of programs; and preference. Pulmonary rehabilitation may also be used therapeutically in other disorders besides COPD, including asthma, CF, lung cancer, interstitial lung disease, thoracic surgery, and lung transplantation. Despite their proven efficacy, comprehensive programs for patients with moderate to severe COPD are covered by Medicare only for those who meet specific criteria.

Patient Education

Nurses play a key role in identifying potential candidates for pulmonary rehabilitation and in facilitating and reinforcing the material learned in the rehabilitation program. Not all patients have access to a formal rehabilitation program. However, nurses can be instrumental in educating patients and families as well as facilitating specific services, such as respiratory therapy education, physical therapy for exercise and breathing retraining, occupational therapy for conserving energy during activities of daily living, and nutritional counseling. Patient education is a major component of pulmonary rehabilitation and includes a broad variety of topics. (See Chart 20-3, Nursing Research Profile: Managing Anxiety among Patients with Advanced COPD.)

Depending on the length and setting of the educational program, topics may include normal anatomy and physiology of the lung, pathophysiology and changes with COPD, medications and home oxygen therapy, nutrition, respiratory therapy treatments, symptom alleviation, smoking cessation, sexuality and COPD, coping with chronic disease, communicating with the health care team, and planning for the future (advance directives, living wills, informed decision making about health care alternatives). Education, including that relating to smoking cessation, should be incorporated into all aspects of care for COPD and in many settings (primary providers' offices, clinics, hospitals, home and community health care settings, and comprehensive rehabilitation programs).

Nutritional Therapy

Nutritional assessment and counseling are important for patients with COPD. Nutritional status is reflected in severity of symptoms, degree of disability, and prognosis. Significant weight loss is often a major problem; however, excessive weight can also be problematic, although it occurs less often. Most patients with COPD have difficulty gaining and maintaining weight. A thorough assessment of caloric needs and counseling about meal planning and supplementation is part of the rehabilitation process. Continual monitoring of weight and interventions as necessary are important parts of the care of patients with COPD.

Chart 20-3 **NURSING RESEARCH PROFILE**

Managing Anxiety among Patients with Advanced COPD

Bove, D. G., Midtgaard, G., Kaldan, D., et al. (2017). Home-based COPD psychoeducation: A qualitative study of the patients' experiences. *Journal of Psychosomatic Research, 98*, 71–77.

Purpose

This study was a nested posttrial qualitative study conducted in the context of a randomized controlled trial (RCT), *Efficacy of a Minimal Home-Based Psychoeducative Intervention in Patients with Advanced COPD.* Quantitative results from the RCT found that the nurse-led home-based intervention significantly reduced anxiety and increased mastery of dyspneic symptoms in patients with advanced COPD. The purpose of this qualitative study was to explore whether patients with advanced COPD who received this intervention found the intervention meaningful and applicable to their everyday lives.

Design

This qualitative study utilized the Interpretive Description methodology and collected data from 20 participants enrolled in the RCT. The participants accepted an invitation for the qualitative interview and signed informed consent to participate in the study. With one exception, all participants were interviewed at home. Interviews were conducted by researchers who did not previously meet the participants. All interviews were recorded and transcribed for data analysis.

Findings

Transcribed interviews revealed three main themes: (1) Making anxiety visible makes it manageable and provides relief; (2) Anxiety management is about getting control of cognitions; and (3) Being alone with anxiety and dyspnea. The first theme centered on recognition of anxiety as an aspect of COPD; nonetheless, participants expressed difficulty in talking about anxiety with relatives. Some participants felt that their spouses were annoyed when they talked about anxiety and dyspnea. They validated the usefulness of patient education materials that gave legitimacy to the problems they struggled with on a daily basis. The second theme focused on anxiety management and revealed that participants believed they had to deal with their anxiety privately. The behavioral cognitive intervention gave them the freedom to verbalize their thoughts and worries, especially thoughts of death and the dying process. The third theme revolved around feelings of isolation associated with anxiety and dyspnea. Participants verbalized that the psychoeducation intervention helped them establish a sense of control and self-preservation despite feeling alone during acute episodes.

Nursing Implications

This study validated that the nurse-led psychoeducation intervention that decreased anxiety and improved dyspneic symptoms among patients with advanced COPD also had the favorable effect of being perceived as meaningful and helpful to these participants. Participants in this study felt better equipped to manage their anxiety and dyspnea after having received the intervention, and found it valuable. They expressed relief that the intervention was focused upon their anxieties. These findings illustrate the importance of acknowledging and assessing anxiety during dyspneic episodes among patients with COPD. Legitimizing the anxiety experienced by patients with advanced COPD can establish a solid foundation for providing education to them and their spouses on the disease process and help them understand what to expect as the disease progresses. Increasing their knowledge on COPD and disease management will help them feel a sense of control that in turn could help diminish feelings of anxiety. Moreover, including family members in patient education could diminish feelings of isolation, which in turn will help decrease anxiety and ultimately improve disease management.

Palliative Care

Palliative care is integral for the patient with advanced COPD. Unfortunately, palliative care is often not considered until the disease is far advanced. The overall goals of palliative care are to manage symptoms and improve the quality of life for patients and families with advanced disease (GOLD, 2019). Areas addressed in palliative care include effective and empathetic communication with patients and families; close attention to pain, dyspnea, panic, anxiety, depression and other symptoms; psychosocial, spiritual and bereavement support; and coordination of the wide range of medical and social services required with this disease (GOLD, 2019). Palliative, hospice care, and end-of-life care are fundamental components of treatment for patients with advanced COPD (GOLD, 2019) (see Chapter 13).

Nursing Management

An overview of the nursing care of the patient with COPD is provided in Chart 20-4. Additional nursing considerations with regard to assessing the patient with COPD and promoting optimal nursing and collaborative outcomes are specified as follows.

Assessing the Patient

Assessment involves obtaining information about current symptoms as well as previous disease manifestations. See Chart 20-2 for sample questions that may be used to obtain a clear history of the disease process. In addition to the history, the nurse reviews the results of diagnostic tests.

Achieving Airway Clearance

Bronchospasm, which occurs in many pulmonary diseases, reduces the caliber of the small bronchi and may cause dyspnea, static secretions, and infection. Bronchospasm can sometimes be detected on auscultation with a stethoscope when wheezing or diminished breath sounds are heard. Increased mucus production, along with decreased mucociliary action, contributes to further reduction in the caliber of the bronchi and results in decreased airflow and decreased gas exchange. This is further aggravated by the loss of lung elasticity that occurs with COPD (GOLD, 2019). These changes in the airway require that the nurse monitor the patient for dyspnea and hypoxemia. The relief of bronchospasm is confirmed by measuring improvement in expiratory flow rates and volumes (the force of expiration, how long it takes to exhale, and the amount of air exhaled) as well as by assessing the dyspnea and making sure that it has lessened.

Chart 20-4 **PLAN OF NURSING CARE**

Care of the Patient with Chronic Obstructive Pulmonary Disease

Nursing Diagnosis: Impaired gas exchange and impaired airway clearance due to chronic inhalation of toxins
Goal: Improvement in gas exchange

Nursing Interventions	Rationale	Expected Outcomes
1. Evaluate current smoking status, educate regarding smoking cessation, and facilitate efforts to quit. a. Evaluate current smoking habits of patient and family. b. Educate regarding hazards of smoking and relationship to COPD. c. Evaluate previous smoking cessation attempts. d. Provide educational materials. e. Refer to a smoking cessation program or resource.	1. Smoking causes permanent damage to the lungs and diminishes the lungs' protective mechanisms. Airflow is obstructed, secretions are increased, and lung capacity is reduced. Continued smoking increases morbidity and mortality in COPD and is also a risk factor for lung cancer.	• Identifies the hazards of cigarette smoking • Identifies resources for smoking cessation, if appropriate • Enrolls in smoking cessation program, if appropriate • Reports success in stopping smoking
2. Evaluate current exposure to occupational toxins or pollutants and indoor/outdoor pollution. a. Emphasize primary prevention to occupational exposures. This	2. Chronic inhalation of both indoor and outdoor toxins causes damage to the airways and impairs gas exchange.	• Verbalizes types of inhaled toxins • Minimizes or eliminates exposures • Monitors public announcements regarding air quality and minimizes or eliminates exposures during episodes of severe pollution

is best achieved by elimination or reduction in exposures in the workplace. b. Educate regarding types of indoor and outdoor air pollution (e.g., biomass fuel burned for cooking and heating in poorly ventilated buildings, outdoor air pollution). c. Advise patient to monitor public announcements regarding air quality.		
Nursing Diagnosis: Impaired gas exchange associated with ventilation–perfusion inequality **Goal:** Improvement in gas exchange		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Administer bronchodilators as prescribed. a. Inhalation is the preferred route. b. Observe for side effects: tachycardia, arrhythmias, central nervous system excitation, nausea, and vomiting.	1. Bronchodilators dilate the airways. The medication dosage is carefully adjusted for each patient, in accordance with clinical response.	• Verbalizes need for bronchodilators and for taking them as prescribed • Evidences minimal side effects; heart rate near normal, absence of arrhythmias,

c. Assess for correct technique of pressurized metered-dose inhaler (pMDI), dry-powder inhaler (DPI), or small-volume nebulizer (SVN) administration. 2. Evaluate effectiveness of pMDI, DPI, or SVN treatments. a. Assess for decreased shortness of breath, decreased wheezing or crackles, loosened secretions, and decreased anxiety. b. Ensure that treatment is given before meals to avoid nausea and to reduce fatigue that accompanies eating. 3. Instruct and encourage patient in diaphragmatic breathing and effective coughing. 4. Administer oxygen by the method prescribed. a. Explain rationale and	2. Combining medication with aerosolized bronchodilators is typically used to control bronchoconstriction in an acute exacerbation. Generally, however, the pMDI with spacer is the preferred route (less cost and time to treatment). 3. These techniques improve ventilation by opening airways to facilitate clearing the airways of sputum. Gas exchange is improved, and fatigue is minimized. 4. Oxygen will correct the hypoxemia. Careful observation of the liter flow or the percentage given and its effect on the patient is important. These patients generally require low-flow oxygen rates of 1–2 L/min. Monitor and titrate to achieve desired PaO_2. Periodic arterial blood gases and pulse oximetry help evaluate adequacy of oxygenation. Smoking may	normal mentation • Reports a decrease in dyspnea • Shows an improved expiratory flow rate • Uses and cleans respiratory therapy equipment as applicable • Demonstrates diaphragmatic breathing and coughing • Uses oxygen equipment appropriately when indicated • Evidences improved arterial blood gases or pulse oximetry • Demonstrates correct technique for use of pMDI, DPI, or SVN

	importance to patient. b. Evaluate effectiveness; observe for signs of hypoxemia. Notify primary provider if restlessness, anxiety, somnolence, cyanosis, or tachycardia is present. c. Analyze arterial blood gases and compare with baseline values. When arterial puncture is performed and a blood sample is obtained, hold puncture site for 5 minutes to prevent arterial bleeding and development of ecchymoses. d. Initiate pulse oximetry to monitor oxygen saturation. e. Explain that no smoking is permitted by patient or visitors while oxygen is in use.	render pulse oximetry inaccurate because the carbon monoxide from cigarette smoke also saturates hemoglobin.

Nursing Diagnosis: Impaired airway clearance associated with bronchoconstriction, increased mucus production, ineffective cough, bronchopulmonary infection, and other complications

Goal: Achievement of airway clearance

Nursing Interventions	Rationale	Expected Outcomes
1. Adequately hydrate the patient.	1. Systemic hydration keeps secretions moist and easier to expectorate. Fluids must be given with caution if right- or left-sided heart failure is present.	• Verbalizes need to drink fluids
2. Instruct in and encourage the use of diaphragmatic breathing and coughing techniques.	2. These techniques help to improve ventilation and mobilize secretions without causing breathlessness and fatigue.	• Demonstrates diaphragmatic breathing and coughing • Performs postural drainage correctly
3. Assist in administering pMDI, DPI, or SVN.	3. This ensures adequate delivery of medication to the airways.	• Coughing is minimized
4. If indicated, perform postural drainage with percussion and vibration in the morning and at night as prescribed.	4. This uses gravity to help raise secretions so they can be more easily expectorated or suctioned.	• Does not smoke
5. Instruct patient to avoid bronchial irritants such as cigarette smoke, aerosols, extremes of temperature, and fumes.	5. Bronchial irritants cause bronchoconstriction and increased mucus production, which then interfere with airway clearance.	• Verbalizes that pollens, fumes, gases, dusts, and extremes of temperature and humidity are irritants to be avoided
6. Educate about early signs of infection that are to be reported to the primary provider immediately: a. Increased sputum production	6. Minor respiratory infections that are of no consequence to the person with normal lungs can produce fatal disturbances in the lungs of the person with COPD. Early	• Identifies signs of early infection • Is free of infection (no fever, no change in sputum, lessening of dyspnea) • Verbalizes need to notify primary provider at the earliest sign of infection • Verbalizes need to stay away from crowds or people with

b. Change in color of sputum c. Increased thickness of sputum d. Increased shortness of breath, tightness in chest, or fatigue e. Increased coughing f. Fever or chills 7. Administer antibiotics as prescribed. 8. Encourage patient to be immunized against influenza and *Streptococcus pneumoniae.*	recognition is crucial. 7. Antibiotics may be prescribed to prevent or treat infection. 8. Patients with respiratory conditions are prone to respiratory infections and are encouraged to be immunized.	colds in flu season • Discusses flu and pneumonia vaccines with clinician to help prevent infection
Nursing Diagnosis: Impaired breathing associated with shortness of breath, mucus, bronchoconstriction, and airway irritants **Goal:** Improvement in breathing pattern		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Instruct patient in diaphragmatic and pursed-lip breathing. 2. Encourage alternating activity with rest periods. Encourage patient to make some decisions (bath, shaving) about care based on tolerance level.	1. This helps patient prolong expiration time and decreases air trapping. With these techniques, patient will breathe more efficiently and effectively. 2. Pacing activities permits patient to perform activities without excessive distress. 3. This strengthens and conditions the respiratory muscles.	• Practices pursed-lip and diaphragmatic breathing and uses them when short of breath and with activity • Shows signs of decreased respiratory effort and paces activities • Uses inspiratory

3. Encourage the use of an inspiratory muscle trainer if prescribed.		muscle trainer as prescribed

Nursing Diagnosis: Impaired ability to manage regime associated with fatigue secondary to increased work of breathing and insufficient ventilation and oxygenation

Goal: Independence in health management activities

Nursing Interventions	Rationale	Expected Outcomes
1. Educate patient to coordinate diaphragmatic breathing with activity (e.g., walking, bending). 2. Encourage patient to begin to bathe self, dress self, walk, and drink fluids. Discuss energy conservation measures. 3. Educate patient about postural drainage if appropriate.	1. This will encourage the patient to be more active and to avoid excessive fatigue or dyspnea during activity. 2. As condition resolves, patient will be able to do more but needs to be encouraged to avoid increasing dependence. 3. This encourages patient to become involved in own care and prepares patient to manage at home.	• Uses controlled breathing while bathing, bending, and walking • Paces activities of daily living to alternate with rest periods to reduce fatigue and dyspnea • Describes energy conservation strategies • Performs same self-care activities as before • Performs postural drainage correctly

Nursing Diagnosis: Activity intolerance due to fatigue, hypoxemia, and impaired breathing
Goal: Improvement in activity tolerance

Nursing Interventions	Rationale	Expected Outcomes
1. Support patient in establishing a regular regimen of exercise using treadmill and exercise bicycle, walking, or other appropriate exercises, such as mall walking. a. Assess the patient's current level of functioning, and develop exercise plan based on baseline functional status. b. Suggest consultation with a physical therapist or pulmonary rehabilitation program to determine an exercise program specific to the patient's capability. Have portable oxygen unit available if oxygen is prescribed for exercise.	1. Muscles that are deconditioned consume more oxygen and place an additional burden on the lungs. Through regular, graded exercise, these muscle groups become more conditioned, and the patient can do more without getting as short of breath. Graded exercise breaks the cycle of debilitation.	• Performs activities with less shortness of breath • Verbalizes need to exercise daily and demonstrates an exercise plan to be carried out at home • Walks and gradually increases walking time and distance to improve physical condition • Exercises both upper and lower body muscle groups

Nursing Diagnosis: Difficulty coping associated with reduced socialization, anxiety, depression, lower activity level, and the inability to work

Goal: Attainment of an optimal level of coping

Nursing Interventions	Rationale	Expected Outcomes
1. Help the patient develop realistic goals.	1. Developing realistic goals will promote a sense of hope and accomplishment rather than defeat and hopelessness.	• Expresses interest in the future • Participates in the discharge plan
2. Encourage activity to level of symptom tolerance.	2. Activity reduces tension and decreases degree of dyspnea as patient becomes conditioned.	• Discusses activities or methods that can be performed to ease shortness of breath
3. Educate the patient about relaxation techniques or provide a relaxation recording on audiotape, CD, or digital audio available on smartphones or tablets.	3. Relaxation reduces stress, anxiety, and dyspnea and helps patient to cope with disability.	• Uses relaxation techniques appropriately
4. Enroll patient in pulmonary rehabilitation program where available.	4. Pulmonary rehabilitation programs have been shown to promote a subjective improvement in a patient's status and self-esteem as well as increased exercise tolerance and decreased hospitalizations.	• Expresses interest in a pulmonary rehabilitation program

Nursing Diagnosis: Lack of knowledge about self-management to be performed at home
Goal: Adherence to therapeutic program and home care

Nursing Interventions	Rationale	Expected Outcomes
1. Help patient identify/develop short- and long-term goals. a. Educate the patient about disease, medications, procedures, and how and when to seek help. b. Refer patient to pulmonary rehabilitation. 2. Give strong message to stop smoking. Discuss smoking cessation strategies. Provide information about resource groups (e.g., SmokEnders, American Cancer Society, American Lung Association).	1. Patient needs to be a partner in developing the plan of care and needs to know what to expect. Education about COPD is one of the most important aspects of care; it will prepare the patient to live and cope with the COPD and improve quality of life. 2. Smoking causes permanent damage to the lung and diminishes the lungs' protective mechanisms. Airflow is obstructed, and lung capacity is reduced. Smoking increases morbidity and mortality and is also a risk factor for lung cancer.	• Understands disease and what affects it • Verbalizes the need to preserve existing lung function by adhering to the prescribed program • Understands purposes and proper administration of medications • Stops smoking or enrolls in a smoking cessation program • Identifies when and whom to call for assistance

Collaborative Problem: Atelectasis
Goal: Absence of atelectasis on x-ray and physical examination

Nursing Interventions	Rationale	Expected Outcomes
1. Monitor respiratory status, including rate and pattern of respirations, breath sounds,	1. A change in respiratory status, including tachypnea, dyspnea, and diminished or absent	• Normal (baseline for patient) respiratory

signs and symptoms of respiratory distress, and pulse oximetry. 2. Instruct in and encourage diaphragmatic breathing and effective coughing techniques. 3. Promote the use of lung expansion techniques (e.g., deep breathing exercises, incentive spirometry) as prescribed.	breath sounds, may indicate atelectasis. 2. These techniques improve ventilation and lung expansion and ideally improve gas exchange. 3. Deep breathing exercises and incentive spirometry promote maximal lung expansion.	rate and pattern • Normal breath sounds for patient • Demonstrates diaphragmatic breathing and effective coughing • Performs deep breathing exercises, incentive spirometry as prescribed • Pulse oximetry ≥90%

Collaborative Problem: Pneumothorax
Goal: Absence of signs and symptoms of pneumothorax

Nursing Interventions	Rationale	Expected Outcomes
1. Monitor respiratory status, including rate and pattern of respirations, symmetry of chest wall movement, breath sounds, signs and symptoms of respiratory distress, and pulse oximetry. 2. Assess pulse. 3. Assess for chest pain and precipitating factors.	1. Dyspnea, tachypnea, tachycardia, acute pleuritic chest pain, tracheal deviation away from the affected side, absence of breath sounds on the affected side, and decreased tactile fremitus may indicate pneumothorax. 2. Tachycardia is associated with pneumothorax and anxiety. 3. Pain may accompany pneumothorax.	• Normal respiratory rate and pattern for patient • Normal breath sounds bilaterally • Normal pulse for patient • Normal tactile fremitus • Absence of pain • Tracheal position is midline • Pulse oximetry ≥90%

4. Palpate for tracheal deviation/shift away from the affected side. 5. Monitor pulse oximetry and, if indicated, arterial blood gases. 6. Administer supplemental oxygen therapy, as indicated. 7. Administer analgesic agents, as indicated, for chest pain. 8. Assist with chest tube insertion and use pleural drainage system, as prescribed.	4. Early detection of pneumothorax and prompt intervention will prevent other serious complications. 5. Recognition of deterioration in respiratory function will prevent serious complications. 6. Oxygen will correct hypoxemia; administer it with caution. 7. Pain interferes with deep breathing, resulting in decreased lung expansion. 8. Removal of air from the pleural space will re-expand the lung.	• Maintains normal oxygen saturation and arterial blood gas measurements • Exhibits no hypoxemia and hypercapnia (or returns to baseline values) • Absence of pain • Symmetric chest wall movement • Lungs fully expanded bilaterally on chest x-ray
Collaborative Problem: Respiratory failure **Goal:** Absence of signs and symptoms of respiratory failure; no evidence of respiratory failure on laboratory tests		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Monitor respiratory status, including rate and pattern of respirations, breath sounds, and signs and symptoms of acute respiratory distress. 2. Monitor pulse oximetry and arterial blood gases.	1. Early recognition of deterioration in respiratory function will avert further complications, such as respiratory failure, severe hypoxemia, and hypercapnia. 2. Recognition of changes in oxygenation and acid–base balance will guide in correcting and	• Normal respiratory rate and pattern for patient with no acute distress • Recognizes symptoms of hypoxemia and hypercapnia • Maintains normal arterial blood

3. Administer supplemental oxygen and initiate mechanisms for mechanical ventilation, as prescribed.	preventing complications. 3. Acute respiratory failure is a medical emergency. Hypoxemia is a hallmark sign. Administration of oxygen therapy and mechanical ventilation (if indicated) are critical to survival.	gases/pulse oximetry or returns to baseline values

Collaborative Problem: Pulmonary arterial hypertension
Goal: Absence of evidence of pulmonary arterial hypertension on physical examination or laboratory tests

Nursing Interventions	Rationale	Expected Outcomes
1. Monitor respiratory status, including rate and pattern of respirations, breath sounds, pulse oximetry, and signs and symptoms of acute respiratory distress. 2. Assess for signs and symptoms of right-sided heart failure, including peripheral edema, ascites, distended neck veins, crackles, and heart murmur. 3. Administer oxygen therapy, as prescribed.	1. Dyspnea is the primary symptom of pulmonary arterial hypertension. Other symptoms include fatigue, angina, near-syncope, edema, and palpitations. 2. Right-sided heart failure is a common clinical manifestation of pulmonary arterial hypertension due to increased right ventricular workload. 3. Continuous oxygen therapy is a major component of management of pulmonary arterial hypertension; it prevents hypoxemia, thereby reducing pulmonary vascular constriction	• Normal respiratory rate and pattern for patient • Exhibits no signs and symptoms of right-sided failure • Maintains baseline pulse oximetry values and arterial blood gases

	(resistance) secondary to hypoxemia.

Diminishing the quantity and viscosity of sputum can clear the airway and improve pulmonary ventilation and gas exchange. All pulmonary irritants should be eliminated or reduced, particularly cigarette smoke, which is the most persistent source of pulmonary irritation. The nurse instructs the patient in directed or controlled coughing, which is more effective and reduces the fatigue associated with undirected forceful coughing. Directed coughing consists of a slow, maximal inspiration followed by breath-holding for several seconds and then two or three coughs. "Huff" coughing may also be effective. The technique consists of one or two forced exhalations (huffs) from low to medium lung volumes with the glottis open.

Chest physiotherapy (CPT), increased fluid intake, and bland aerosol mists (with normal saline solution or water) may be useful for some patients with COPD. The use of these measures must be based on the response and tolerance of each patient. **Chest physiotherapy (CPT)** includes postural drainage, chest percussion and vibration, and breathing retraining. The goals of CPT are consistent with improved airway clearance as they are to remove bronchial secretions, improve ventilation, and increase the efficiency of the respiratory muscles.

Postural Drainage (Segmented Bronchial Drainage)

Postural drainage allows the force of gravity to assist in the removal of bronchial secretions. The secretions drain from the affected bronchioles into the bronchi and trachea and are removed by coughing or suctioning. Because the patient usually sits in an upright position, secretions are likely to accumulate in the lower parts of the lungs. Several other positions (Fig. 20-6) are used so that the force of gravity helps move secretions from the smaller bronchial airways to the main bronchi and trachea. Each position contributes to effective drainage of a different lobe of the lungs; lower and middle lobe bronchi drain more effectively when the head is down, whereas the upper lobe bronchi drain more effectively when the head is up. The secretions then are removed by coughing.

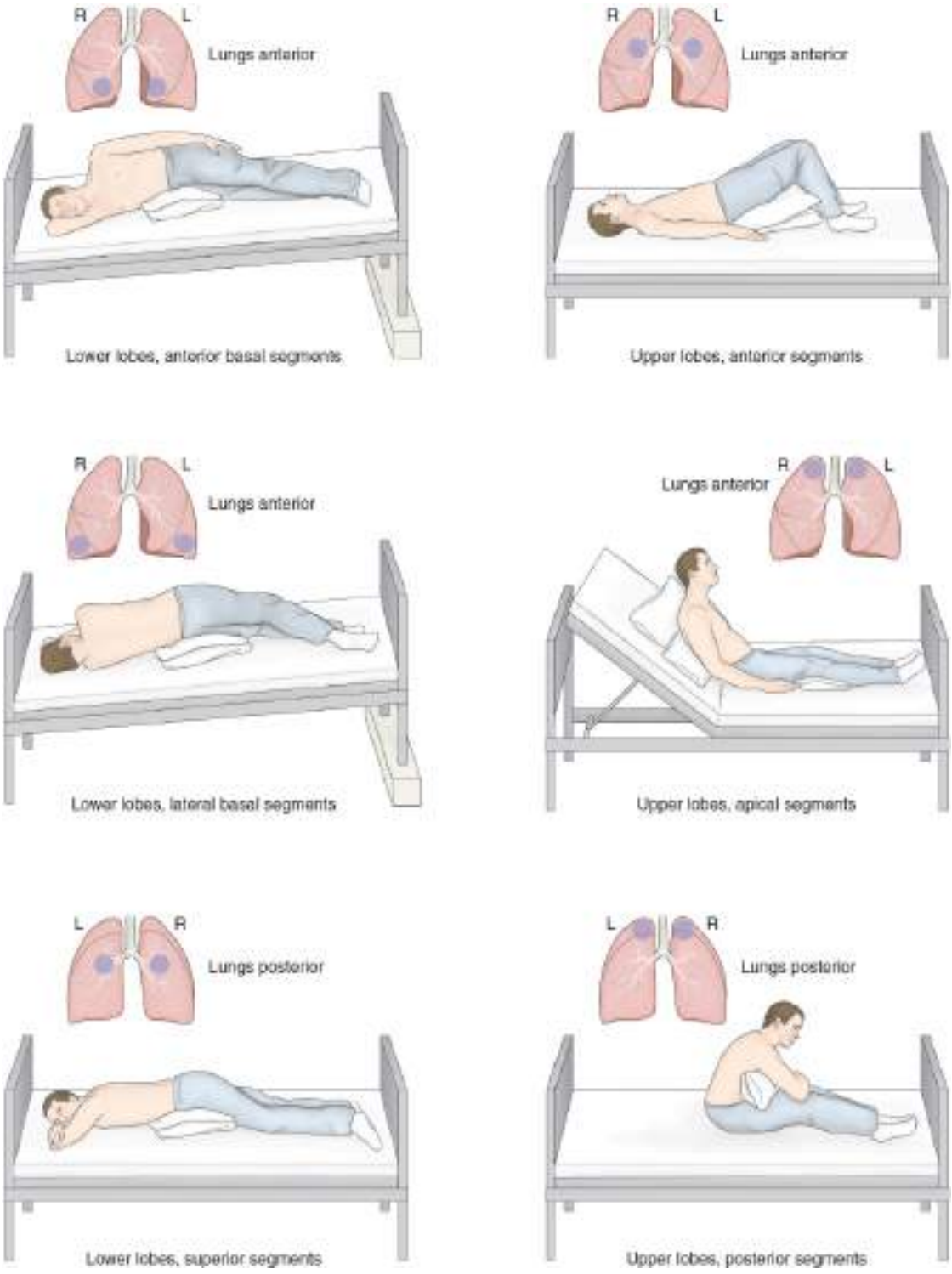


Figure 20-6 • Postural drainage positions and the areas of lung drained by each position.

The nurse should keep in mind the medical diagnosis, the lung lobes or segments involved, the cardiac status, and any structural deformities of the chest wall and spine. Auscultation of the chest before and after the procedure is used to identify the areas that need drainage and assess the effectiveness of

treatment. The nurse educates family members who will assist the patient at home to evaluate breath sounds before and after treatment. The nurse explores strategies that will enable the patient to assume the indicated positions at home. This may require the creative use of objects readily available at home, such as pillows, cushions, or cardboard boxes.

Postural drainage is usually performed two to four times daily, before meals (to prevent nausea, vomiting, and aspiration) and at bedtime. Prescribed bronchodilators, mucolytic agents, water, or saline may be nebulized and inhaled before postural drainage to dilate the bronchioles, reduce bronchospasm, decrease the thickness of mucus and sputum, and combat edema of the bronchial walls. The recommended sequence starts with positions to drain the lower lobes, followed by positions to drain the upper lobes.

The patient is made as comfortable as possible in each position and provided with an emesis basin, sputum cup, and paper tissues. The nurse instructs the patient to remain in each position for 10 to 15 minutes and to breathe in slowly through the nose and out slowly through pursed lips to help keep the airways open so that secretions can drain. If a position cannot be tolerated, the nurse helps the patient assume a modified position. When the patient changes position, instructions for how to cough and remove secretions are provided.

If the patient cannot cough, the nurse may need to suction the secretions mechanically. It also may be necessary to use chest percussion and vibration or a high-frequency chest wall oscillation (HFCWO) vest to loosen bronchial secretions and mucus plugs that adhere to the bronchioles and bronchi and to propel sputum in the direction of gravity drainage (see later discussion). If suctioning is required at home, the nurse instructs caregivers in safe suctioning technique and care of the suctioning equipment.

After the procedure, the nurse or family caregivers note the amount, color, viscosity, and character of the expelled sputum. The nurse evaluates the patient's skin color and pulse the first few times the procedure is performed. It may be necessary to administer oxygen during postural drainage.

If the sputum is foul smelling, postural drainage is performed in a room away from other patients or family members. Deodorizers may be used to counteract the odor. However, because aerosol sprays can cause bronchospasm and irritation, deodorizers should be used sparingly and with caution. After the procedure, the patient may find it refreshing to brush the teeth and use a mouthwash before resting.

Chest Percussion and Vibration

Thick secretions that are difficult to cough up may be loosened by percussing (tapping) and vibrating the chest or through the use of an HFCWO vest. Chest percussion and vibration help dislodge mucus adhering to the bronchioles and

bronchi. A scheduled program of coughing and clearing sputum, together with hydration, reduces the amount of sputum in most patients.

Chest percussion is carried out by cupping the hands and lightly striking the chest wall in a rhythmic fashion over the lung segment to be drained. The wrists are alternately flexed and extended so that the chest is cupped or clapped in a painless manner (Fig. 20-7). A soft cloth or towel may be placed over the segment of the chest that is being cupped to prevent skin irritation and redness from direct contact. Percussion, alternating with vibration, is performed for 3 to 5 minutes for each position. The patient uses diaphragmatic breathing during this procedure to promote relaxation (see later discussion on Breathing Retraining). As a precaution, percussion over chest drainage tubes and the sternum, spine, liver, kidneys, spleen, or breasts (in women) is avoided. Percussion is performed cautiously in older adult patients because of their increased incidence of osteoporosis and risk of rib fracture.

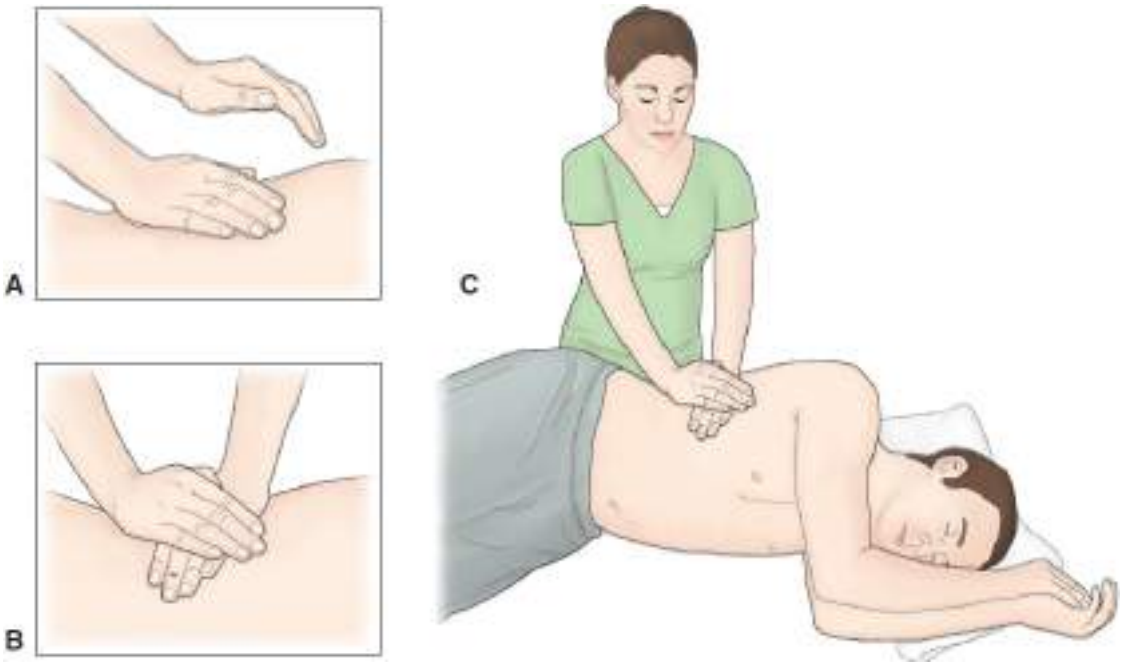


Figure 20-7 • Percussion and vibration. **A.** Proper hand position for percussion. **B.** Proper hand position for vibration. **C.** Proper technique for vibration. The wrists and elbows remain stiff; the vibrating motion is produced by the shoulder muscles.

Figure 20-8 • High-frequency chest wall oscillation (HFCWO) vest. © 2013 Hill-Rom Services, Inc. Reprinted with permission—all rights reserved.

Vibration is the technique of applying manual compression and tremor to the chest wall during the exhalation phase of respiration (see Fig. 20-7). This helps increase the velocity of the air expired from the small airways, thus freeing mucus. After three or four vibrations, the patient is encouraged to cough, contracting the abdominal muscles to increase the effectiveness of the cough.

The number of times the percussion and coughing cycle is repeated depends on the patient's tolerance and clinical response. The nurse evaluates breath sounds before and after application of these techniques.

An inflatable HFCWO vest (Fig. 20-8) may be used to provide chest therapy. The vest uses air pulses to compress the chest wall 8 to 18 times/sec, causing secretions to detach from the airway wall and enabling the patient to expel them by coughing. Patients prescribed vest therapy are generally more satisfied with this mode of treatment delivery than patients who receive manual CPT. Furthermore, research suggests that the vest is equally effective to manual CPT; however, the mode of therapy selected should consider the patient's specific needs and preferences (Hanlon, 2015; Powner, Nesmith, Kirkpatrick, et al., 2019). Technologic advances to the HFCWO vest include portable versions, the AffloVest® and Monarch®, which allow users to move about freely during therapy, thus improving patient adherence and satisfaction. In addition, CPT may also be delivered using specialized beds. These beds

feature programmable mattresses that deliver vibropercussion and may rotate the upper torso up to 45 degrees to help mobilize pulmonary secretions.

To increase the effectiveness of coughing, a flutter valve may be used, which is especially useful for patients who have CF (see later discussion). The **flutter valve** looks like a pipe but has a cap covering the bowl, which contains a steel ball. When the patient exhales actively into the device, movement of the ball causes pressure oscillations, thereby decreasing viscosity of the mucus, facilitating mucous clearance (Fig. 20-9).

When performing CPT, the nurse ensures that the patient is comfortable, is not wearing restrictive clothing, and has not just eaten. The nurse gives medication for pain, as prescribed, before applying the techniques of percussion and vibration, splints any incision, and provides pillows for support as needed. The positions are varied, but focus is placed on the affected areas. On completion of the treatment, the nurse assists the patient to assume a comfortable position.

If an HFCWO vest is being used, the patient may assume whatever position is most comfortable and may even continue to perform light activity during therapy, such as household chores (e.g., folding laundry) or engaging in hobbies (e.g., playing the guitar). The patient does not need to assume specific positions for the vest to be effective.

Treatment should be stopped if any of the following occur: increased pain, increased shortness of breath, weakness, lightheadedness, or hemoptysis. Therapy is indicated until the patient has normal respirations, can mobilize secretions, and has normal breath sounds, and until the chest x-ray findings are normal.

Nursing management of the patient using flutter valve therapy includes ensuring that the patient assumes the proper position, educating the patient on the technique for using the flutter valve, and setting realistic goals for the patient.

Improving Breathing Patterns

The breathing pattern of most people with COPD is shallow, rapid, and inefficient; the more severe the disease, the more inefficient the breathing pattern. Impaired breathing patterns and shortness of breath are due to the modified respiratory mechanics of the chest wall and lung resulting from **air trapping** (i.e., incomplete emptying of alveoli during expiration), ineffective diaphragmatic movement, airway obstruction, the metabolic cost of breathing, and stress. Breathing retraining may help improve breathing patterns. Training in diaphragmatic breathing reduces the respiratory rate, increases alveolar ventilation, and sometimes helps expel as much air as possible during expiration. Pursed-lip breathing helps slow expiration, prevent collapse of small airways, and control the rate and depth of respiration. It also promotes

relaxation, which allows patients to gain control of dyspnea and reduce feelings of panic.

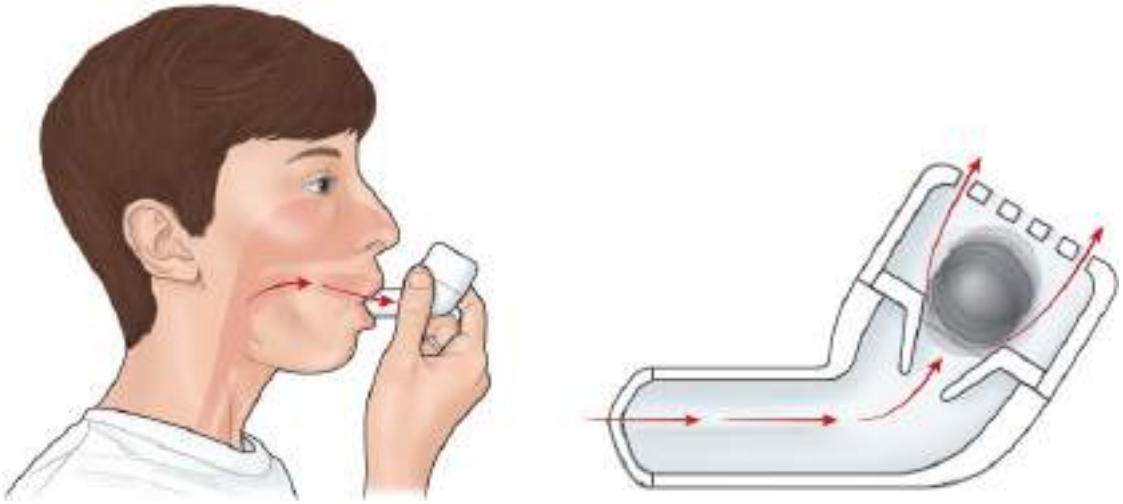


Figure 20-9 • The flutter valve is a handheld pipe-shaped device with a mouthpiece on one end, a perforated cover on the other end, and a steel ball on the inside. When the patient expires through this device, positive end pressure is enhanced, thus helping to clear respiratory secretions.

Chart 20-5 PATIENT EDUCATION

General Instructions

The nurse instructs the patient to:

- Breathe slowly and rhythmically to exhale completely and empty the lungs completely.
- Inhale through the nose to filter, humidify, and warm the air before it enters the lungs.
- Breathe more slowly by prolonging the exhalation time when feeling out of breath.
- Keep the air moist with a humidifier.

Diaphragmatic Breathing

Goal: To use and strengthen the diaphragm during breathing

The nurse instructs the patient to:

- Place one hand on the abdomen (just below the ribs) and the other hand on the middle of the chest to increase the awareness of the position of the diaphragm and its function in breathing.
- Breathe in slowly and deeply through the nose, letting the abdomen protrude as far as possible.
- Breathe out through pursed lips while tightening (contracting) the abdominal muscles.
- Press firmly inward and upward on the abdomen while breathing out.
- Repeat for 1 min; follow with a rest period of 2 min.
- Gradually increase duration up to 5 min, several times a day (before meals and at bedtime).

Pursed-Lip Breathing

Goal: To prolong exhalation and increase airway pressure during expiration, thus reducing the amount of trapped air and the amount of airway resistance

The nurse instructs the patient to:

- Inhale through the nose while slowly counting to 3—the amount of time needed to say “Smell a rose.”
- Exhale slowly and evenly against pursed lips while tightening the abdominal muscles. (Pursing the lips increases intratracheal pressure; exhaling through the mouth offers less resistance to expired air.)
- Count to 7 slowly while prolonging expiration through pursed lips—the length of time to say “Blow out the candle.”
- While sitting in a chair:
  Fold arms over the abdomen.
  Inhale through the nose while counting to 3 slowly.
  Bend forward and exhale slowly through pursed lips while counting to 7 slowly.

- While walking:
  Inhale while walking two steps.
  Exhale through pursed lips while walking four or five steps.

Breathing Retraining

Breathing retraining consists of exercises and breathing practices that are designed to achieve more efficient and controlled ventilation and to decrease the work of breathing. These exercises promote maximal alveolar inflation and muscle relaxation; relieve anxiety; eliminate ineffective, uncoordinated patterns of respiratory muscle activity; and slow the respiratory rate (Kacmarek et al., 2017). Slow, relaxed, rhythmic breathing also helps to control the anxiety that occurs with dyspnea. Specific breathing exercises include diaphragmatic and pursed-lip breathing (Chart 20-5).

Diaphragmatic breathing can become automatic with sufficient practice and concentration. Pursed-lip breathing, which improves oxygen transport, helps induce a slow, deep breathing pattern and assists the patient to control breathing, even during periods of stress. Breathing exercises should be practiced in several positions because air distribution and pulmonary circulation vary with the position of the chest.

Promoting Self-Care

As gas exchange, airway clearance, and the breathing pattern improve, the patient is encouraged to assume increasing participation in self-care activities. The patient is taught to coordinate diaphragmatic breathing with activities such as walking, bathing, bending, or climbing stairs. The patient should bathe, dress, and take short walks, resting as needed to avoid fatigue and excessive dyspnea. Fluids should always be readily available for the patient to promote adequate hydration. Patient education should address self-regulation of fluid intake. This could include the use of fluid diaries and using premeasured water containers to help patients become more cognizant of their fluid intake.

If management of secretions is a problem and some type of postural drainage or airway clearance maneuver is to be performed at home, the nurse or respiratory therapist instructs and supervises the patient before discharge or in an outpatient setting.

Improving Activity Tolerance

People with COPD have decreased exercise tolerance during specific periods of the day, especially in the morning on arising, because bronchial secretions have collected in the lungs during the night while the patient was lying down. The patient may have difficulty bathing or dressing and may become fatigued. Activities that require the arms to be supported above the level of the thorax may produce fatigue or respiratory distress but may be tolerated better after the

patient has been up and moving around for an hour or more. The nurse can help the patient reduce these limitations by planning self-care activities and determining the best times for bathing, dressing, and other daily activities.

Patients with COPD of all grades may benefit from exercise training programs. These benefits may include increased exercise tolerance and decreased dyspnea and fatigue (GOLD, 2019). Physical conditioning techniques include breathing exercises and general exercises intended to conserve energy and increase pulmonary ventilation. Graded exercises and physical conditioning programs using treadmills, stationary bicycles, and measured level walks can improve symptoms and increase work capacity and exercise tolerance. Any physical activity that can be performed regularly is helpful. Walking aids may be beneficial (GOLD, 2019). Lightweight portable oxygen systems are available for ambulatory patients who require oxygen therapy during physical activity. Education is focused on rehabilitative therapies to promote independence in executing activities of daily living. These may include pacing activities throughout the day or using supportive devices to decrease energy expenditure. The nurse evaluates the patient's activity tolerance and limitations and uses education strategies to promote independent activities of daily living. Other health care professionals (rehabilitation therapist, occupational therapist, physical therapist) may be consulted as additional resources.

Encouraging Effective Coping

Any factor that interferes with normal breathing quite naturally induces anxiety, depression, and changes in behavior. Constant shortness of breath and fatigue may make the patient irritable and apprehensive to the point of panic. Restricted activity (and reversal of family roles due to loss of employment), the frustration of having to work to breathe, and the realization that the disease is prolonged and unrelenting may cause the patient to become angry, depressed, and anxious. Sexual function may be compromised, which also diminishes self-esteem. The nurse should provide education and support to spouses or significant others and families, because the caregiver role in end-stage COPD can be challenging.

Monitoring and Managing Potential Complications

The nurse must assess for various complications of COPD, such as life-threatening respiratory insufficiency and failure, as well as respiratory infection and chronic atelectasis, which may increase the risk of respiratory failure. The nurse monitors for cognitive changes (personality and behavioral changes, memory impairment), increasing dyspnea, tachypnea, and tachycardia, which may indicate increasing hypoxemia and impending respiratory failure.

The nurse monitors pulse oximetry values to assess the patient's need for oxygen and administers supplemental oxygen as prescribed. The nurse also instructs the patient about signs and symptoms of respiratory infection that may worsen hypoxemia and reports changes in the patient's physical and cognitive status to the primary provider.

Bronchopulmonary infections must be controlled to diminish inflammatory edema and to permit recovery of normal ciliary action. Minor respiratory infections that are of no consequence to people with normal lungs can be life-threatening to people with COPD. Infection compromises lung function and is a common cause of respiratory failure in people with COPD. In COPD, infection may be accompanied by subtle changes. The nurse instructs the patient to report any signs of infection, such as a fever or change in sputum color, character, consistency, or amount. Any worsening of symptoms (increased tightness of the chest, increased dyspnea, fatigue) also suggests pneumonia and must be reported. Viral infections are hazardous to the patient because they are often followed by pneumonia caused by bacterial organisms, such as *Streptococcus pneumoniae, Moraxella catarrhalis,* and *Haemophilus influenzae* (Bartlett & Sethi, 2018).

To prevent pneumonia, the nurse encourages the patient with COPD to be immunized against influenza and pneumococcal pneumonia, because the patient is prone to respiratory infection. In addition, because each patient reacts differently to external exposures (significant air pollution, high or low temperatures, high humidity, strong smells), the nurse must assess the patient's actual and potential triggers that cause bronchospasm so that avoidance or a treatment plan can be established.

Pneumothorax is a potential complication of COPD and can be life-threatening in patients with COPD who have minimal pulmonary reserve. Patients with severe emphysematous changes can develop large bullae, which may rupture and cause a pneumothorax. Development of a pneumothorax may be spontaneous or related to an activity such as severe coughing or large intrathoracic pressure changes. If a rapid onset of shortness of breath occurs, the nurse should quickly evaluate the patient for potential pneumothorax by assessing the symmetry of chest movement, differences in breath sounds, and a decrease in pulse oximetry.

Over time, pulmonary hypertension may occur as a result of chronic hypoxemia, which causes the pulmonary arteries to constrict and leads to this complication. Pulmonary hypertension may be prevented by maintaining adequate oxygenation through an adequate hemoglobin level, improved ventilation–perfusion of the lungs, or continuous administration of supplemental oxygen (if needed).

Promoting Home, Community-Based, and Transitional Care

Referral for home, community-based, or transitional care is important. These referrals assess the patient's home environment in relation to their physical and psychological status and the patient's ability to adhere to a prescribed therapeutic regimen. These assessments include evaluating the patient's ability to cope with changes in lifestyle and physical status so that their medical management can be tailored to their specific needs. Once home care is set up, the visits provide an opportunity to reinforce the information and activities learned in the inpatient or outpatient pulmonary rehabilitation program and to have the patient and family demonstrate correct administration of medications and oxygen, if indicated, and performance of exercises. If the patient does not have access to a formal pulmonary rehabilitation program, the nurse provides the education and breathing retraining necessary to optimize the patient's functional status.

Educating Patients About Self-Care

When providing education about self-management, the nurse must assess the knowledge of patients and family members about self-care and the therapeutic regimen. The nurse should also consider whether they are comfortable with this knowledge. Familiarity with potential side effects of prescribed medications is essential. In addition, patients and family members need to learn the early signs and symptoms of infection and other complications so that they seek appropriate health care promptly. Nurses are key in promoting smoking cessation and educating patients about its importance. Patients diagnosed with COPD who continue to smoke must be encouraged and assisted to quit.

A major area of patient education involves setting and accepting realistic short-term and long-range goals. If the COPD is mild (e.g., grade I), the objectives of treatment are to increase exercise tolerance and prevent further loss of pulmonary function. If the COPD is severe (e.g., grade III), the objectives are to preserve current pulmonary function and relieve symptoms as much as possible. It is important to plan and share the goals and expectations of treatment with the patient. Both the patient and the care provider need patience to achieve these goals.

Chart 20-6 **PATIENT EDUCATION**

Use of Pressurized Metered-Dose Inhaler (pMDI)

The nurse instructs the patient to:

- Remove the cap and hold the inhaler upright.
- Shake the inhaler.
- Sit upright or stand upright. Breathe out slowly and all the way.
- Use one of two techniques: open- or closed-mouth technique.
  - *Open-mouth technique*
  - Place the pMDI 2 finger widths away from lips.
  - With mouth open and tongue flat, tilt outlet of the pMDI so that it is pointed toward the upper back of the mouth.
  - Actuate the pMDI and begin to breathe in slowly. Breathe slowly and deeply through the mouth and try to hold breath for 10 s.
  - *Closed-mouth technique*
  - Place the pMDI between the teeth and make sure the tongue is flat under the mouthpiece and does not block pMDI.
  - Seal lips around mouthpiece and actuate the pMDI. Breathe in slowly through the mouth and try to hold breath for 10 s.
- Repeat puffs as directed, allowing 1 min between puffs. There is no need to wait for other medications.
- Apply the cap to the pMDI for storage.
- After inhalation, rinse mouth with water when using a corticosteroid-containing pMDI.

The pMDI mouthpiece should be cleaned on a regular basis as should the nozzle of the canister based on the manufacturer's recommendations. As there are many types of inhalers, it is important to follow the manufacturer's instructions for use and care of the inhaler.

Adapted from Cairo, J. M. (2018). *Mosby's respiratory care equipment* (10th ed.). St. Louis, MO: Elsevier Mosby.

The nurse instructs the patient to avoid extremes of heat and cold. Heat increases the body temperature, thereby raising oxygen requirements, and cold tends to promote bronchospasm. Air pollutants such as fumes, smoke, dust, and even talcum, lint, and aerosol sprays may initiate bronchospasm. High altitudes aggravate hypoxemia.

A patient with COPD should adopt a lifestyle of moderate activity, ideally in a climate with minimal shifts in temperature and humidity. As much as possible, the patient should avoid emotional disturbances and stressful situations that might trigger a coughing episode. Self-management also includes getting sufficient rest and sleep. The medication regimen can be quite complex; patients receiving aerosol medications by a pMDI or other type of inhaler may be particularly challenged. The nurse must review educational

information and have the patient demonstrate correct pMDI use before discharge, during follow-up visits to a caregiver's office or clinic, and during home visits (Chart 20-6).

Smoking cessation goes hand in hand with lifestyle changes, and reinforcing the patient's efforts is a key nursing activity. Smoking cessation is the single most important therapeutic intervention for patients with COPD. There are many strategies, including prevention, cessation with or without oral or topical patch medications, and behavior modification techniques.

At times, the patient will need oxygen at home. The nurse instructs the patient or family in the methods for administering oxygen safely and informs the patient and family that oxygen is available in gas, liquid, and concentrated forms. The gas and liquid forms come in portable devices so that the patient can leave home while receiving oxygen therapy. Humidity must be provided while oxygen is used (except with portable devices) to counteract the dry, irritating effects of compressed oxygen on the airway (Chart 20-7). To help the patient adhere to the oxygen prescription, the nurse explains the proper flow rate and required number of hours for oxygen use as well as the dangers of arbitrary changes in flow rate or duration of therapy. The nurse also reassures the patient that oxygen is not "addictive" and explains the need for regular evaluations of blood oxygenation by pulse oximetry or arterial blood gas analysis.

Chart 20-7 **HOME CARE CHECKLIST**

Oxygen Therapy

At the completion of education, the patient and/or caregiver will be able to:

- State proper care of and administration of oxygen to patient.
- State primary provider's prescription for oxygen and the manner in which it is to be used.
- Indicate when a humidifier should be used.
- Identify signs and symptoms indicating the need for change in oxygen therapy.
- Describe precautions and safety measures to be used when oxygen is in use:
  - Know NOT to smoke or be around people who are smoking while using oxygen.
  - Post "No Smoking—Oxygen in Use" signs on doors.
  - Notify local fire department and electric company of oxygen use in home.
  - Never use paint thinners, cleaning fluids, gasoline, aerosol sprays, and other flammable materials while using oxygen.
  - Keep all methods of oxygen delivery at least 15 feet away from matches, candles, gas stove, or other source of flame, and 5 feet away from television, radio, and other appliances.
  - Keep oxygen tank out of direct sunlight.
  - When traveling in automobile, place oxygen tank on floor behind front seat.
  - If traveling by airplane, notify air carrier of need for oxygen at least 2 wks in advance.
- State how and when to place an order for more oxygen.
- Maintain and use equipment properly:
  - Identify when a portable oxygen delivery device should be used.
  - Demonstrate safe and appropriate use of and how to change from one oxygen delivery system to another (e.g., from oxygen concentrator to portable oxygen delivery).
  - Demonstrate correct adjustment of prescribed flow rate.
  - Describe how to clean and when to replace oxygen tubing.
  - Identify causes of malfunction of equipment and when to call for the replacement of equipment.
  - Describe the importance of determining that all electrical outlets are working properly.

Resources

See Chapter 2, Chart 2-6 for additional information related to durable medical equipment, adaptive equipment, and mobility skills.

Numerous educational materials are available to assist nurses in educating patients with COPD (see Resources at the end of the chapter).

Continuing and Transitional Care

Home visits by a nurse or respiratory therapist may be arranged based on the patient's status and needs. It is important to assess the patient's home environment, the patient's physical and psychological status, and the need for further education. The nurse reinforces educational points on how to use oxygen safely and effectively, including fire safety tips. To maintain a consistent quality of care and to maximize the patient's financial reimbursement for home oxygen therapy, the nurse ensures that the prescription given by the primary provider includes the diagnosis, the prescribed oxygen flow, and conditions for use (e.g., continuous use, nighttime use only). Because oxygen is a medication, the nurse reminds the patient receiving long-term oxygen therapy and the family about the importance of keeping follow-up appointments with the patient's primary provider. The patient is instructed to see the primary provider every 6 months or more often, if indicated. Arterial blood gas measurements and laboratory tests are repeated annually or more often if the patient's condition changes.

The nurse directs patients to community resources, such as pulmonary rehabilitation programs and smoking cessation programs, to help improve patients' ability to cope with their chronic condition and the therapeutic regimen and to provide a sense of worth, hope, and well-being. In addition, the nurse reminds the patient and family about the importance of participating in general health promotion activities and health screening.

Patients with COPD have indicated that information about their end-of-life needs is limited. Areas to discuss regarding end-of-life care may include symptom management, quality of life, satisfaction with care, information/communication, use of care professionals, use of differing care facilities, hospital admission, and place of death. It is crucial that patients know what to expect as the disease progresses. In addition, they should have information about their role in decisions regarding aggressiveness of care near the end of life and access to specialists who may help them and their families. As the disease course progresses, a holistic assessment of physical and psychological needs should be undertaken at each hospitalization, clinic visit, or home visit. This helps gauge the patient's assessment of the progression of the disease and its impact on quality of life and guides planning for future interventions and management (see Chapter 13 for additional information).

Bronchiectasis

Bronchiectasis is a chronic, irreversible dilation of the bronchi and bronchioles that results from destruction of muscles and elastic connective tissue. Numerous factors can induce or contribute to the development of bronchiectasis. Some of these include recurrent respiratory infections, CF, rheumatic and other systemic diseases, primary ciliary dysfunction, tuberculosis, or immune deficiency disorders (Barker, King, & Hollingsworth, 2019). Between 340,000 and 522,000 adults were living with non-CF bronchiectasis in 2013, estimates show (Weycker, Hansen, & Seifer, 2017). The increased prevalence of bronchiectasis, with an annual growth rate of 8% since 2001, may be attributed to advances in the technology for diagnosing the disease (GOLD, 2019). Bronchiectasis, a disease process separate from COPD, is often a comorbidity with COPD (GOLD, 2019). Bronchiectasis and sinusitis are the major respiratory manifestations of CF (discussed later in this chapter) (Barker et al., 2019).

Pathophysiology

The inflammatory process associated with pulmonary infections damages the bronchial wall, causing a loss of its supporting structure and resulting in thick sputum that ultimately obstructs the bronchi. The walls become permanently distended and distorted, impairing mucociliary clearance. In saccular bronchiectasis, each dilated peribronchial tube amounts to a lung abscess, the exudate of which drains freely through the bronchus. Bronchiectasis is usually localized, affecting a segment or lobe of a lung, most frequently the lower lobes.

The retention of secretions and subsequent obstruction ultimately cause the alveoli distal to the obstruction to collapse (atelectasis). Inflammatory scarring or fibrosis replaces functioning lung tissue. In time, the patient develops respiratory insufficiency with reduced vital capacity, decreased ventilation, and an increased ratio of residual volume to total lung capacity. There is impairment in the match of ventilation to perfusion (ventilation–perfusion imbalance) and hypoxemia.

Clinical Manifestations

Characteristic symptoms of bronchiectasis include chronic cough and the production of purulent sputum in copious amounts. Many patients with this disease have hemoptysis. Clubbing of the fingers is also common because of respiratory insufficiency. Patients usually have repeated episodes of pulmonary infection.

Assessment and Diagnostic Findings

Bronchiectasis is not readily diagnosed because the symptoms can be mistaken for those of chronic bronchitis. A definite sign is a prolonged history of productive, chronic cough, with sputum consistently negative for tubercle bacilli. The diagnosis is established by a CT scan, which reveals bronchial dilation. The advent of high-resolution CT scanning makes it possible to diagnose this disease during its earlier stages.

Medical Management

Treatment objectives are to promote bronchial drainage, to clear excessive secretions from the affected portion of the lungs, and to prevent or control infection and inflammation. Chest physiotherapy (CPT; see previous discussion) is essential for promoting airway drainage. Sometimes, mucopurulent sputum must be removed by bronchoscopy. Smoking cessation is important, because smoking impairs bronchial drainage by paralyzing ciliary action, increasing bronchial secretions, and causing inflammation of the mucous membranes, resulting in hyperplasia of the mucous glands.

Antibiotics are the cornerstone therapy for management of a bronchiectatic exacerbation. Antimicrobial therapy choice is based on the results of sensitivity studies on organisms cultured from sputum; however, empiric coverage (i.e., broad-spectrum antibiotics that are effective in treating commonly implicated pathogens) is often prescribed initially, pending results of sputum cultures. The most commonly implicated pathogens include *H. influenzae, M. catarrhalis, Staphylococcus aureus,* and *Pseudomonas aeruginosa* (Barker, Stoller, King, et al., 2018). Because infection with *P. aeruginosa* is associated with a greater rate of lung function deterioration, more aggressive oral or IV antibiotic therapy may be used for a longer duration. For patients with recurrent exacerbations (usually two or more during the past year), a low dose macrolide antibiotic may be used as preventative, ongoing therapy (Barker et al., 2018). In addition, patients should be vaccinated against influenza and pneumococcal pneumonia.

Secretion management is an issue for patients with bronchiectasis. Nebulized mucolytics may help to clear airway secretions. These drugs promote expectoration by breaking down the mucus blocking the airways. The administration of nebulized hypertonic saline also improves airway clearance by decreasing the viscosity of the mucus and improving the ability of secretions to move out of the airways. Bronchodilators might be prescribed to help open up the airways, thus enhancing the ability of the other medications (e.g., mucolytics, hypertonic saline) to mobilize secretions. These agents also allow a better passageway for the secretions to move through. Bronchodilators are typically administered at the beginning of each pulmonary treatment. Ensuring adequate hydration and employing CPT may also be of help in loosening and thinning secretions (Barker et al., 2018).

Surgical intervention, although used infrequently, may be indicated for patients who continue to expectorate large amounts of sputum and have repeated bouts of pneumonia and hemoptysis despite adherence to treatment regimens. The disease must involve only one or two areas of the lung that can be removed without producing respiratory insufficiency. The goals of surgical treatment are to conserve normal pulmonary tissue and to avoid infectious complications. Diseased tissue is removed, provided that postoperative lung function will be adequate. It may be necessary to remove a segment of a lobe (segmental resection), a lobe (lobectomy), or, rarely, an entire lung (pneumonectomy). Segmental resection is the removal of an anatomic subdivision of a pulmonary lobe. In select cases, video-assisted surgery (VATS) segmentectomy or lobectomy may be performed, which is associated with fewer complications and decreased length of stay. The chief advantage is that only diseased tissue is removed, and healthy lung tissue is conserved.

The surgery is preceded by a period of careful preparation. The objective is to obtain a dry (free of infection) tracheobronchial tree to prevent complications (atelectasis, pneumonia, bronchopleural fistula, and empyema). This is accomplished by postural drainage or, depending on the location, by direct suction through a bronchoscope. A course of antibacterial therapy may be prescribed. After surgery, care is the same as for any patient who has undergone chest surgery.

Nursing Management

Nursing management focuses on alleviating symptoms and helping patients clear pulmonary secretions. Patient education targets eliminating smoking and other factors that increase the production of mucus and hamper its removal. Patients and families are taught to perform postural drainage and to avoid exposure to people with upper respiratory or other infections. If the patient experiences fatigue and dyspnea, they are informed about strategies to conserve energy while maintaining as active a lifestyle as possible. The patient is educated about the early signs of respiratory infection and the progression of the disorder so that appropriate treatment can be implemented promptly. The presence of a large amount of mucus may decrease the patient's appetite and result in an inadequate dietary intake; therefore, the patient's nutritional status is assessed and strategies are implemented to ensure an adequate diet.

Asthma

Asthma is a heterogeneous disease, usually characterized by chronic airway inflammation (Global Initiative for Asthma [GINA], 2019a). This chronic inflammatory disease of the airways causes airway hyperresponsiveness,

mucosal edema, and mucus production. This inflammation ultimately leads to recurrent episodes of asthma symptoms: cough, chest tightness, wheezing, and dyspnea (Fig. 20-10). In the United States, asthma affects approximately 19 million adults and accounted for approximately 3564 deaths in 2017 (CDC, 2017b; Kochanek, Murphy, Xu, et al., 2019). Of these adults, 35.2% have intermittent severity and 64.8% have persistent severity of asthma symptoms (CDC, 2015). Nearly 10% of all ED visits are related to asthma (CDC, 2018c). Although asthma is the most common chronic disease of childhood, it can occur at any age. For most patients, asthma is a disruptive disease, affecting school and work attendance, occupational choices, physical activity, and general quality of life.

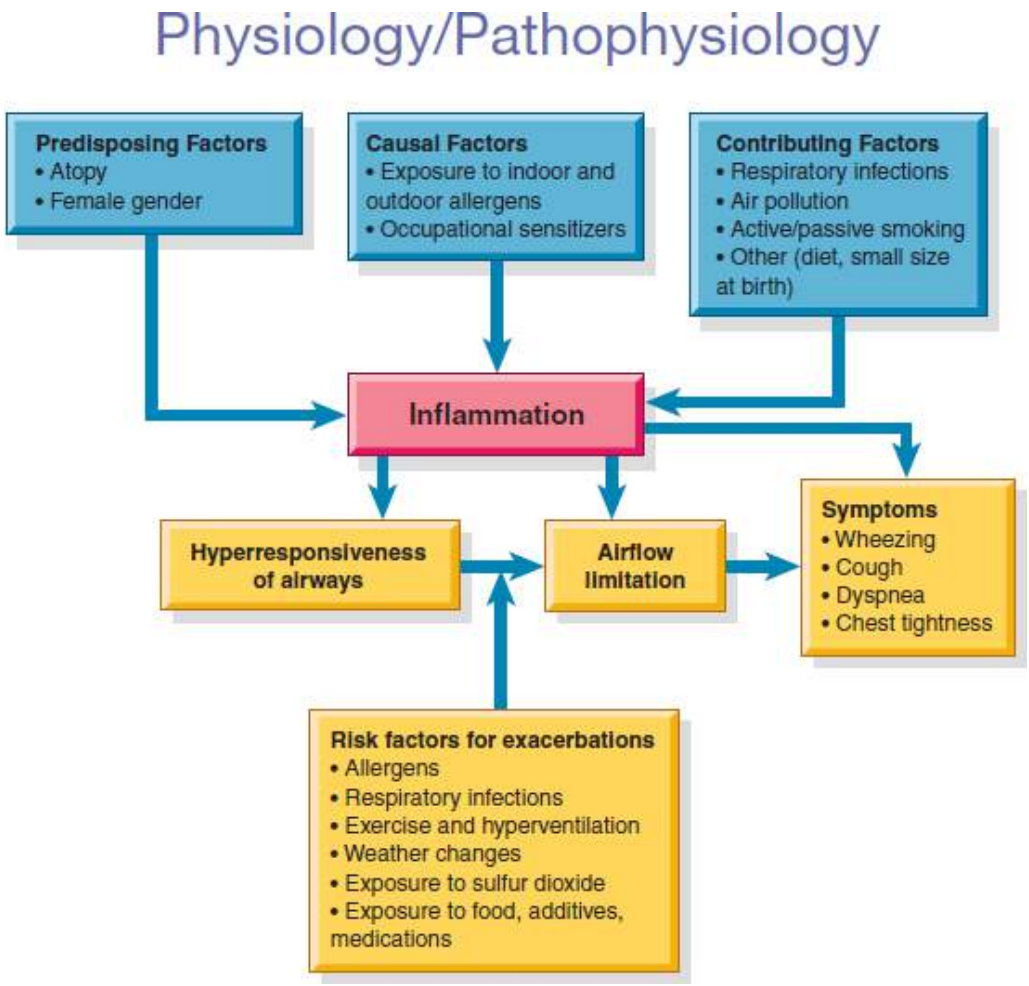


Figure 20-10 • Pathophysiology of asthma. Adapted from materials developed for the Global Initiative for Asthma (2019). Global strategy for asthma management and prevention. Available at: www.ginasthma.org

Twenty-one percent of patients with asthma smoke, even though cigarette smoke is known to trigger an attack, while nearly 17% of people without asthma smoke (CDC, 2015). Asthma–COPD overlap refers to patients who

have clinical presentations of both conditions (Papi, Brightling, Pedersen, et al., 2018). Smokers are at higher risk for having asthma–COPD overlap (Papi et al., 2018).

Despite increased knowledge regarding the pathology of asthma and the development of improved medications and management plans, the death rate from the disease continues to rise. Ethnic and racial disparities affect morbidity and mortality in asthma, particularly for African American and Hispanic/Latino American urban populations (Sullivan, Ghushchyan, Kavati, et al., 2019). Contributing to these disparities are epidemiologic considerations and risk factors that include genetic and molecular aspects; inner-city environments; limited community assets; health care access/delivery/and quality; and insufficient health insurance coverage.

Unlike other obstructive lung diseases, asthma is largely reversible, either spontaneously or with treatment. Patients with asthma may experience symptom-free periods alternating with acute exacerbations that last from minutes to hours or days.

Allergy is the strongest predisposing factor for asthma. Chronic exposure to airway irritants or allergens also increases the risk of asthma. Common allergens can be seasonal (e.g., grass, tree, weed pollens) or perennial (e.g., mold, dust, roaches, animal dander). Common triggers for asthma symptoms and exacerbations include airway irritants (e.g., air pollutants, cold, heat, weather changes, strong odors or perfumes, smoke, occupational exposure), foods (e.g., shellfish, nuts), exercise, stress, hormonal factors, medications, viral respiratory tract infections, and gastroesophageal reflux. Most people who have asthma are sensitive to a variety of triggers.

Pathophysiology

The underlying pathology in asthma is reversible diffuse airway inflammation that leads to long-term airway narrowing. This narrowing, which is exacerbated by various changes in the airway, includes bronchoconstriction, airway edema, airway hyperresponsiveness, and airway remodeling (Papi et al., 2018). The interaction of these factors determines the clinical manifestations and severity of asthma (GINA, 2019a). Over the course of a lifetime, the impact of increasing pathophysiologic changes and environmental susceptibility lead to an irreversible disease process.

Asthma is a complex disease process that involves numerous inflammatory and structural cells as well as mediators that lead to the disorder's effects. Mast cells, macrophages, T lymphocytes, neutrophils, and eosinophils all play a key role in the inflammation of asthma. When activated, mast cells release several chemicals called *mediators*. These chemicals, which include histamine, bradykinin, prostanoids, cytokines, leukotrienes, and other mediators, perpetuate the inflammatory response, causing increased blood flow,

vasoconstriction, fluid leak from the vasculature, attraction of white blood cells to the area, mucus secretion, and bronchoconstriction (Kacmarek et al., 2017; McCance & Huether, 2019).

During acute exacerbations of asthma, bronchial smooth muscle contraction or bronchoconstriction occurs quickly to narrow the airway in response to an exposure. Acute bronchoconstriction due to allergens results from an immunoglobulin E (IgE)-dependent release of mediators from mast cells; these mediators include histamine, tryptase, leukotrienes, and prostaglandins that directly contract the airway. In addition, alpha- and beta-2–adrenergic receptors of the sympathetic nervous system located in the bronchi play a role. When the alpha-adrenergic receptors are stimulated, bronchoconstriction occurs. The balance between alpha- and beta-2–adrenergic receptors is controlled primarily by cyclic 3′,5′-adenosine monophosphate (cyclic AMP). Beta-2–adrenergic stimulation results in increased levels of cyclic AMP, which inhibits the release of chemical mediators and causes bronchodilation.

As asthma becomes more persistent, the inflammation progresses and other factors may be involved in airflow limitation. These include airway edema, mucus hypersecretion, and the formation of mucus plugs. In addition, airway "remodeling" (i.e., structural changes) may occur in response to chronic inflammation, causing further airway narrowing.

Clinical Manifestations

The three most common symptoms of asthma are cough, dyspnea, and wheezing. In some instances, cough may be the only symptom. An asthma attack often occurs at night or early in the morning, possibly because of circadian variations that influence airway receptor thresholds.

An asthma exacerbation may begin abruptly but most frequently is preceded by increasing symptoms over the previous few days. There is cough, with or without mucus production. At times, the mucus is so tightly wedged in the narrowed airway that the patient cannot cough it up. There may be generalized wheezing (the sound of airflow through narrowed airways), first on expiration and then possibly during inspiration as well. Generalized chest tightness and dyspnea occur. Expiration requires effort and becomes prolonged. As the exacerbation progresses, diaphoresis, tachycardia, and a widened pulse pressure may occur along with hypoxemia and central cyanosis (a late sign of poor oxygenation). Severe, life-threatening hypoxemia can occur in asthma but is relatively uncommon. The hypoxemia is secondary to a ventilation–perfusion mismatch and readily responds to supplemental oxygenation.

Symptoms of exercise-induced asthma include maximal symptoms during exercise, absence of nocturnal symptoms, and sometimes only a description of a "choking" sensation during exercise.

Assessment and Diagnostic Findings

To establish the diagnosis, the clinician must determine that episodic symptoms of airflow obstruction are present, airflow is at least partially reversible, and other causes have been excluded. A positive family history and environmental factors, including seasonal changes, high pollen counts, mold, pet dander, climate changes (particularly cold air), and air pollution, are primarily associated with asthma. In addition, asthma is associated with a variety of foods, compounds, and occupation-related chemicals. Comorbid conditions that may accompany asthma include viral infections, gastroesophageal reflux disease, drug-induced asthma, and allergic bronchopulmonary aspergillosis. Other possible allergic reactions that may accompany asthma include eczema, rashes, and temporary edema. Questions in the assessment that may help to evaluate the patient's asthma control include:

- Have your symptoms awakened you at night or in the early morning?
- Have you needed your quick-acting relief medication more than usual?
- Have you needed unscheduled care for your asthma—a call to the primary provider's office, office visit, ED?
- Have your symptoms impacted your normal activities at school/work/sports?

During acute episodes, sputum and blood tests may disclose eosinophilia (elevated levels of eosinophils). Serum levels of IgE may be elevated if allergy is present. Arterial blood gas analysis and pulse oximetry reveal hypoxemia during acute attacks. Initially, hypocapnia and respiratory alkalosis are present. As the patient's condition worsens and they become more fatigued, the $PaCO_2$ may increase. Because carbon dioxide is 20 times more diffusible than oxygen, it is rare for $PaCO_2$ to be normal or elevated in a person who is breathing very rapidly.

Quality and Safety Nursing Alert

Normal $PaCO_2$ during an asthma attack may be a signal of impending respiratory failure.

During an exacerbation, the FEV_1 and FVC are markedly decreased but improve with bronchodilator administration (demonstrating reversibility). Pulmonary function is usually normal between exacerbations. The occurrence of a severe, continuous reaction is referred to as status asthmaticus and is considered life-threatening (see later discussion).

Asthma severity is considered in the selection of the initial type, amount, and schedule of treatments (GINA, 2019a). Disease severity is classified by current impairment and future risk of adverse events. Impairment is defined by the following factors: nighttime awakenings, the need for short-acting bronchodilators for symptom relief, work/school days missed, ability to engage in normal activities, and quality of life. Lung function is evaluated by spirometry. Assessment of risk of future adverse events is evaluated by numbers of exacerbations, the need for ED care or hospitalizations in the past year, demographic data (gender, ethnicity, nonuse of prescribed ICS therapy, existing smoking), psychosocial factors and attitudes, and beliefs about taking medication (GINA, 2019a).

Prevention

Patients with recurrent asthma should undergo testing to identify the substances that precipitate the symptoms. Possible causes are dust, dust mites, roaches, certain types of cloth, pets, horses, detergents, soaps, certain foods, molds, and pollens. If the attacks are seasonal, pollens can be strongly suspected. Patients are instructed to avoid the causative agents whenever possible. Knowledge is the key to quality asthma care. Evaluation of impairment and risk are primary methods that help ensure control.

Occupational asthma refers to asthma induced by exposure in the work environment to dusts, vapors, or fumes, with or without a preexisting diagnosis of asthma. An estimated 5% to 20% of new asthma cases in the United States are related to workplace exposures (GINA, 2019a). Work-related asthma should be part of the differential diagnosis of every case of adult-onset asthma. A detailed work history evaluation is key to identifying occupational asthma. Immediate treatment is aimed at removing or decreasing the exposure in the patient's environment and following the patient on an ongoing basis. Standard asthma medications may be prescribed to minimize bronchoconstriction and airway inflammation. In certain cases, patients may be impaired or disabled from the disease. Compensation systems are in place to protect a worker; however, these systems are often slow and complex to navigate.

Complications

Complications of asthma may include status asthmaticus, respiratory failure, pneumonia, and atelectasis. Airway obstruction, particularly during acute asthmatic episodes, often results in hypoxemia, requiring the administration of oxygen and the monitoring of pulse oximetry and arterial blood gases. Fluids are given because people with asthma are frequently dehydrated from diaphoresis and insensible fluid loss with hyperventilation.

Medical Management

Primary treatment focuses on preventing impairment of lung function, minimizing symptoms, and preventing exacerbations (Papi et al., 2018). GINA (2019a) recommendations are based on the concept of severity and control of asthma along with the domains of reducing impairment and reducing risk as keys to improving care. Asthma control is assessed by symptom management and future risk of adverse outcomes (GOLD, 2019). In an acute situation, symptom control includes using immediate intervention to diminish bronchoconstriction, which prevents increased anxiety resulting from progressive dyspnea. Uncontrolled anxiety could aggravate the situation and ultimately worsen dyspnea. Poor symptom control increases the risk of exacerbations (GINA, 2019a).

Pharmacologic Therapy

There are two general classes of asthma medications: quick-relief medications for immediate treatment of asthma symptoms and exacerbations and long-acting medications to achieve and maintain control of persistent asthma (Tables 20-5 and 20-6). Because the underlying pathology of asthma is inflammation, control of persistent asthma is accomplished primarily with regular use of anti-inflammatory medications. The route of choice for administration of these medications is a pMDI or other type of inhaler, because it allows for localized administration within the lungs (see Chart 20-6 and Table 20-3).

Quick-Relief Medications

Short-acting beta-2–adrenergic agonists (SABAs) (e.g., albuterol, levalbuterol, pirbuterol) are the medications of choice for relief of acute symptoms and prevention of exercise-induced asthma. They are used to relax smooth muscle.

Anticholinergics (e.g., ipratropium) inhibit muscarinic cholinergic receptors and reduce intrinsic vagal tone of the airway. These may be used in patients who do not tolerate short-acting beta-2–adrenergic agonists.

TABLE 20-5 Quick-Relief Medications for Treatment of Asthma

Medication	Indications/Mechanisms	Potential Adverse Effects	Nursing Considerations
Inhaled Short-Acting Beta-2 Adrenergic Agonists			
albuterol levalbuterol HFA metaproterenol sulfate	*Indications* Relief of acute symptoms; quick-relief medication Preventive treatment for exercise-induced bronchospasm *Mechanisms* Bronchodilation; binds to the beta-2 adrenergic receptor, producing smooth muscle relaxation and decreased bronchoconstriction	Tachycardia, muscle tremor, hypokalemia, increased lactic acid, headache, and hyperglycemia. Inhaled route causes few systematic adverse effects. Patients with preexisting cardiovascular disease, especially older adults, may have adverse cardiovascular reactions with inhaled therapy Lack of effect or need for regular use indicates inadequate asthma control	Instruct patient in correct use of inhaled agents and how to evaluate amount of remaining medication in pressurized metered-dose inhaler. Recommend periodic cleaning of device. Inform patient about possible adverse effects and need to inform primary provider about increased use of medication to control symptoms.
Anticholinergics			
ipratropium	*Indications* Relief of acute bronchospasm *Mechanisms* Bronchodilation; inhibition of muscarinic cholinergic receptors Reduction in vagal tone of airways May decrease mucous gland secretion	Dryness of mouth and respiratory secretions; may cause increased wheezing in some patients Does not block exercise-induced bronchospasm Is not effective in long-term control of asthma	Instruct patient in correct use of inhaled agents. Ensure adequate fluid intake. Assess patient for hypersensitivity to atropine, soybeans, peanuts; glaucoma; prostatic hypertrophy.
Corticosteroids			
Systemic methylprednisolone prednisolone	*Indications* For short-term (3–10 d) "burst;" to gain prompt	Blood glucose abnormalities, increased	Explain to patient that action is often rapid in

prednisone	control of inadequately controlled persistent asthma For moderate or severe exacerbations to prevent progression of exacerbation, reverse inflammation, speed recovery, and reduce rate of relapse *Mechanisms* Anti-inflammatory; block reaction to allergen and reduce hyperresponsiveness; inhibit cytokine production, adhesion protein activation, and inflammatory cell migration and activation; reverses beta-2 receptor downregulation	appetite, fluid retention, weight gain, mood alteration, hypertension, peptic ulcer, insomnia Consideration must be given to comorbidities that may be worsened by systemic corticosteroids	onset, although resolution of symptoms may take 3–10 d. Instruct patient about possible side effects and the importance of taking the medication as prescribed. If the patient is taking multiple doses a day, administering the last dose prior to 2 PM (when possible) may help to prevent sleep disturbances.

HFA, hydrofluoroalkane.

Adapted from Global Initiative for Asthma (GINA) (2019b). Pocket guide for asthma management. Retrieved on 7/01/2019 at: www.ginasthma.org/wp-content/uploads/2019/04/GINA-2019-main-Pocket-Guide-wms.pdf

TABLE 20-6 Long-Term Medications for Treatment of Asthma (Controller Medications)

Medication	Dosage Information	Indications/Mechanism	Potential Adverse Effects	Nursing Considerations
Inhaled Corticosteroids beclomethasone dipropionate budesonide ciclesonide flunisolide fluticasone mometasone furoate		Indication Long-term prevention of symptoms suppression, control, and reversal of inflammation Reduce need for oral corticosteroid Mechanism Anti-inflammatory; block late reaction to allergen and reduce airway hyperresponsiveness Inhibit cytokine production, adhesion protein activation, and inflammatory cell migration and activation; reverse beta-2 receptor downregulation; inhibit microvascular leakage	Cough, dysphonia, oral thrush (candidiasis), headache In high doses, systemic effects may occur (e.g., adrenal suppression, osteoporosis, skin thinning, easy bruising)	Instruct patient in correct use of pMDI and use of spacer/holding chamber devices Instruct patient to rinse mouth after inhalation to reduce local side effects.

Systemic Corticosteroids methylprednisolone prednisolone prednisone	*Indications* For prevention of symptoms in severe persistent asthma; suppression, control, and reversal of inflammation *Mechanism* Same as inhaled corticosteroids	*Long-Term Use:* adrenal axis suppression, growth suppression, dermal thinning, hypertension, diabetes, Cushing's syndrome, cataracts, muscle weakness, and, in rare instances, impaired immune function, insomnia Consideration should be given to comorbidities that could be worsened by systemic corticosteroids	Instruct patient about possible side effects and the importance of taking the medication as prescribed (usually a single dose in the morning daily or on an alternate-day schedule, which may produce less adrenal suppression). If the patient is taking multiple doses a day, administering the last dose prior to 2 PM (when possible) may help to prevent sleep disturbances.
Long-Acting Beta-2 Adrenergic Agonists Inhaled salmeterol formoterol	*Indications* Long-term prevention of symptoms, added to ICS Prevention of exercise-induced bronchospasm *Mechanism* Bronchodilation; smooth muscle relaxation following adenylate cyclase activation and increase in cAMP, producing functional antagonism of bronchoconstriction Compared to SABA, salmeterol (but not formoterol) has slower onset of action (15–30 min). Both salmeterol and formoterol have longer duration (>12 h) compared to SABA	Should not be used to treat acute symptoms or exacerbations Decreased protection against exercise-induced bronchospasm may occur with regular use Tachycardia, muscle tremor, hypokalemia, ECG changes with overdose. A diminished bronchoprotective effect may occur within 1 wk of chronic therapy. Potential risk of uncommon, severe, life-threatening, or fatal exacerbation	Reinforce to patient that these medications should not be used to treat acute asthma symptoms or exacerbations. Instruct patient about correct use of pMDI or inhaler inhaler.
Oral albuterol sustained release		Inhaled route is preferred to oral route because LABAs are longer acting and have fewer side effects than oral sustained-release agents	
Phosphodiesterase Inhibitors theophylline sustained-release tablets and capsules	*Indications* Long-term control and prevention of symptoms in mild persistent asthma or as adjunctive with ICS, in moderate or persistent asthma *Mechanism* Bronchodilation; smooth muscle relaxation from phosphodiesterase inhibition and possibly adenosine antagonism May affect eosinophilic infiltration into bronchial mucosa as well as decreased T-lymphocyte numbers in epithelium Increases diaphragm contractility and mucociliary clearance	Dose-related acute toxicities include tachycardia, nausea and vomiting, tachyarrhythmias (SVT), central nervous system stimulation, headache, seizures, hematemesis, hyperglycemia, and hypokalemia Adverse effects at usual therapeutic doses include insomnia, gastric upset, aggravation of ulcer or reflux, and difficulty in urination in older males who have prostatism Not generally recommended for exacerbations. There is minimal evidence for added benefit to optimal dose of SABA	Maintain steady-state serum concentrations between 5 and 15 mcg/mL. Be aware that absorption and metabolism may be affected by numerous factors that can produce significant changes in steady-state serum theophylline concentrations. Instruct patient to discontinue if toxicity occurs. Serum concentration monitoring is mandatory. Inform patient about the importance of blood tests to monitor serum concentration. Instruct patient to check with primary provider before taking any new medications.

Combined Medication (Corticosteroid/Long-Acting Beta-2 Adrenergic Agonist)				
fluticasone/ salmeterol	Lowest dose of DPI or HFA used for patients whose asthma is not controlled on low- to medium-dose ICS Higher dose of DPI or HFA used for patients whose asthma is not controlled on medium- to high-dose ICS	DPI 100 mcg/50 mcg 250 mcg/50 mcg 500 mcg/50 mcg HFA 45 mcg/21 mcg 115 mcg/21 mcg 230 mcg/21 mcg		
budesonide/ formoterol fluticasone furoate/vilanterol mometasone/ formoterol	Lower dose used for patients who have asthma not controlled on low- to medium-dose ICS Higher dose used for patients who have asthma not controlled on medium- to high-dose ICS Used if asthma not controlled on long-term asthma control medication.	HFA pMDI 80 mcg/4.5 mcg 160 mcg/4.5 mcg 100 mcg/25 mcg 200 mcg/25 mcg 100 mcg/5 mcg 200 mcg/5 mcg	Do not use with other long-acting beta-agonist drugs	
Leukotriene Modifiers				
Leukotriene Receptor Antagonists montelukast Available in tablets and granules		Mechanism Selective competitive inhibitor of CysLT1 receptor Indications Long-term control and prevention of symptoms in mild persistent asthma for patients ≥1 year of age May also be used with ICS as combination therapy in moderate persistent asthma	May attenuate EIB in some patients, but less effective than ICS therapy LTRA + LABA should not be used as a substitute for ICS + LABA. Headache, dizziness, upper respiratory infections, pharyngitis, sinusitis	Instruct patient to take at least 1 h before meals or 2 h after meals.
zafirlukast Available in tablets		Long-term control and prevention of symptoms in mild persistent asthma may also be used with ICS as combination therapy in moderate persistent asthma	Cases of reversible hepatitis have been reported along with rare cases of irreversible hepatic failure resulting in death and liver transplantation	Inform patient that zafirlukast can inhibit the metabolism of warfarin. INRs should be monitored if patient is taking both zafirlukast and montelukast. Instruct patients to discontinue use if they experience signs and symptoms of liver dysfunction (right upper quadrant pain, pruritus, lethargy, jaundice, nausea), and to notify their primary provider.
5-Lipoxygenase Inhibitor zileuton		Mechanism Inhibits the production of leukotrienes from arachidonic acid, both LTB and the cysteinyl leukotrienes Indications Long-term control and prevention of symptoms in mild persistent asthma for patients May be used with ICS as combination therapy in moderate persistent asthma in patients	Elevation of liver enzymes has been reported. Limited case reports of reversible hepatitis and hyperbilirubinemia	Inform patient that zileuton can inhibit the metabolism of warfarin and theophylline. Therefore, the doses of these medications should be monitored accordingly. Educate patient about the importance of monitoring medication levels and tests of liver function.

Immunomodulators				
IgE-Inhibiting IgG monoclonal antibody omalizumab Given by subcutaneous injection	Dose is given either every 2 or 4 wks and depends on the patient's body weight and IgE level before therapy A maximum of 150 mg can be given as 1 injection Medication needs to be stored under refrigeration at 2°–8°C (35.6°–46.4°F)	*Indications* Long-term control and prevention of symptoms with moderate or severe persistent allergic asthma inadequately controlled with ICS *Mechanism* Monoclonal antibody that binds to circulating IgE, preventing it from binding to the high-affinity receptors on basophils and mast cells Decreases mast cell mediator release from allergen exposure	Anaphylaxis has been reported in 0.2% of treated patients Pain, bruising, and skin reactions (itching, redness, stinging) at injection sites It is unknown if patients will develop significant antibody titers to the drug with long-term administration	Monitor patients for allergic reactions or anaphylaxis following administration. Be prepared to initiate emergency treatment if anaphylaxis occurs. Instruct patient about signs and symptoms that indicate allergic reaction and immediate action to take. Remind patient to continue to take other medications prescribed for treatment of asthma.
Interleukin-5 Receptor (IL-5R) Antagonists mepolizumab reslizumab benralizumab Mepolizumab and benralizumab are given by subcutaneous injection. Reslizumab is given by intravenous infusion.		*Indications* Long-term control and prevention of symptoms in patients with severe persistent asthma of eosinophilic phenotype. Mepolizumab and benralizumab are approved for adolescents and adults ≥12 years of age, and reslizumab is approved for adults ≥18 years of age *Mechanism* Monoclonal antibodies that decrease production and survival of eosinophils by binding to and inhibiting IL-5R. However, the specific mechanism in which these agents exert their effects in asthma has not been definitively established		Ensure the patient understands appropriate administration technique to minimize administration and dosing errors and to optimize patient safety. Note that dose and frequency of administration of biologics may be influenced by various factors such as weight, blood work, or the need for titration. Education is key to adherence and it is important to confirm patient knowledge and understanding.
Interleukin-4 Receptor Alpha (IL-4Rα) Antagonist dupilumab Given by subcutaneous injection		*Indications* Long-term control and prevention of symptoms in adolescents and adults ≥12 years of age with moderate or severe asthma of eosinophilic phenotype or oral corticosteroid dependent asthma *Mechanism* Monoclonal antibody that binds to IL-4Rα, a receptor present on various cell types and mediators involved in the inflammatory response, that inhibits IL-4 and IL-13 cytokine-induced inflammatory responses. However, the specific mechanism in which dupilumab exerts its effects in asthma has not been definitively established		

cyclic AMP; cyclic 3′,5′-adenosine monophosphate; CysLT1, cysteinyl leukotriene receptor 1; DPI, dry-powder inhaler; ECG, electrocardiogram; EIB, exercise-induced bronchospasm; HFA, hydrofluoroalkane; ICS, inhaled corticosteroid; IgE, immunoglobulin E; IgG, immunoglobulin G; INR, international normalized ratio; LABA, long-acting beta-2 adrenergic agonist; LTB, leukotriene B; LTRA, leukotriene receptor antagonist; pMDI, pressurized metered-dose inhaler; SABA, short-acting beta-2 adrenergic agonist; SVT, supraventricular tachycardia.

Adapted from Ferguson, G. T., Stoller, J. K., & Hollingsworth, H. (2019). Management of severe, chronic, obstructive pulmonary disease. UpToDate. Retrieved on 2/20/2019 at: www.uptodate.com/contents/management-of-stable-chronic-obstructive-pulmonary-disease; Global Initiative for Asthma (GINA). (2019b). Pocket guide for asthma management. Retrieved on 2/01/2019 at: www.ginasthma.org/wp-content/uploads/2019/04/GINA-2019-main-Pocket-Guide-wms.pdf; Wenzel, S., Bochner, B. S., & Hollingsworth, H. (2019). Treatment of severe asthma in adolescents and adults. UpToDate. Retrieved on 2/20/2019 at: www.uptodate.com/contents/treatment-of-severe-asthma-in-adolescents-and-adults

The combination medication ipratropium bromide and albuterol sulfate is used for quick relief of asthma symptoms and acute exacerbations. This medication is administered using a small-volume nebulizer (SVN; discussed previously).

Long-Acting Control Medications

Corticosteroids are the most potent and effective anti-inflammatory medications currently available. They are broadly effective in alleviating symptoms, improving airway function, and decreasing peak flow variability.

Initially, an inhaled form is used. All patients should rinse their mouth with water (and should not swallow the rinse) after administration of ICSs to prevent thrush, a common complication associated with the use of these drugs. However, those who lack the coordination to ensure proper administration technique should use a spacer. This will reduce medication deposition within the mouth and further reduce the risk of thrush. A systemic preparation may be used to gain rapid control of the disease; to manage severe, persistent asthma; to treat moderate to severe exacerbations; to accelerate recovery; and to prevent recurrence.

Long-acting beta-2 adrenergic agonists (LABAs) are used with anti-inflammatory medications to control asthma symptoms, particularly those that occur during the night. These agents are also effective in the prevention of exercise-induced asthma. LABAs are not indicated for immediate relief of symptoms. Salmeterol and formoterol have duration of bronchodilation of at least 12 hours. They are used with other medications in long-term control of asthma.

Leukotriene modifiers (inhibitors), or *antileukotrienes,* are a class of medications that include montelukast, zafirlukast, and zileuton. Leukotrienes, which are synthesized from membrane phospholipids through a cascade of enzymes, are potent bronchoconstrictors that also dilate blood vessels and alter permeability. Leukotriene inhibitors act either by interfering with leukotriene synthesis or by blocking the receptors where leukotrienes exert their action. They may provide an alternative to ICSs for mild persistent asthma, or they may be added to a regimen of ICSs in more severe asthma to attain further control.

Phosphodiesterase inhibitors cause bronchodilation and act as mild anti-inflammatory agents by influencing epinephrine release. Theophylline is used as an add-on agent and in conjunction with inhaled steroids; however, it is not as effective in treating asthma as the medications previously discussed. Theophylline should be used with reservation because it has the potential to cause many drug interactions and its higher risk of side effects (GOLD, 2019).

Immunomodulators prevent binding of IgE to the high-affinity receptors of basophils and mast cells. The U.S. Food and Drug Administration (FDA) approved five biologic immunomodulators for the treatment of asthma (omalizumab, mepolizumab, reslizumab, benralizumab, and dupilumab) and several others are in development. Medications in this class are add-on treatments used when patients experience poor symptom control on high-dose inhaled corticosteroids with a LABA (ICS-LABA). These immunomodulators are monoclonal antibodies that are derived from biologic sources and are therefore sometimes referred to as biologics. They help with symptom control by interfering with the inflammatory response that is associated with acute asthmatic episodes (Krings, McGregor, Bacharier, et al., 2019). Cost and patient preference for route of administration must be considered when adding

on this treatment (GOLD, 2019). Biologics are either administered subcutaneously or intravenously.

Management of Exacerbations

Asthma exacerbations are best managed by early treatment and education, including the use of written action plans as part of any overall effort to educate patients about self-management techniques, especially those with moderate or severe persistent asthma or with a history of severe exacerbations (GINA, 2019a). GINA (2019a) recommends using an ICS treatment for the prevention of exacerbations in adults. Short-acting beta-2–adrenergic agonist medications are used at the time of the exacerbation for prompt relief of airflow obstruction. Systemic corticosteroids may be necessary to decrease airway inflammation in patients who fail to respond to inhaled beta-adrenergic medications. In some patients, oxygen supplementation may be required to relieve hypoxemia associated with moderate to severe exacerbations. In addition, response to treatment may be monitored by serial measurements of lung function. Patients with persistent symptoms and/or exacerbations may benefit from routinely using ICS-LABA to improve symptom management and prevent the occurrence of exacerbations.

Evidence from clinical trials suggests that antibiotic therapy, whether given routinely or when suspicion of bacterial infection is low, is not beneficial for asthma exacerbations (GINA, 2019a). Antibiotics may be appropriate in the treatment of acute asthma exacerbations in patients who have symptoms of a respiratory infection (e.g., fever and purulent sputum, evidence of pneumonia, suspected bacterial sinusitis).

Despite insufficient data supporting or refuting the benefits of using a written asthma action plan as compared to medical management alone, it is recommended to use a written asthma action plan to educate patients about self-management (Fig. 20-11). Plans can be based on either symptoms or peak flow measurements. They should focus on daily management as well as the recognition and handling of worsening symptoms. Patient self-management and early recognition of problems lead to more efficient communication with health care providers about asthma exacerbations (GINA, 2019a).

Peak Flow Monitoring

Peak flow meters measure the highest airflow during a forced expiration (Fig. 20-12). Daily peak flow monitoring is recommended for patients who meet one or more of the following criteria: have moderate or severe persistent asthma, have poor perception of changes in airflow or worsening symptoms, have unexplained response to environmental or occupational exposures, or at the discretion of the clinician and patient (GINA, 2019a). Peak flow

monitoring helps measure asthma severity and, when added to symptom monitoring, indicates the current degree of asthma control.

The patient is instructed in the proper technique (Chart 20-8), particularly about using maximal effort; peak flows are monitored for 2 or 3 weeks after receipt of optimal asthma therapy. Then, the patient's "personal best" value is measured. The green (80% to 100% of personal best), yellow (60% to 80%), and red (less than 60%) zones are determined, and specific actions are delineated for each zone, enabling the patient to monitor and manipulate their own therapy after careful instruction (GINA, 2019a).

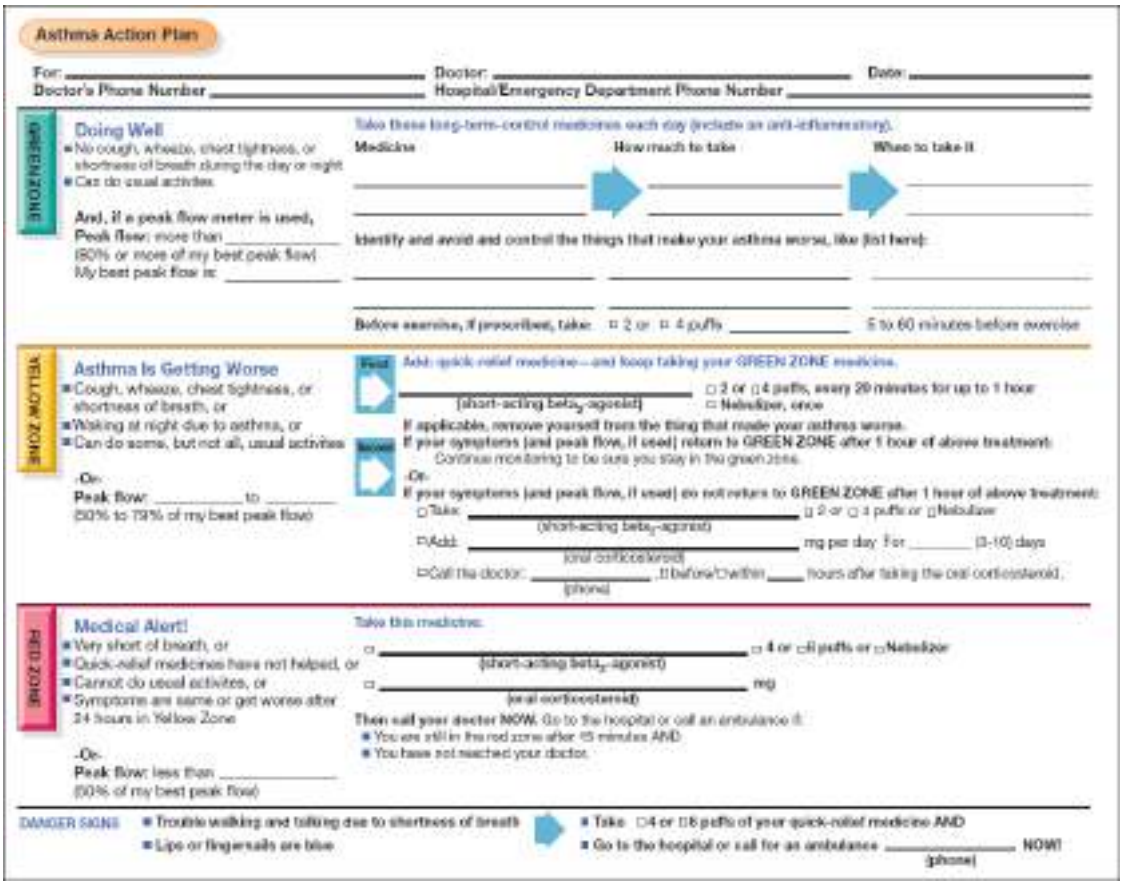


Figure 20-11 • Asthma action plan. Adapted from National Heart, Lung, and Blood Institute (NHLBI). (2012). Asthma care quick reference: Diagnosing and managing asthma. NIH Publication No. 12–5075. Revised September 2012.

Figure 20-12 • Peak flow meters measure the highest volume of airflow during a forced expiration. The patient takes a deep breath and places lips around the mouthpiece (**A**), and then exhales hard and fast (**B**). Volume may be measured in color-coded zones: the green zone signifies 80% to 100% of personal best; yellow, 60% to 80%; and red, less than 60%. If peak flow falls below the red zone, the patient should take the appropriate actions prescribed by the patient's primary provider.

Chart 20-8 HOME CARE CHECKLIST

Use of Peak Flow Meter in Asthma Management

At the completion of education, the patient and/or caregiver will be able to:

- Describe the rationale for using a peak flow meter in asthma management.
- Explain how peak flow monitoring is used along with symptoms to determine severity of asthma.
- Demonstrate steps for using the peak flow meter correctly.
  1. Move the indicator to the bottom of the numbered scale.
  2. Stand up.
  3. Take a deep breath, and fill the lungs completely.
  4. Place mouthpiece in mouth, and close lips around mouthpiece. (Do not put tongue inside opening.)
  5. Blow out hard and fast with a single blow.
  6. Record the number achieved on the indicator. If patient coughs or a mistake is made in the process, do it again.
  7. Repeat steps 1–5 two more times, and write the highest number in the asthma diary.
- Explain how to determine the "personal best" peak flow reading.
- Describe the significance of the color zones for peak flow monitoring.
- Demonstrate how to clean the peak flow meter.
- Discuss how and when to contact the primary provider about changes or decreases in peak flow values.

GINA (2019a) recommends that peak flow monitoring be considered an adjunct to asthma management for patients with moderate to severe persistent asthma. Peak flow monitoring plans may enhance communication between the patient and health care providers and may increase the patient's awareness of disease status and control.

Nursing Management

The immediate nursing care of patients with asthma depends on the severity of symptoms. The patient may be treated successfully as an outpatient if asthma symptoms are relatively mild or may require hospitalization and intensive care if symptoms are acute and severe. The patient and family are often frightened and anxious because of the patient's dyspnea. Therefore, a calm approach is an important aspect of care. The nurse assesses the patient's respiratory status by monitoring the severity of symptoms, breath sounds, peak flow, pulse oximetry, and vital signs.

The nurse generally performs the following interventions:

- Obtains a history of allergic reactions to medications before administering medications.
- Identifies medications the patient is taking.
- Administers medications as prescribed and monitors the patient's responses to those medications. These medications may include an antibiotic if the patient has an underlying respiratory infection.
- Administers fluids if the patient is dehydrated.

If the patient requires intubation because of acute respiratory failure, the nurse assists with the intubation procedure, continues close monitoring of the patient, and keeps the patient and family informed about procedures. (See Chapter 19 for discussion of intubation and mechanical ventilation.)

Promoting Home, Community-Based, and Transitional Care

Implementation of basic asthma management principles at the community level is a major challenge. Strategies include education of health care providers, establishment of programs for asthma education (for patients and providers), the use of outpatient follow-up care for patients, and a focus on chronic management versus acute episodic care. Nurses are pivotal to achievement of these objectives.

Educating Patients About Self-Care

Patient education is a critical component of care for patients with asthma. Multiple inhalers, different types of inhalers, antiallergy therapy, antireflux medications, and avoidance measures are essential for long-term control. This complex therapy requires a partnership between the patient and the health care providers to determine the desired outcomes and to formulate a plan to achieve those outcomes. The patient then carries out daily therapy as part of self-care management, with input and guidance by their health care providers. Before a partnership can be established, the patient must understand the following:

- Nature of asthma as a chronic inflammatory disease
- Definitions of inflammation and bronchoconstriction
- Purpose and action of each medication
- Triggers to avoid and how to avoid them
- Proper inhalation technique
- How to perform peak flow monitoring (see Chart 20-8)
- How to implement an asthma action plan (see Fig. 20-11)
- When to seek assistance, and how to do so

An assortment of excellent educational materials is available from the National Heart, Lung, and Blood Institute and other sources (see Resources section at the end of the chapter). The nurse should obtain current educational materials for the patient based on the patient's diagnosis, causative factors, educational level, and cultural background. If a patient has a coexisting sensory impairment (i.e., vision loss or hearing impairment), materials should be provided in an alternative format.

Continuing and Transitional Care

Nurses who have contact with patients with asthma in any setting use the opportunity to assess the patient's respiratory status and ability to manage self-care to prevent serious exacerbations. Nurses emphasize adherence to the prescribed therapy, preventive measures, and the need to keep follow-up appointments with health care providers. Home visits to assess the home environment for allergens may be indicated for patients with recurrent exacerbations. Nurses refer patients to community support groups. In addition, nurses remind patients and families about the importance of health promotion strategies and recommended health screening.

Unfolding Patient Stories: Jennifer Hoffman • Part 1

Jennifer Hoffman is a 33-year-old woman diagnosed with asthma in childhood. She has come to the clinic multiple times over the last 2 mo complaining of continued symptoms. Her asthma action plan was adjusted by her primary provider last month. What measures can the nurse take to determine areas needing education reinforcement? How can the nurse ensure that Jennifer is accurately following the prescribed asthma regimen and monitoring medication effectiveness? (Jennifer Hoffman's story continues in Chapter 33.)

Care for Jennifer and other patients in a realistic virtual environment: vSim (**thepoint.lww.com/vSimMedicalSurgical**). Practice documenting these patients' care in DocuCare (**thepoint.lww.com/DocuCareEHR**).

Status Asthmaticus

An asthma exacerbation can range from mild to severe with potential respiratory arrest (GINA, 2019a). The term *status asthmaticus* is sometimes used to describe rapid onset, severe, and persistent asthma that does not

respond to conventional therapy. The attacks can occur with little or no warning and can progress rapidly to asphyxiation. Infection, anxiety, inhaler abuse, dehydration, increased adrenergic blockage, and nonspecific irritants may contribute to these episodes. An acute episode may be precipitated by hypersensitivity to medications, such as aspirin, beta-blockers, and nonsteroidal anti-inflammatory drugs (NSAIDs) (American Academy of Allergy, Asthma & Immunology [AAAAI], 2019; GOLD, 2019).

Pathophysiology

The basic characteristics of asthma (inflammation of bronchial mucosa, constriction of the bronchiolar smooth muscle, and thickened secretions) decrease the diameter of the bronchi and occur in status asthmaticus. The most common scenario is severe bronchospasm, with mucus plugging leading to asphyxia. A ventilation–perfusion abnormality results in hypoxemia. There is a reduced PaO_2 and initial respiratory alkalosis, with a decreased $PaCO_2$ and an increased pH. As status asthmaticus worsens, the $PaCO_2$ increases and the pH decreases, reflecting respiratory acidosis.

Clinical Manifestations

The clinical manifestations are the same as those seen in severe asthma; signs and symptoms include labored breathing, prolonged exhalation, distended neck veins, and wheezing. However, the extent of wheezing does not indicate the severity of the attack. As the obstruction worsens, the wheezing may disappear; this is frequently a sign of impending respiratory failure.

Assessment and Diagnostic Findings

The severity of an exacerbation may be evaluated by a general assessment of the patient (degree of breathlessness, ability to talk, positioning of patient, level of alertness or cognitive function), physical assessment (respiratory rate, the use of accessory muscles, presence of central cyanosis, auscultatory findings, pulse, and pulsus paradoxus), and laboratory evaluation (peak expiratory flow after a bronchodilator, PaO_2 and $PaCO_2$, and pulse oximetry). Pulmonary function studies are the most accurate means of assessing an acute, severe airway obstruction, though not practical to obtain during this type of an emergent situation. Arterial blood gas measurement and/or pulse oximetry are obtained if the patient cannot perform pulmonary function maneuvers because of severe obstruction or fatigue, or if the patient does not respond to treatment. Respiratory alkalosis (low $PaCO_2$) is the most common early finding in patients with an ongoing asthma exacerbation and is due to hyperventilation. At this early stage, relatively fewer acinar units (i.e., pulmonary alveolar units

where gas exchange occurs) are obstructed/constricted compared to those that are functional, and hyperventilation occurs as part of the sympathetic response.

Quality and Safety Nursing Alert

In status asthmaticus, increasing PaCO2 (to normal levels or levels indicating respiratory acidosis) is a danger sign signifying impending respiratory failure.

Medical Management

Close monitoring of the patient and objective reevaluation for response to therapy are key in status asthmaticus. In the emergency setting, the patient is treated initially with a short-acting beta-2–adrenergic agonist and subsequently a short course of systemic corticosteroids, especially if the patient does not respond to the short-acting beta-2–adrenergic agonist. Corticosteroids are critical in the therapy of status asthmaticus and are used to decrease the intense airway inflammation and swelling. Inhaled short-acting beta-2–adrenergic agonists provide the most rapid relief from bronchospasm. A pMDI, with or without a spacer, may be used for administering the medications. However, more commonly, short-acting bronchodilators will be given via an SVN. A mouthpiece or facemask can be used and the bronchodilator is continuously given to the patient. The patient does not have to work to coordinate the breathing pattern, which can otherwise cause additional anxiety in this acute situation. The patient requires supplemental oxygen and IV fluids for hydration. Oxygen therapy is initiated to treat dyspnea, central cyanosis, and hypoxemia. High-flow supplemental oxygen is best delivered using a partial or complete non-rebreathing mask. Sedatives are contraindicated. Magnesium sulfate, a calcium antagonist, may be given to induce smooth muscle relaxation; the magnesium can relax smooth muscle and hence cause bronchodilation by competing with calcium at calcium-mediated smooth muscle–binding sites. IV magnesium sulfate is not recommended for routine use in asthma exacerbations; however, when given as a single 2-g infusion over 20 minutes, it may be helpful in treating patients who present with severely compromised pulmonary function, who have not responded to initial therapy, and with persistent hypoxemia (GINA, 2019a). Adverse effects of magnesium sulfate may include facial warmth, flushing, tingling, nausea, central nervous system depression, respiratory depression, and hypotension.

If there is no response to repeated treatments, hospitalization is required. Other criteria for hospitalization include poor pulmonary function test results and deteriorating blood gas levels (respiratory acidosis), which may indicate that the patient is tiring and will require mechanical ventilation. Most patients

do not need mechanical ventilation, but it is used for patients in respiratory failure, for those who tire and are too fatigued by the attempt to breathe, and for those whose condition does not respond to initial treatment.

For a very select group of patients with uncontrolled severe asthma, bronchial thermoplasty may be considered. Bronchial thermoplasty is the first nondrug therapy for the treatment of severe, uncontrolled asthma. It consists of controlled radiofrequency heating of the central airways through a bronchoscope. The thermal energy reduces the amount of smooth muscle involved in bronchospasm and potentially decreases the severity and frequency of symptoms. This therapy is invasive and relatively new; therefore, only select centers have the ability to perform this procedure, and it should only be considered in a select group of patients (GINA, 2019a).

Death from asthma is associated with several risk factors, including the following (GINA, 2019a):

- Past history of severe exacerbation (e.g., intubation or intensive care unit admission)
- Hospitalizations or emergency care visits for asthma within the past year
- Currently or having recently stopped using oral corticosteroids
- Not using ICSs
- Overuse of SABAs
- Concurrent psychiatric disease or psychosocial problems
- Poor adherence to written asthma action plan
- Poor adherence to medication regimen
- Presence of a food allergy

Nursing Management

The main focus of nursing management is to actively assess the airway and the patient's response to treatment. The nurse should be prepared for the next intervention if the patient does not respond to treatment.

The nurse vigilantly monitors the patient for the first 12 to 24 hours, or until the severe exacerbation resolves. The nurse also assesses the patient's skin turgor for signs of dehydration. Fluid intake is essential to combat dehydration, to loosen secretions, and to facilitate expectoration. Nurses administer IV fluids as prescribed, up to 3 to 4 L/day, unless contraindicated. Blood pressure and cardiac rhythm should be monitored continuously during the acute phase and until the patient stabilizes and responds to therapy. The patient's energy needs to be conserved, and his or her room should be quiet and free of respiratory irritants, including flowers, tobacco smoke, perfumes, or odors of cleaning agents. Nonallergenic pillows should be used. An asthma attack may also be precipitated or aggravated by exposure to latex if the patient has a latex

allergy; therefore, this type of hypersensitivity must be identified and latex-free products used, as warranted. Once the exacerbation is resolved, the factors that precipitated the exacerbation should be identified and strategies for their future avoidance implemented. In addition, the patient's medication plan should be reviewed.

Cystic Fibrosis

CF is the most common fatal autosomal recessive disease among Caucasians. It is less frequently found among Hispanic, Asian, and African Americans. A person must inherit a defective copy of the CF gene (one from each parent) to have CF. Each year, 1000 new cases of CF are diagnosed, and more than 75% of patients are diagnosed by 2 years of age (Cystic Fibrosis Foundation [CFF], 2019a). In 2010, over 50% of people with CF in the United States were diagnosed with newborn screening (Heltshe, Cogen, Ramos, et al., 2017). Approximately 30,000 children and adults in the United States have CF and half are over the age of 18. CF was once a fatal childhood disease; however, the median expected survival age is now 37 (National Institutes of Health, 2018). Furthermore, survival age is projected to rise to 57 years if the survival rate continues to improve 1.8% per year (Heltshe et al., 2017). The improved survival rate is due to advances in medical management and procedures such as lung transplantation. Now that the median survival age has increased to 37 years for patients with CF, issues that were not present in past generations have arisen. These issues include antibiotic resistance and the desire for patients with CF to have their own biologic children.

Although most patients are diagnosed by 2 years of age, this disease may not be diagnosed until later in life (CFF, 2019b). Respiratory symptoms are frequently the major manifestation of CF when it is diagnosed later in life. These patients will not demonstrate the classic symptoms of CF, which may potentially cause a diagnostic dilemma.

Pathophysiology

CF is caused by mutations or dysfunction in the protein cystic fibrosis transmembrane conductance regulator (CFTR), which normally transports chloride ions across epithelial cell membranes. Gene mutations affect transport of these ions, leading to CF, which is characterized by thick, viscous secretions in the lungs, pancreas, liver, intestine, and reproductive tract as well as increased salt content in sweat gland secretions. The most common mutation is ΔF508; however, researchers have identified more than 1700 mutations of the disease (CFF, 2019a). The numerous mutations of the CFTR gene create multiple variations in the presentation and progression of the disease.

The ability to detect the common mutations of this gene allows for routine screening for CF and the detection of carriers of the disease. Genetic counseling is an important part of health care for couples at risk (see Chapter 6). People who are heterozygous for CF (i.e., have one defective gene and one normal gene) do not have the disease but can be carriers and pass the defective gene on to their children. If both parents are carriers, their risk of having a child with CF is one in four (25%) with each pregnancy. Any biologic offspring of a patient with CF will have CF. Genetic testing should be offered to adults with a positive family history of CF and to partners of people with CF who are planning a pregnancy or seeking prenatal counseling. The hallmark pathology of CF is bronchial mucus plugging, inflammation, and eventual bronchiectasis. Commonly, the bronchiectasis begins in the upper lobes and progresses to involve all lobes.

Clinical Manifestations

The pulmonary manifestations of CF include a productive cough, wheezing, hyperinflation of the lung fields on chest x-ray, and pulmonary function test results consistent with obstructive disease of the airways. Chronic respiratory inflammation and infection are caused by impaired mucus clearance. Colonization of the airways with pathogenic bacteria usually occurs early in life. *S. aureus* and *H. influenzae* are common organisms during early childhood. As the disease progresses, *P. aeruginosa* is ultimately isolated from the sputum of most patients (Simon, Mallory, & Hoppin, 2019b). Upper respiratory manifestations of the disease include sinusitis and nasal polyps. Pulmonary complications of CF are the primary cause of morbidity and mortality in the United States (Simon, Mallory, & Hoppin, 2019a).

Nonpulmonary manifestations include gastrointestinal problems (e.g., pancreatic insufficiency, recurrent abdominal pain, biliary cirrhosis, vitamin deficiencies, recurrent pancreatitis, weight loss), CF-related diabetes, and genitourinary problems (male and female infertility). (See Chapter 44 for a discussion of pancreatitis.)

Assessment and Diagnostic Findings

The diagnosis of CF requires a clinical picture consistent with the CF phenotype and laboratory evidence of CFTR dysfunction. Key assessment findings in adults include (Katkin, Mallory, & Hoppin, 2019):

- Chronic sinopulmonary disease as manifested by chronic cough and sputum production, persistent infection consistent with typical CF pathogens, and x-ray evidence of bronchiectasis and chronic sinusitis, often with nasal polyps

- Gastrointestinal tract and nutritional abnormalities (pancreatic insufficiency, recurrent pancreatitis, biliary cirrhosis and portal hypertension, CF-related diabetes)
- Male urogenital problems as manifested by congenital bilateral absence of the vas deferens; reduced female fertility

Medical Management

CF requires both acute and chronic therapy. Cornerstones of treatment include multimodal antibiotic regimens, airway clearance measures, bronchodilators, CFTR modulators, nutritional support, and exercise (Simon et al., 2019a). Multimodal antibiotic regimens use different types of antibiotics and routes (oral, inhaled, and IV) to help control, suppress, and treat exacerbation of bacterial infections. Airway clearance measures entail the use of the mucolytics (e.g., dornase alfa; see later discussion), inhaled hypertonic saline, and various pulmonary techniques that promote mucus expectoration.

Because chronic infection (viral and bacterial) of the airways occurs in CF, control of infections is essential to treatment. It is best to prevent viral infections. Administering viral influenza vaccinations is essential for CF patients. Due to the increased risk of viral influenza, some CF patients may benefit from prophylactic treatment with a neuraminidase inhibitor (e.g., zanamivir, oseltamivir) (Simon et al., 2019a).

Bacterial infection requires aggressive therapy to improve airway clearance and the use of antibiotics based on results of sputum cultures. The majority of patients are colonized with *P. aeruginosa;* however, *S. aureus,* methicillin-resistant *Staphylococcus aureus,* and *Burkholderia cepacia* complex are examples of other commonly found pathogens (Simon et al., 2019b).

Chronic infection with *P. aeruginosa* is an independent risk factor for accelerated loss of lung function and decreased survival (Simon et al., 2019b). *P. aeruginosa* is also common in CF exacerbations and new strains may develop with recurring infections leading to different antibiotic-resistance profiles (Simon et al., 2019b). As CF patients are living longer and experiencing more exacerbations, antibiotic resistance is becoming a serious concern and can affect life expectancy.

B. cepacia complex consists of different species of bacteria. Infection with *B. cepacia* complex, in general, is associated with poor outcomes in CF patients as a result of the bacteria's inherent antibiotic resistance. Infection with this complex may prevent a CF patient from becoming a lung transplant candidate (Hachem, 2019).

Routine cultures of respiratory secretions are used to identify organisms and guide antibiotic selection. Two IV antibiotics have been typically prescribed to treat a severe exacerbation of *P. aeruginosa.* Tobramycin, along with piperacillin-tazobactam, a third-generation cephalosporin (e.g., ceftizoxime,

ceftazidime), a carbapenem (e.g., meropenem, aztreonam) may be prescribed (Simon et al., 2019b). Three newer combination medications, ceftazidime and avibactam, meropenem and vaborbactam, and ceftolozane and tazobactam, unite commonly known antibiotics with a beta-lactamase inhibitor to counteract bacterial resistance. Dosing of antibiotics is determined on a case-by-case basis; some patients may require higher doses or an extended IV infusion. When methicillin-resistant *S. aureus* accompanies *P. aeruginosa*, vancomycin is administered in addition to dual IV antibiotic therapy (Simon et al., 2019b). Careful monitoring is always required to minimize any side effects of the antibiotics.

Maintenance oral antibiotic therapies are sometimes employed to help suppress infections caused by other common bacteria such as methicillin-sensitive *S. aureus*. These infections vary across patients and require individualized patient care. The antibiotic regimens used vary depending on the specific organism grown and severity of infection.

Inhaled antibiotics are mainly used to treat *P. aeruginosa*. Tobramycin is the first-line inhaled antibiotic choice but aztreonam can be used as an alternative treatment. Typically, these antibiotics are used on a 28-day on and 28-day off regimen. Patients with deteriorating lung function or recurrent exacerbations may use these antibiotics by rotating courses of inhaled tobramycin and aztreonam without implementing a 28-day off period (Simon, Mallory, & Hoppin, 2019c). Although there is no general consensus on the use of inhaled colistimethate sodium, this drug can be used with patients who do not respond well with the other inhaled antibiotics (Simon et al., 2019c).

Various pulmonary techniques are used to promote airway clearance through the expectoration of secretions. Examples include CPT with manual postural drainage; HFCWO; autogenic drainage (a combination of breathing techniques at different lung volume levels to move the secretions to where they can be huff-coughed out); and other devices that assist in airway clearance, such as masks that generate positive expiratory pressure (PEP masks) and flutter valves (devices that provide an oscillatory expiratory pressure pattern with PEP and assist with expectoration of secretions). It is important to assure that the patient is properly positioned when using the flutter valve and that the patient uses proper technique with this treatment.

Dornase alfa is a nebulized medication given to degrade the large amount of deoxyribonucleic acid (DNA) that accumulates within CF mucus. This agent helps decrease the viscosity of the sputum and promotes expectoration of secretions. It is recommended for patients with moderate to severe disease (severity of lung disease classification is based on predicted FEV_1 percentage). In addition, inhaled hypertonic saline may be used in the chronic treatment of CF. Inhalations increase hydration of the airway surface liquid in patients with CF and improve airway clearance.

Nebulized and IV antibiotics or a combination may be used to treat chronic colonization of the lung. Nebulization provides high intrapulmonary drug concentrations and minimal systemic absorption. Inhaled tobramycin or aztreonam have been shown to decrease the frequency of pulmonary exacerbations. Acute infections are treated with a variety of IV antibiotics. Such infections remain a major cause of mortality related to pulmonary exacerbations in adults with CF.

Other therapeutic measures may be necessary as well. Anti-inflammatory agents may be used to treat inflammatory response in the airways. There is insufficient evidence for the use of routine inhaled or oral corticosteroids (Simon et al., 2019b). IV corticosteroids are used during acute exacerbations and only for those patients with asthmalike symptoms (Simon et al., 2019b). Inhaled bronchodilators (e.g., salmeterol, tiotropium bromide) may be used in patients who have a significant bronchoconstrictive component; this is confirmed by spirometry before and after therapy is instituted (Simon et al., 2019c).

Pancreatic exocrine insufficiency occurs frequently in people with CF and requires oral pancreatic enzyme supplementation with meals (Katkin, Baker, & Baker, 2019). Given the fat malabsorption in CF and increased caloric needs due to the work of breathing, nutritional counseling and weight monitoring are extremely important. Supplements of fat-soluble vitamins A, D, E, and K are also used.

CFTR modulators are a class of drugs that help prevent the progression of CF (Simon et al., 2019c). These agents are novel in that they aim to address the cause of CF as opposed to treating symptoms. There are two classes of modulators used in treating CF: potentiators (help salt and water flow through the CFTR protein channel at the cell surface) and correctors (help the CFTR protein to form the right 3D shape so that it is able to move to the cell surface). The selection of the CFTR modulator depends on the patient's specific CFTR mutation and the patient's age (Simon et al., 2019a).

Ivacaftor, a potentiator, improves salt and water movement across the membrane (thus improving hydration and clearing of mucus from the airways). The drug does not correct the gene mutation; it only helps in the movement of salt and water across the membrane. Monotherapy of ivacaftor is approved for patients with CF who are 6 months of age and older (Simon et al., 2019c).

Although corrector drugs (e.g., lumacaftor, tezacaftor) help the CFTR protein reach the cell surface, they do not diminish CF symptoms because the proteins that do reach the cell surface are unable to improve the flow of salt and water across the cell membrane. This is why lumacaftor and tezacaftor are used in combination with ivacaftor. Combined, these drugs can modestly improve lung function and reduce CF exacerbations (Simon et al., 2019c). Lumacaftor-ivacaftor is approved for patients 2 years of age and older, but is only recommended for treating patients age 2 to 5. Tezacaftor-ivacaftor is the

preferred treatment for patients 6 years of age and older because it produces fewer side effects and drug–drug interactions than lumacaftor-ivacaftor (Simon et al., 2019c).

Currently, a triple combination of tezacaftor-ivacaftor with an additional CFTR corrector is being investigated for treating various CFTR mutations. One such medication, elexacaftor-tezacaftor-ivacaftor, completed phase 3 clinical trials and is being reviewed by the FDA to treat patients with CF age 12 years and older. This drug improves ΔF508 CFTR protein processing, trafficking, and function (Simon et al., 2019c). The goal of these new modulators is to improve the functionality of the CFTR and restore chloride transport at the cellular level, thus decreasing symptoms and complications related to the disease. These positive effects include less viscous mucus production, decreased exacerbation frequency, and improved nutrient absorption.

As the pulmonary deterioration advances, supplemental oxygen is used to treat the progressive hypoxemia that occurs with CF. It helps correct the hypoxemia and may minimize the complications seen with chronic hypoxemia (pulmonary hypertension). Lung transplantation is an option for a small, select population of patients with CF. A double-lung transplantation technique is used because of chronic infection of both lungs in end-stage CF. Because there is a long waiting list for lung transplants, many patients die while waiting for suitable lungs for transplantation.

Nursing Management

Nursing management is crucial to the interdisciplinary approach required for care of adults with CF. Nursing care includes helping patients manage pulmonary symptoms and prevent complications. Specific measures include strategies that promote removal of pulmonary secretions, CPT (including postural drainage, chest percussion, and vibration), and breathing exercises (which are implemented and taught to the patient and family when the patient is very young). The patient is reminded of the need to reduce risk factors associated with respiratory infections (e.g., exposure to crowds or to people with known infections). In addition, the patient is taught the early signs and symptoms of respiratory infection and disease progression that indicate the need to notify a primary provider.

The nurse emphasizes the importance of an adequate fluid and dietary intake to promote removal of secretions and to ensure an adequate nutritional status. Because CF is a lifelong disorder, patients often have learned to modify their daily activities to accommodate their symptoms and treatment modalities. As the disease progresses, periodic reassessment of the home environment may be warranted to identify modifications required to address changes in the patient's needs, increasing dyspnea and fatigue, and nonpulmonary symptoms.

As with any chronic disease, palliative care and end-of-life issues and concerns need to be addressed with the patient when warranted. For the patient whose disease is progressing and who is developing increasing hypoxemia, preferences for end-of-life care should be discussed, documented, and honored (see Chapter 13). Patients and family members require support as they face a shortened lifespan and an uncertain future (Tomaszek, Debska, Cepuch, et al., 2019).

CRITICAL THINKING EXERCISES

1 ipc A 55-year-old man presented to the ED with complaints of acute shortness of breath and difficulty breathing. SpO_2 on admission to the ED was 85% on room air. His admitting diagnosis was acute exacerbation of COPD. He was admitted to a general medicine unit, and arrived to his room on 4 L of O_2 via nasal cannula. During his admission assessment, the patient tells you that he works in the coal mines and his shift supervisor had to bring him to the hospital. He also states that he has a long history of smoking 1 to 2 packs of cigarettes per day and his attempts to quit have been unsuccessful. While conducting the assessment, you note that the patient has a productive cough and is becoming confused to time. What is your priority as you admit this patient? What information would you provide the primary provider? What tests might be ordered to help further evaluate the patient's condition? What information would you need to ask the patient to plan for a home discharge? What health care team members would you consult to plan for a home discharge?

2 pq A 20-year-old male with a history of asthma presents to the ED with severe shortness of breath and dyspnea at rest. He said he had a cold last week and was coughing up clear sputum. This morning he began expectorating yellow sputum and became increasingly short of breath. He used his rescue inhaler with little relief. Before he came to the ED, he used his rescue inhaler every half hour. Upon presentation to ED triage, his SpO_2 was 90% on room air, but is now 84% on room air. Physical examination reveals tachycardia at 136 bpm, cyanotic lips, and tachypnea at 30 breaths/min with signs of accessory muscle use. When asked about his asthma medications, he admits he only uses his prescribed daily inhaler once a day because it is too expensive. He also stated his primary provider gave him a breathing machine for medicine but he did not know how to use it. What is your priority of care? What evidence-based medical and nursing interventions would improve the patient's respiratory status? What educational needs does this patient have?

3 ebp A 25-year-old woman is hospitalized for CF. She was admitted for elevated temperature and weight loss. At the time of admission, she was not using oxygen therapy at home. She was working full-time in a department store prior to this exacerbation. She told the social worker yesterday that she is afraid she will have to quit her job and will lose her health insurance. Her husband, who is unemployed, is also dependent on her for health insurance. Today, she is unable to eat due to the severe dyspnea. Physical assessment reveals SpO_2 of 87% on 2 L of O_2 via nasal cannula, bilateral crackles with severely diminished breath sounds on the right, and expectoration of thick yellow sputum. What evidence-based

interventions might be used to alleviate her CF symptoms? Identify the criteria used to evaluate the strength of the evidence for these practices.

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Resources

Agency for Healthcare Research and Quality (AHRQ), www.ahrq.gov
Alpha-1 Foundation, www.alpha1.org
American Academy of Allergy, Asthma & Immunology (AAAAI), www.aaaai.org
American Association for Respiratory Care (AARC), www.aarc.org
American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), www.aacvpr.org
American Cancer Society, www.cancer.org
American College of Chest Physicians (ACCP), www.chestnet.org
American Lung Association, www.lung.org
American Thoracic Society (ATS), www.thoracic.org
Centers for Disease Control and Prevention (CDC), www.cdc.gov
COPD Foundation, www.copdfoundation.org
Cystic Fibrosis Foundation, www.cff.org
National Heart, Lung, and Blood Institute (NHLBI), www.nhlbi.nih.gov
SmokEnders, www.smokenders.org
U.S. Department of Health & Human Services (HHS), www.hhs.gov or healthfinder.gov

UNIT 5

Cardiovascular and Circulatory Function

Case Study

USING TECHNOLOGY TO PREVENT MEDICATION ERRORS

An 85-year-old male presents to the emergency department with complaints of substernal chest pressure rated 9 on a 0–10 pain scale with pain radiating to his left arm. Other signs and symptoms include nausea, dizziness, shortness of breath (SOB), diaphoresis, and a feeling of "something bad is happening to me." He is emergently sent for cardiac catheterization; a 90% distal and 85% proximal stenosis of the right coronary artery was detected. He subsequently underwent a percutaneous coronary intervention with balloon angioplasty and placement of stents. Once recovered from anesthesia he is admitted to the cardiac step-down unit where you work. When receiving report you notice in the electronic health record (EHR) that the patient should have received the first dose of two medications in the cardiac catheterization lab following the procedure. However, these medications were not administered as prescribed and you notify the interventional cardiologist about this error.

QSEN Competency Focus: **Informatics**

The complexities inherent in today's health care system challenge nurses to demonstrate integration of specific interdisciplinary core competencies. These competencies are aimed at ensuring the delivery of safe, quality patient care (Institute of Medicine, 2003). The Quality and Safety Education for Nurses project (Cronenwett, Sherwood, Barnsteiner, et al., 2007; QSEN, 2020) provides a framework for the knowledge, skills, and attitudes (KSAs) required for nurses to demonstrate competency in these key areas, which include *patient-centered care*, *interdisciplinary teamwork and collaboration*, *evidence-based practice*, *quality improvement*, *safety*, and *informatics.*

Informatics Definition: Use information and technology to communicate, manage knowledge, mitigate error, and support decision-making.

SELECT PRE-LICENSURE KSAs	APPLICATION AND REFLECTION
Knowledge	
Explain why information and technology skills are essential for safe patient care	Describe how the use of the EHR and other technology can relay information to the nurse to prevent medication errors.
Skills	
Apply technology and information management tools to support safe processes of care	Describe the type of training needed to navigate the EHR efficiently. Identify how you can utilize technology to ensure effective communication, manage medication administration, and prevent errors.
Attitudes	
Value technologies that support clinical decision-making, error prevention, and care coordination	Reflect on how you value technologies that support clinical decision-making, error prevention, and care coordination. Do these values have the potential to create barriers to effective use of technology to prevent errors in your workplace?

Cronenwett, L., Sherwood, G., Barnsteiner, J., et al. (2007). Quality and safety education for nurses. *Nursing Outlook*, *55*(3), 122–131; Institute of Medicine. (2003). *Health professions education: A bridge to quality*. Washington, DC: National Academies Press; QSEN Institute. (2020). *QSEN competencies: Definitions and pre-licensure KSAs; Informatics*. Retrieved on 8/15/2020 at: qsen.org/competencies/pre-licensure-ksas/#informatics

21 Assessment of Cardiovascular Function

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the structure and function of the cardiovascular system as well as associated cardiac risk factors.
2. Explain and demonstrate the proper techniques to perform a comprehensive cardiovascular assessment.
3. Discriminate between normal and abnormal assessment findings identified by inspection, palpation, percussion, and auscultation of the cardiovascular system.
4. Recognize and evaluate the major manifestations of cardiovascular dysfunction by applying information from the patient's health history and physical assessment findings.
5. Identify diagnostic tests and methods of hemodynamic monitoring (e.g., central venous pressure, pulmonary artery pressure, arterial pressure monitoring) of the cardiovascular system and related nursing implications.

NURSING CONCEPTS

Perfusion

GLOSSARY

acute coronary syndrome: a constellation of signs and symptoms due to the rupture of atherosclerotic plaque and resultant partial or complete thrombosis within a diseased coronary artery

afterload: the amount of resistance to ejection of blood from the ventricle

apical impulse: impulse normally palpated at the fifth intercostal space, left midclavicular line; caused by contraction of the left ventricle (*synonym*: point of maximal impulse)

atrioventricular (AV) node: secondary pacemaker of the heart, located in the right atrial wall near the tricuspid valve

baroreceptors: nerve fibers located in the aortic arch and carotid arteries that are responsible for control of the blood pressure

cardiac catheterization: an invasive procedure used to measure cardiac chamber pressures and assess patency of the coronary arteries

cardiac conduction system: specialized heart cells strategically located throughout the heart that are responsible for methodically generating and coordinating the transmission of electrical impulses to the myocardial cells

cardiac output: amount of blood pumped by each ventricle in liters per minute

cardiac stress test: a test used to evaluate the functioning of the heart during a period of increased oxygen demand; test may be initiated by exercise or medications

contractility: ability of the cardiac muscle to shorten in response to an electrical impulse

depolarization: electrical activation of a cell caused by the influx of sodium into the cell while potassium exits the cell

diastole: period of ventricular relaxation resulting in ventricular filling

ejection fraction: percentage of the end-diastolic blood volume ejected from the ventricle with each heartbeat

hemodynamic monitoring: the use of pressure monitoring devices to directly measure cardiovascular function

hypertension: blood pressure that is persistently greater than 130/80 mm Hg

hypotension: a decrease in blood pressure to less than 90/60 mm Hg that compromises systemic perfusion

murmurs: sounds created by abnormal, turbulent flow of blood in the heart

myocardial ischemia: condition in which heart muscle cells receive less oxygen than needed

myocardium: muscle layer of the heart responsible for the pumping action of the heart

normal heart sounds: sounds produced when the valves close; normal heart sounds are S_1 (atrioventricular valves) and S_2 (semilunar valves)

opening snaps: abnormal diastolic sounds generated during opening of rigid atrioventricular valve leaflets

orthostatic hypotension: a significant drop in blood pressure (20 mm Hg systolic or more or 10 mm Hg diastolic or more) after an upright posture is assumed

preload: degree of stretch of the cardiac muscle fibers at the end of diastole

pulmonary vascular resistance: resistance to blood flow out of the right ventricle created by the pulmonary circulatory system

pulse deficit: the difference between the apical and radial pulse rates

radioisotopes: unstable atoms that give off small amounts of energy in the form of gamma rays as they decay; used in cardiac nuclear medicine studies

repolarization: return of the cell to resting state, caused by reentry of potassium into the cell while sodium exits the cell

S_1: the first heart sound produced by closure of the atrioventricular (mitral and tricuspid) valves

S_2: the second heart sound produced by closure of the semilunar (aortic and pulmonic) valves

S_3: an abnormal heart sound detected early in diastole as resistance is met to blood entering either ventricle; most often due to volume overload associated with heart failure

S_4: an abnormal heart sound detected late in diastole as resistance is met to blood entering either ventricle during atrial contraction; most often caused by hypertrophy of the ventricle

sinoatrial (SA) node: primary pacemaker of the heart, located in the right atrium

stroke volume: amount of blood ejected from one of the ventricles per heartbeat

summation gallop: abnormal sounds created by the presence of an S_3 and S_4 during periods of tachycardia

systemic vascular resistance: resistance to blood flow out of the left ventricle created by the systemic circulatory system

systole: period of ventricular contraction resulting in ejection of blood from the ventricles into the pulmonary artery and aorta

systolic click: abnormal systolic sound created by the opening of a calcified aortic or pulmonic valve during ventricular contraction

telemetry: the process of continuous electrocardiographic monitoring by the transmission of radio waves from a battery-operated transmitter worn by the patient

Nearly half, or 121.5 million, of American adults have one or more types of cardiovascular disease (CVD), including hypertension, coronary artery disease (CAD), heart failure (HF), and stroke (American Heart Association [AHA], 2019). Because of the increased prevalence of CVD, nurses practicing in any setting across the continuum of care, whether in the home, office, hospital, long-term care facility, or rehabilitation facility, must be able to assess the cardiovascular system. Key components of assessment include a health history, physical assessment, and monitoring of a variety of laboratory and diagnostic test results. This assessment provides the information necessary to identify nursing diagnoses, formulate an individualized plan of care, evaluate the response of the patient to the care provided, and revise the plan as needed.

Anatomic and Physiologic Overview

An understanding of the structure and function of the heart in health and in disease is essential to develop cardiovascular assessment skills.

Anatomy of the Heart

The heart is a hollow, muscular organ located in the center of the thorax, where it occupies the space between the lungs (mediastinum) and rests on the diaphragm. It weighs approximately 300 g (10.6 oz); the weight and size of the heart are influenced by age, gender, body weight, extent of physical exercise and conditioning, and heart disease. The heart pumps blood to the tissues, supplying them with oxygen and other nutrients.

The heart is composed of three layers (Fig. 21-1). The inner layer, or endocardium, consists of endothelial tissue and lines the inside of the heart and valves. The middle layer, or **myocardium**, is made up of muscle fibers and is responsible for the pumping action. The exterior layer of the heart is called the *epicardium.*

The heart is encased in a thin, fibrous sac called the *pericardium,* which is composed of two layers. Adhering to the epicardium is the visceral pericardium. Enveloping the visceral pericardium is the parietal pericardium, a tough fibrous tissue that attaches to the great vessels, diaphragm, sternum, and vertebral column and supports the heart in the mediastinum. The space between these two layers (pericardial space) is normally filled with about 20 mL of fluid, which lubricates the surface of the heart and reduces friction during systole.

Heart Chambers

The pumping action of the heart is accomplished by the rhythmic relaxation and contraction of the muscular walls of its two top chambers (atria) and two bottom chambers (ventricles). During the relaxation phase, called **diastole**, all four chambers relax simultaneously, which allows the ventricles to fill in preparation for contraction. Diastole is commonly referred to as the period of ventricular filling. **Systole** refers to the events in the heart during contraction of the atria and the ventricles. Unlike diastole, atrial and ventricular systoles are not simultaneous events. Atrial systole occurs first, just at the end of diastole, followed by ventricular systole. This synchronization allows the ventricles to fill completely prior to ejection of blood from these chambers.

The right side of the heart, made up of the right atrium and right ventricle, distributes venous blood (deoxygenated blood) to the lungs via the pulmonary artery (pulmonary circulation) for oxygenation. The pulmonary artery is the only artery in the body that carries deoxygenated blood. The right atrium receives venous blood returning to the heart from the superior vena cava (head, neck, and upper extremities), inferior vena cava (trunk and lower extremities), and coronary sinus (coronary circulation). The left side of the heart, composed of the left atrium and left ventricle, distributes oxygenated blood to the remainder of the body via the aorta (systemic circulation). The left atrium receives oxygenated blood from the pulmonary circulation via four pulmonary veins. The flow of blood through the four heart chambers is shown in Figure 21-1.

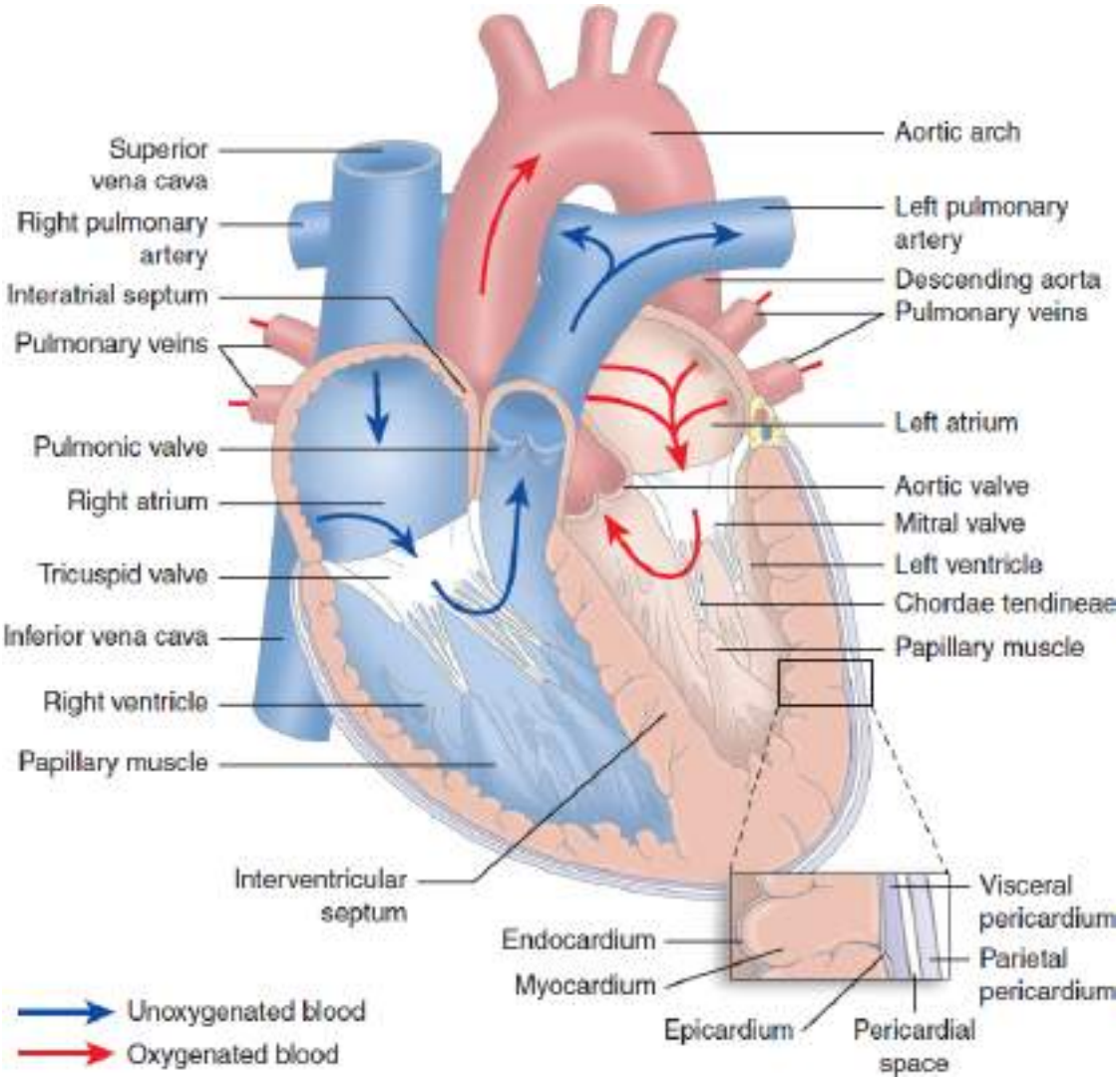


Figure 21-1 • Structure of the heart. *Arrows* show course of blood flow through the heart chambers.

The varying thicknesses of the atrial and ventricular walls are due to the workload required by each chamber. The myocardial layer of both atria is much thinner than that of the ventricles because there is little resistance as blood flows out of the atria and into the ventricles during diastole. In contrast, the ventricular walls are much thicker than the atrial walls. During ventricular systole, the right and left ventricles must overcome resistance to blood flow from the pulmonary and systemic circulatory systems, respectively. The left ventricle is two to three times more muscular than the right ventricle. It must overcome high aortic and arterial pressures, whereas the right ventricle contracts against a low-pressure system within the pulmonary arteries and capillaries (Pappano & Weir, 2019). Figure 21-2 identifies the pressures in each of these areas.

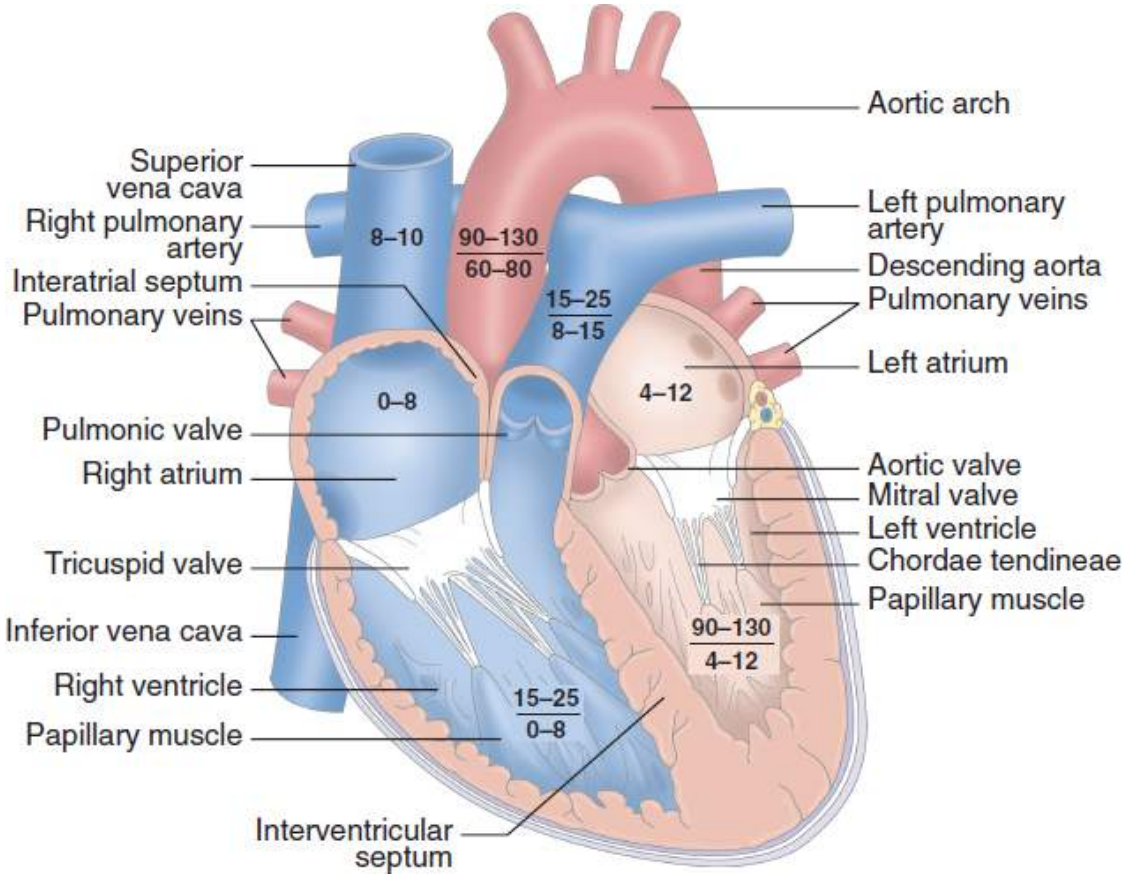


Figure 21-2 • Great vessel and chamber pressures. Pressures are identified in millimeters of mercury (mm Hg) as mean pressure or systolic over diastolic pressure.

The heart lies in a rotated position within the chest cavity. The right ventricle lies anteriorly (just beneath the sternum), and the left ventricle is situated posteriorly. As a result of this close proximity to the chest wall, the pulsation created during normal ventricular contraction, called the **apical impulse** (also called the *point of maximal impulse* [PMI]), is easily detected. In the normal heart, the PMI is located at the intersection of the midclavicular line of the left chest wall and the fifth intercostal space (Bickley, 2017).

Heart Valves

The four valves in the heart permit blood to flow in only one direction. The valves, which are composed of thin leaflets of fibrous tissue, open and close in response to the movement of blood and pressure changes within the chambers. There are two types of valves: atrioventricular (AV) and semilunar.

Atrioventricular Valves

The AV valves separate the atria from the ventricles. The tricuspid valve, so named because it is composed of three cusps or leaflets, separates the right

atrium from the right ventricle. The mitral or bicuspid (two cusps) valve lies between the left atrium and the left ventricle (see Fig. 21-1).

During diastole, the tricuspid and mitral valves are open, allowing the blood in the atria to flow freely into the relaxed ventricles. As ventricular systole begins, the ventricles contract and blood flows upward into the cusps of the tricuspid and mitral valves, causing them to close. As the pressure against these valves increases, two additional structures, the papillary muscles and the chordae tendineae, maintain valve closure. The papillary muscles, located on the sides of the ventricular walls, are connected to the valve leaflets by the chordae tendineae, which are thin fibrous bands. During ventricular systole, contraction of the papillary muscles causes the chordae tendineae to become taut, keeping the valve leaflets approximated and closed. This action prevents backflow of blood into the atria (regurgitation) as blood is ejected out into the pulmonary artery and aorta.

Semilunar Valves

The two semilunar valves are composed of three leaflets, which are shaped like half-moons. The valve between the right ventricle and the pulmonary artery is called the *pulmonic valve.* The valve between the left ventricle and the aorta is called the *aortic valve.* The semilunar valves are closed during diastole. At this point, the pressure in the pulmonary artery and aorta decreases, causing blood to flow back toward the semilunar valves. This action fills the cusps with blood and closes the valves. The semilunar valves are forced open during ventricular systole as blood is ejected from the right and left ventricles into the pulmonary artery and aorta, respectively.

Coronary Arteries

The left and right coronary arteries and their branches supply arterial blood to the heart. These arteries originate from the aorta just above the aortic valve leaflets. Unlike other arteries, the coronary arteries are perfused during diastole. With a normal heart rate of 60 to 80 bpm, there is ample time during diastole for myocardial perfusion. However, as heart rate increases, diastolic time is shortened, which may not allow adequate time for myocardial perfusion. As a result, patients are at risk for **myocardial ischemia** (inadequate oxygen supply) during tachycardia (heart rate greater than 100 bpm), especially patients with CAD.

The left coronary artery has three branches. The artery from the point of origin to the first major branch is called the *left main coronary artery.* Two branches arise from the left main coronary artery: the left anterior descending artery, which courses down the anterior wall of the heart, and the circumflex artery, which circles around to the lateral left wall of the heart.

The right side of the heart is supplied by the *right coronary artery,* which travels to the inferior wall of the heart. The posterior wall of the heart receives its blood supply by an additional branch from the right coronary artery called the *posterior descending artery* (see Chapter 23, Fig. 23-2).

Superficial to the coronary arteries are the coronary veins. Venous blood from these veins returns to the heart primarily through the coronary sinus, which is located posteriorly in the right atrium.

Myocardium

The myocardium is the middle, muscular layer of the atrial and ventricular walls. It is composed of specialized cells called *myocytes,* which form an interconnected network of muscle fibers. These fibers encircle the heart in a figure-of-eight pattern, forming a spiral from the base (top) of the heart to the apex (bottom). During contraction, this muscular configuration facilitates a twisting and compressive movement of the heart that begins in the atria and moves to the ventricles. The sequential and rhythmic pattern of contraction, followed by relaxation of the muscle fibers, maximizes the volume of blood ejected with each contraction. This cyclical pattern of myocardial contraction is controlled by the conduction system.

Function of the Heart

Cardiac Electrophysiology

The **cardiac conduction system** generates and transmits electrical impulses that stimulate contraction of the myocardium. Under normal circumstances, the conduction system first stimulates contraction of the atria and then the ventricles. The synchronization of the atrial and ventricular events allows the ventricles to fill completely before ventricular ejection, thereby maximizing cardiac output. Three physiologic characteristics of two types of specialized electrical cells, the nodal cells and the Purkinje cells, provide this synchronization:

- *Automaticity:* ability to initiate an electrical impulse
- *Excitability:* ability to respond to an electrical impulse
- *Conductivity:* ability to transmit an electrical impulse from one cell to another

Both the **sinoatrial (SA) node** (the primary pacemaker of the heart) and the **atrioventricular (AV) node** (the secondary pacemaker of the heart) are composed of nodal cells. The SA node is located at the junction of the superior vena cava and the right atrium (Fig. 21-3). The SA node in a normal resting adult heart has an inherent firing rate of 60 to 100 impulses per minute; however, the rate changes in response to the metabolic demands of the body (Weber & Kelley, 2018).

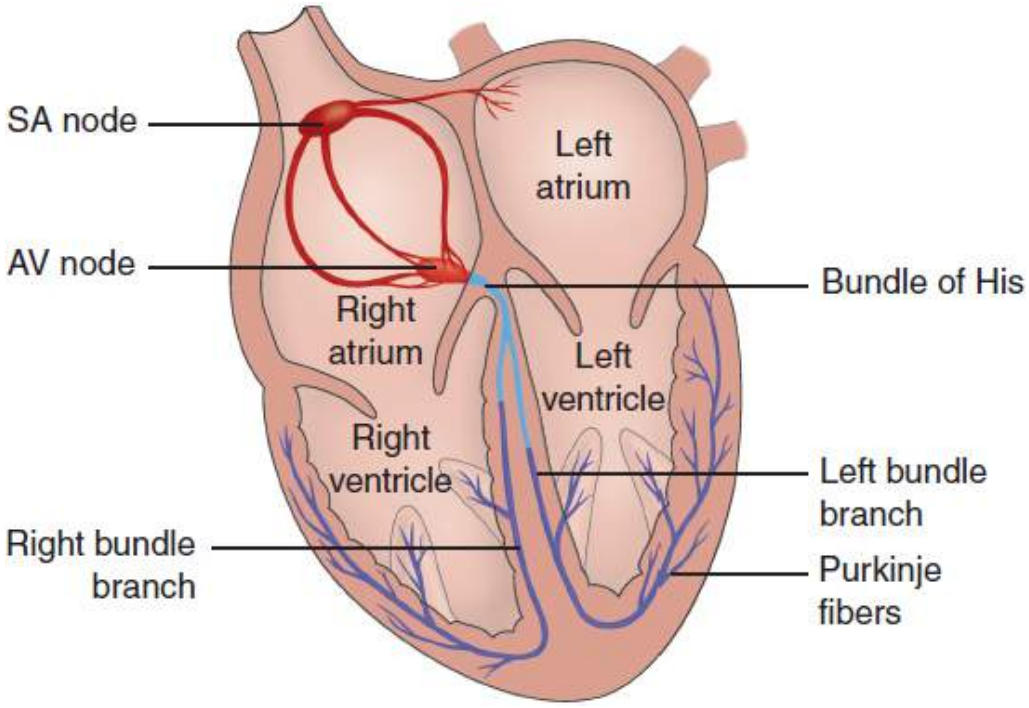


Figure 21-3 • Cardiac conduction system. AV, atrioventricular; SA, sinoatrial.

The electrical impulses initiated by the SA node are conducted along the myocardial cells of the atria via specialized tracts called *internodal pathways.* The impulses cause electrical stimulation and subsequent contraction of the atria. The impulses are then conducted to the AV node, which is located in the right atrial wall near the tricuspid valve (see Fig. 21-3). The AV node coordinates the incoming electrical impulses from the atria and after a slight delay (allowing the atria time to contract and complete ventricular filling) relays the impulse to the ventricles.

Initially, the impulse is conducted through a bundle of specialized conducting tissue, referred to as the bundle of His, which then divides into the right bundle branch (conducting impulses to the right ventricle) and the left bundle branch (conducting impulses to the left ventricle). To transmit impulses to the left ventricle—the largest chamber of the heart—the left bundle branch divides into the left anterior and left posterior bundle branches. Impulses travel through the bundle branches to reach the terminal point in the conduction system, called the *Purkinje fibers.* These fibers are composed of Purkinje cells that rapidly conduct impulses throughout the thick walls of the ventricles. This action stimulates the ventricular myocardial cells to contract (Weber & Kelley, 2018).

The heart rate is determined by the myocardial cells with the fastest inherent firing rate. Under normal circumstances, the SA node has the highest inherent rate (60 to 100 impulses per minute), the AV node has the second-highest inherent rate (40 to 60 impulses per minute), and the ventricular

pacemaker sites have the lowest inherent rate (30 to 40 impulses per minute) (Wesley, 2017). If the SA node malfunctions, the AV node generally takes over the pacemaker function of the heart at its inherently lower rate. Should both the SA and the AV nodes fail in their pacemaker function, a pacemaker site in the ventricle will fire at its inherent bradycardic rate of 30 to 40 impulses per minute.

Cardiac Action Potential

The nodal and Purkinje cells (electrical cells) generate and transmit impulses across the heart, stimulating the cardiac myocytes (working cells) to contract. Stimulation of the myocytes occurs due to the exchange of electrically charged particles, called *ions,* across channels located in the cell membrane. The channels regulate the movement and speed of specific ions—namely, sodium, potassium, and calcium—as they enter and exit the cell. Sodium rapidly enters into the cell through sodium-fast channels, in contrast to calcium, which enters the cell through calcium-slow channels. In the resting or polarized state, sodium is the primary extracellular ion, whereas potassium is the primary intracellular ion. This difference in ion concentration means that the inside of the cell has a negative charge compared with the positive charge on the outside. The relationship changes during cellular stimulation, when sodium or calcium crosses the cell membrane into the cell and potassium ions exit into the extracellular space. This exchange of ions creates a positively charged intracellular space and a negatively charged extracellular space that characterizes the period known as **depolarization**. Once depolarization is complete, the exchange of ions reverts to its resting state; this period is known as **repolarization**. The repeated cycle of depolarization and repolarization is called the *cardiac action potential.*

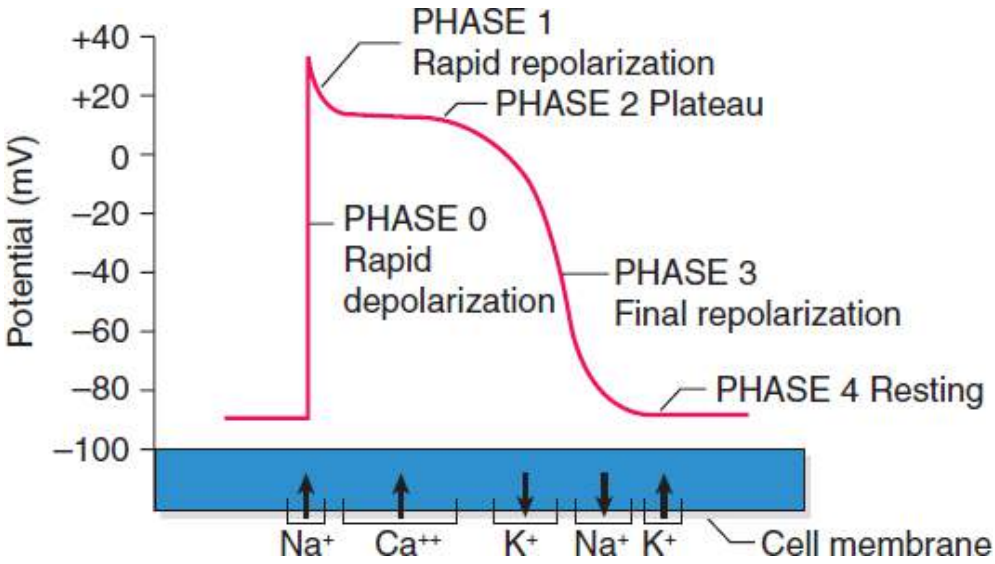


Figure 21-4 • Cardiac action potential of a fast-response Purkinje fiber. The *arrows* indicate the approximate time and direction of movement of each ion influencing membrane potential. Ca^{++} movement out of the cell is not well defined but is thought to occur during phase 4.

As shown in Figure 21-4, the cardiac action potential has five phases:

- *Phase 0:* Cellular depolarization is initiated as positive ions influx into the cell. During this phase, the atrial and ventricular myocytes rapidly depolarize as sodium moves into the cells through sodium-fast channels. The myocytes have a fast-response action potential. In contrast, the cells of the SA and AV node depolarize when calcium enters these cells through calcium-slow channels. These cells have a slow-response action potential.
- *Phase 1:* Early cellular repolarization begins during this phase as potassium exits the intracellular space.
- *Phase 2:* This phase is called the *plateau phase* because the rate of repolarization slows. Calcium ions enter the intracellular space.
- *Phase 3:* This phase marks the completion of repolarization and return of the cell to its resting state.
- *Phase 4:* This phase is considered the resting phase before the next depolarization.

Refractory Periods

Myocardial cells must completely repolarize before they can depolarize again. During the repolarization process, the cells are in a refractory period. There are two phases of the refractory period: the effective (or absolute) refractory period and the relative refractory period. During the effective refractory period, the cell is completely unresponsive to any electrical stimulus; it is

incapable of initiating an early depolarization. The effective refractory period corresponds with the time in phase 0 to the middle of phase 3 of the action potential. The relative refractory period corresponds with the short time at the end of phase 3. During the relative refractory period, if an electrical stimulus is stronger than normal, the cell may depolarize prematurely. Early depolarizations of the atrium or ventricle cause premature contractions, placing the patient at risk for arrhythmias. Premature ventricular contractions in certain situations, such as the presence of myocardial ischemia, are of concern because these early ventricular depolarizations can trigger life-threatening arrhythmias, including ventricular tachycardia or ventricular fibrillation. Several circumstances make the heart more susceptible to early depolarization during the relative refractory period, thus increasing the risk for serious arrhythmias. (These arrhythmias and others are discussed in detail in Chapter 22.)

Cardiac Hemodynamics

An important determinant of blood flow in the cardiovascular system is the principle that fluid flows from a region of higher pressure to one of lower pressure (see Fig. 21-2). The pressures responsible for blood flow in the normal circulation are generated during systole and diastole.

Cardiac Cycle

The cardiac cycle refers to the events that occur in the heart from the beginning of one heartbeat to the next. The number of cardiac cycles completed in a minute depends on the heart rate. Each cardiac cycle has three major sequential events: diastole, atrial systole, and ventricular systole. These events cause blood to flow through the heart due to changes in chamber pressures and valvular function during diastole and systole. During diastole, all four heart chambers are relaxed. As a result, the AV valves are open and the semilunar valves are closed. Pressures in all of the chambers are the lowest during diastole, which facilitates ventricular filling. Venous blood returns to the right atrium from the superior and inferior vena cava, then into the right ventricle. On the left side, oxygenated blood returns from the lungs via the four pulmonary veins into the left atrium and ventricle.

Toward the end of this diastolic period, atrial systole occurs as the atrial muscles contract in response to an electrical impulse initiated by the SA node. Atrial systole increases the pressure inside the atria, ejecting the remaining blood into the ventricles. Atrial systole augments ventricular blood volume by 15% to 25% and is sometimes referred to as the atrial kick (Wesley, 2017). At this point, ventricular systole begins in response to propagation of the electrical impulse that began in the SA node some milliseconds earlier.

Beginning with ventricular systole, the pressure inside the ventricles rapidly increases, forcing the AV valves to close. As a result, blood ceases to flow from the atria into the ventricles, and regurgitation (backflow) of blood into the atria is prevented. The rapid increase in pressure inside the right and left ventricles forces the pulmonic and aortic valves to open, and blood is ejected into the pulmonary artery and aorta, respectively. The exit of blood is at first rapid; then, as the pressure in each ventricle and its corresponding artery equalizes, the flow of blood gradually decreases. At the end of systole, pressure within the right and left ventricles rapidly decreases. As a result, pulmonary arterial and aortic pressures decrease, causing closure of the semilunar valves. These events mark the onset of diastole, and the cardiac cycle is repeated.

Chamber pressures can be measured with the use of special monitoring catheters and equipment. This technique is called **hemodynamic monitoring.** Methods of hemodynamic monitoring are covered in more detail at the end of this chapter.

Cardiac Output

Cardiac output refers to the total amount of blood ejected by one of the ventricles in liters per minute. The cardiac output in a resting adult is 4 to 6 L/min but varies greatly depending on the metabolic needs of the body. Cardiac output is computed by multiplying the stroke volume by the heart rate. **Stroke volume** is the amount of blood ejected from one of the ventricles per heartbeat. The average resting stroke volume is about 60 to 130 mL (Wiegand, 2017).

Effect of Heart Rate on Cardiac Output

The cardiac output responds to changes in the metabolic demands of the tissues associated with stress, physical exercise, and illness. To compensate for these added demands, the cardiac output is enhanced by increases in both stroke volume and heart rate. Changes in heart rate are due to inhibition or stimulation of the SA node mediated by the parasympathetic and sympathetic divisions of the autonomic nervous system. The balance between these two reflex control systems normally determines the heart rate. Branches of the parasympathetic nervous system travel to the SA node by the vagus nerve. Stimulation of the vagus nerve slows the heart rate. The sympathetic nervous system increases heart rate by innervation of the beta-1 receptor sites located within the SA node. The heart rate is increased by the sympathetic nervous system through an increased level of circulating catecholamines (secreted by the adrenal gland) and by excess thyroid hormone, which produces a catecholamine-like effect.

In addition, the heart rate is affected by central nervous system and baroreceptor activity. **Baroreceptors** are specialized nerve cells located in the

aortic arch and in both right and left internal carotid arteries (at the point of bifurcation from the common carotid arteries). The baroreceptors are sensitive to changes in blood pressure (BP). During hypertension (significant elevations in BP), these cells increase their rate of discharge, transmitting impulses to the cerebral medulla. This action initiates parasympathetic activity and inhibits sympathetic response, lowering the heart rate and the BP. The opposite is true during hypotension (low BP). Decreased baroreceptor stimulation during periods of hypotension prompts a decrease in parasympathetic activity and enhances sympathetic responses. These compensatory mechanisms attempt to elevate the BP through vasoconstriction and increased heart rate.

Effect of Stroke Volume on Cardiac Output

Stroke volume is primarily determined by three factors: preload, afterload, and contractility.

Preload refers to the degree of stretch of the ventricular cardiac muscle fibers at the end of diastole. The end of diastole is the period when filling volume in the ventricles is the highest and the degree of stretch on the muscle fibers is the greatest. The volume of blood within the ventricle at the end of diastole determines preload, which directly affects stroke volume. Therefore, preload is commonly referred to as left ventricular end-diastolic pressure. As the volume of blood returning to the heart increases, muscle fiber stretch also increases (increased preload), resulting in stronger contraction and a greater stroke volume. This relationship, referred to as the Frank–Starling (or Starling) law of the heart, is maintained until the physiologic limit of the muscle is reached.

The Frank–Starling law is based on the fact that, within limits, the greater the initial length or stretch of the sarcomeres (cardiac muscle cells), the greater the degree of shortening that occurs. This result is caused by increased interaction between the thick and thin filaments within the cardiac muscle cells. Preload is decreased by a reduction in the volume of blood returning to the ventricles. Diuresis, venodilating agents (e.g., nitrates), excessive loss of blood, or dehydration (excessive loss of body fluids from vomiting, diarrhea, or diaphoresis) reduce preload. Preload is increased by increasing the return of circulating blood volume to the ventricles. Controlling the loss of blood or body fluids and replacing fluids (i.e., blood transfusions and intravenous [IV] fluid administration) are examples of ways to increase preload.

Afterload, or resistance to ejection of blood from the ventricle, is the second determinant of stroke volume. The resistance of the systemic BP to left ventricular ejection is called **systemic vascular resistance.** The resistance of the pulmonary BP to right ventricular ejection is called **pulmonary vascular resistance.** There is an inverse relationship between afterload and stroke volume. For example, afterload is increased by arterial vasoconstriction, which leads to decreased stroke volume. The opposite is true with arterial

vasodilation, in which case afterload is reduced because there is less resistance to ejection, and stroke volume increases.

Contractility refers to the force generated by the contracting myocardium. Contractility is enhanced by circulating catecholamines, sympathetic neuronal activity, and certain medications (e.g., digoxin, dopamine, or dobutamine). Increased contractility results in increased stroke volume. Contractility is depressed by hypoxemia, acidosis, and certain medications (e.g., beta-adrenergic–blocking agents such as metoprolol).

The heart can achieve an increase in stroke volume (e.g., during exercise) if preload is increased (through increased venous return), if contractility is increased (through sympathetic nervous system discharge), and if afterload is decreased (through peripheral vasodilation with decreased aortic pressure).

The percentage of the end-diastolic blood volume that is ejected with each heartbeat is called the **ejection fraction.** The ejection fraction of the normal left ventricle is 55% to 65% (Wiegand, 2017). The right ventricular ejection fraction is rarely measured. The ejection fraction is used as a measure of myocardial contractility. An ejection fraction of less than 40% indicates that the patient has decreased left ventricular function and likely requires treatment of HF (refer to Chapter 25 for further discussion).

Gerontologic Considerations

Changes in cardiac structure and function occur with age. A loss of function of the cells throughout the conduction system leads to a slower heart rate. The size of the heart increases due to hypertrophy (thickening of the heart walls), which reduces the volume of blood that the chambers can hold. Hypertrophy also changes the structure of the myocardium, reducing the strength of contraction. Both of these changes negatively affect cardiac output. The valves, due to stiffening, no longer close properly. The resulting backflow of blood creates heart murmurs, a common finding in older adults (Bickley, 2017; Pappano & Weir, 2019).

As a result of these age-related changes, the cardiovascular system takes longer to compensate from increased metabolic demands due to stress, exercise, or illness. In these situations, older adults may become symptomatic with fatigue, shortness of breath, or palpitations and present with new physical examination findings (Bickley, 2017; Zipes, Libby, Bonow, et al., 2019). The structural and functional changes with aging and associated history and physical examination findings are summarized in Table 21-1.

Gender Considerations

Structural differences between the hearts of men and women have significant implications. The heart of a woman tends to be smaller than that of a man. The coronary arteries of a woman are also narrower in diameter than a man's arteries. When atherosclerosis occurs, these differences make procedures such as cardiac catheterization and angioplasty technically more difficult.

Women typically develop CAD 10 years later than men, as women have the benefit of the cardioprotective effects of the female hormone estrogen. The three major effects of estrogen are (1) an increase in high-density lipoprotein (HDL) that transports cholesterol out of arteries; (2) a reduction in low-density lipoprotein (LDL) that deposits cholesterol in the artery; and (3) dilation of the blood vessels, which enhance blood flow to the heart. As testosterone increases and estrogen decreases, women who are postmenopausal have a greater risk of CAD, CVD, and HF (Zhao, Guallar, Ouyang, et al., 2018). Hormone therapy (HT) is not recommended for routine prevention of CAD in women who are postmenopausal, although there are possible benefits to cardiovascular health if HT is initiated soon after the initiation of menopause (Keck & Taylor, 2018).

Assessment of the Cardiovascular System

The frequency and extent of the nursing assessment of cardiovascular function are based on several factors, including the severity of the patient's symptoms, the presence of risk factors, the practice setting, and the purpose of the assessment. Although the key components of the cardiovascular assessment remain the same, the assessment priorities vary according to patient needs. For example, an emergency department (ED) nurse performs a rapid and focused assessment of a patient in which **acute coronary syndrome** (ACS), signs and symptoms caused by ruptured atheromatous plaque in a diseased coronary artery, is suspected. Diagnosis and treatment must be started immediately, which includes an electrocardiogram (ECG) within 10 minutes of arrival to the ED (Yiadom, Baugh, McWade, et al., 2017). The physical assessment is ongoing and concentrates on evaluating the patient for ACS complications, such as a myocardial infarction (MI), arrhythmias, and HF, and determining the effectiveness of medical treatment.

TABLE 21-1 Age-Related Changes of the Cardiac System

Cardiovascular Structure	Structural Changes	Functional Changes	History and Physical Findings
Atria	↑ Size of left atrium Thickening of the endocardium	↑ Atrial irritability	Irregular heart rhythm from atrial arrhythmias
Left ventricle	Endocardial fibrosis Myocardial hypertrophy (thickening) Infiltration of fat into myocardium	Left ventricle stiff and less compliant Progressive decline in cardiac output ↑ Risk for ventricular arrhythmias Prolonged systole	Fatigue ↓ Exercise tolerance Signs and symptoms of heart failure or ventricular arrhythmias Point of maximal impulse palpated lateral to the midclavicular line ↓ Intensity S_1, S_2; split S_2 S_4 may be present
Valves	Thickening and rigidity of AV valves Calcification of aortic valve	Abnormal blood flow across valves during cardiac cycle	Murmurs may be present Thrill may be palpated if significant murmur is present
Conduction system	Connective tissue collects in SA node, AV node, and bundle branches ↓ Number of SA node cells ↓ Number of AV, bundle of His, and right and left bundle branch cells	Slower SA node rate of impulse discharge Slowed conduction across AV node and ventricular conduction system	Bradycardia Heart block ECG changes consistent with slowed conduction (↑ PR interval, widened QRS complex)
Sympathetic nervous system	↓ Response to beta-adrenergic stimulation	↓ Adaptive response to exercise: contractility and heart rate slower to respond to exercise demands Heart rate takes more time to return to baseline	Fatigue Diminished exercise tolerance ↓ Ability to respond to stress
Aorta and arteries	Stiffening of vasculature	Left ventricular hypertrophy	Progressive increase in systolic BP;

	↓ Elasticity and widening of aorta Elongation of aorta, displacing the brachiocephalic artery upward		slight ↑ in diastolic BP Widening pulse pressure Pulsation visible above right clavicle
Baroreceptor response	↓ Sensitivity of baroreceptors in the carotid artery and aorta to transient episodes of hypertension and hypotension	Baroreceptors unable to regulate heart rate and vascular tone, causing slow response to postural changes in body position	Postural BP changes and reports of feeling dizzy, fainting when moving from lying to sitting or standing position

AV, atrioventricular; BP, blood pressure; ECG, electrocardiographic; SA, sinoatrial.
Adapted from Bickley, L. S. (2017). *Bates' guide to physical examination and history taking* (12th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Health History

The patient's ability to recognize cardiac symptoms and to know what to do when they occur is essential for effective self-care management. All too often, a patient's new symptoms or those of progressing cardiac dysfunction go unrecognized, resulting in lifesaving treatment delays. Research findings suggest that ethnic and socioeconomic factors can lead to patient-related delays (Iacoe, Ratner, Wong, et al., 2018). Women, African Americans, and older patients are reported to delay seeking treatment when they have had MIs (Zipes et al., 2019). Socioeconomic factors such as poverty, high health care costs, lack of insurance, transportation, and proximity to a health care provider or hospital can also lead to delays in care. Patients may also lack knowledge about ACS symptoms, or experience denial, fear, or uncertainty about what to do when having chest pain. Some women have the misperception that the risk for cardiac disease is only linked to weight. A female patient who is embarrassed from the social stigma of being overweight may not see a health care provider, or could be reluctant to disclose important cardiac symptoms (Merz, Andersen, Sprague, et al., 2017). Therefore, during the health history, the nurse determines if the patient and involved family members are able to recognize symptoms of an acute cardiac problem, such as ACS or HF, and seek timely treatment of these symptoms. Responses to this level of inquiry will help the nurse individualize the plan for patient and family education.

Common Symptoms

The signs and symptoms experienced by people with CVD are related to arrhythmias and conduction problems (see Chapter 22); CAD (see Chapter

23); structural, infectious, and inflammatory disorders of the heart (see Chapter 24); and complications of CAD such as HF and cardiogenic shock (see Chapters 11 and 25). These disorders have many signs and symptoms in common; therefore, the nurse must be skillful at recognizing these signs and symptoms so that patients are given timely and often lifesaving care.

The following are the most common signs and symptoms of CVD, with related medical diagnoses in parentheses:

- Chest pain or discomfort (angina pectoris, ACS, arrhythmias, valvular heart disease)
- Pain or discomfort in other areas of upper body, including one or both arms, back, neck, jaw, or stomach (ACS)
- Shortness of breath or dyspnea (ACS, cardiogenic shock, HF, valvular heart disease)
- Peripheral edema, weight gain, abdominal distention due to enlarged spleen and liver or ascites (HF)
- Palpitations (tachycardia from a variety of causes, including ACS, caffeine or other stimulants, electrolyte imbalances, stress, valvular heart disease, ventricular aneurysms)
- Unusual fatigue, sometimes referred to as vital exhaustion (an early warning symptom of ACS, HF, or valvular heart disease, characterized by feeling unusually tired or fatigued, irritable, and dejected)
- Dizziness, syncope, or changes in level of consciousness (cardiogenic shock, cerebrovascular disorders, arrhythmias, hypotension, orthostatic hypotension, vasovagal episode)

Symptoms of ACS can differ between men and women. Chest pain and discomfort related to ACS can occur in both men and women. However, women may experience more atypical or nonspecific symptoms such as chest pain at rest; pain in the jaw, arm, neck, shoulder, middle back, or epigastrium; nausea; vomiting; syncope; sweating; anxiety; and fatigue (Lichtman, Leifheit, Safdar, et al., 2018; Merz et al., 2017).

Chest Pain

Chest pain and chest discomfort are common symptoms that may be caused by a number of cardiac and noncardiac problems. Table 21-2 summarizes the characteristics and patterns of common causes of chest pain or discomfort. To differentiate among these causes of pain, the nurse asks the patient to identify the quantity (0 = no pain to 10 = worst pain), location, and quality of pain. The nurse assesses for radiation of the pain to other areas of the body and determines if associated signs and symptoms are present, such as diaphoresis or nausea. It is important to identify the events that precipitate the onset of

symptoms, the duration of the symptoms, and measures that aggravate or relieve the symptoms.

The nurse keeps the following important points in mind when assessing patients reporting chest pain or discomfort:

- The location of chest symptoms is not well correlated with the cause of the pain. For example, substernal chest pain can result from a number of causes as outlined in Table 21-2.
- The severity or duration of chest pain or discomfort does not predict the seriousness of its cause. For example, when asked to rate pain using a 0 to 10 scale, patients experiencing esophageal spasm may rate their chest pain as a 10. In contrast, patients having an acute MI, which is a potentially life-threatening event, may report having moderate pain rated as a 4 to 6 on the pain scale.
- More than one clinical cardiac condition may occur simultaneously. During an MI, patients may report chest pain from myocardial ischemia, shortness of breath from HF, and palpitations from arrhythmias. Both HF and arrhythmias can be complications of an acute MI. (See Chapter 23 for discussion of clinical manifestations of ACS, including MI.)

Past Health, Family, and Social History

The health history provides an opportunity for the nurse to assess patients' understanding of their personal risk factors for peripheral vascular, cerebrovascular, and CAD and any measures that they are taking to modify these risks. Some risk factors, such as increasing age, male gender, and heredity, including race are not modifiable. However, there are a number of risk factors, such as smoking, hypertension, high cholesterol, diabetes, obesity, and physical inactivity that can be modified by lifestyle changes or medications (Arnett, Blumenthal, Albert, et al., 2019). Online tools from the AHA and the American College of Cardiology (ACC) can be used to screen a person's risk for CVD, including risk for having an MI or stroke (ACC, 2019; AHA, 2018; see Resources at the end of this chapter for a link to these tools).

In an effort to determine how patients perceive their current health status, the nurse asks the following questions:

- How is your health? Have you noticed any changes from last year? From 5 years ago?
- Do you have a cardiologist or primary provider? How often do you go for checkups?
- What health concerns do you have?
- Do you have a family history of genetic disorders that place you at risk for CVD (Chart 21-1)?
- What are your risk factors for CAD (see Chapter 23, Chart 23-1)?

- What do you do to stay healthy and take care of your heart?

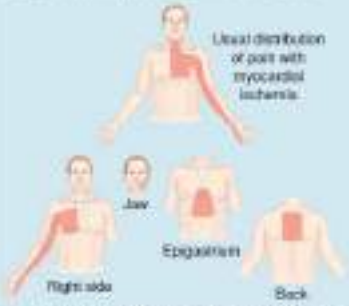
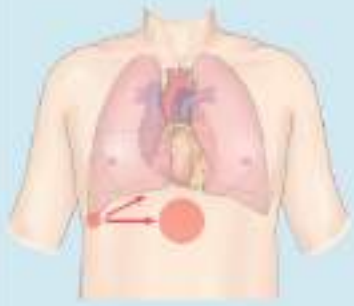
Patients who do not understand the connection between risk factors and CAD may be unwilling to make recommended lifestyle changes or manage their illness effectively. In contrast, patients who have this understanding may be more motivated to alter their lifestyle to avoid the risk of future cardiac events. The AHA published lifestyle management guidelines that identify interventions and treatment goals for each of these risk factors (Arnett et al., 2019). Chapter 23 provides an overview of this information.

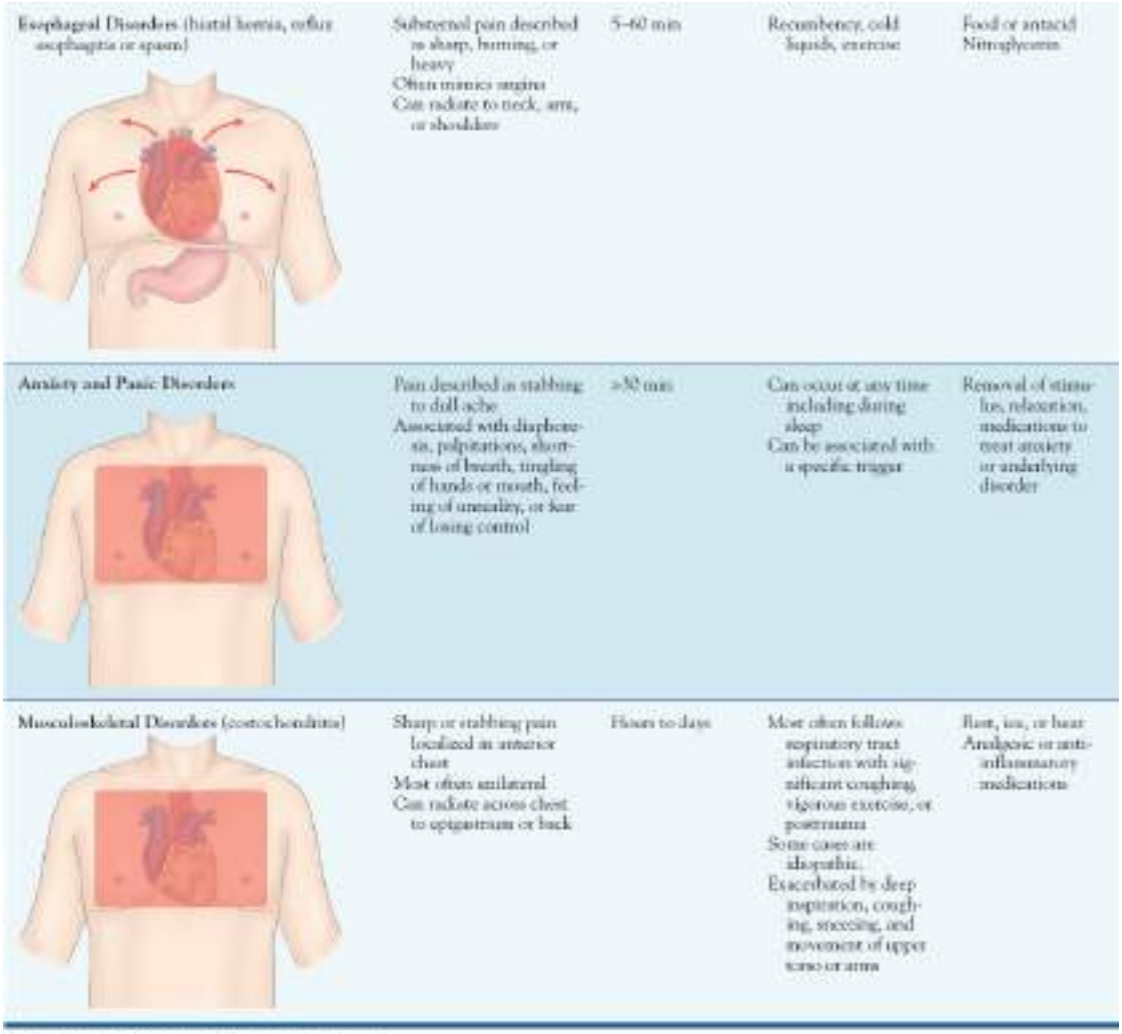
Medications

Nurses collaborate with other health care providers, including pharmacists, to obtain a complete list of the patient's medications, including dose and frequency. Vitamins, herbals, and other over-the-counter medications are included on this list. During this aspect of the health assessment, the nurse asks the following questions to ensure that the patient is safely and effectively taking the prescribed medications.

- What are the names and doses of your medications?
- What is the purpose of each of these medications?
- How and when are these medications taken? Do you ever skip a dose or forget to take them?
- Are there any special precautions associated with any of these medications?
- What symptoms or problems do you need to report to your primary provider?

TABLE 21-2 Assessing Chest Pain

Location	Character	Duration	Precipitating Events and Aggravating Factors	Alleviating Factors
Angina Pectoris, ACS (unstable angina, MI)  Less common sites of pain with myocardial ischemia	Angina: Uncomfortable pressure, squeezing, or fullness in substernal chest area Can radiate across chest to the medial aspect of one or both arms and hands, jaw, shoulders, upper back, or epigastrium Radiation to arms and hands, described as numbness, tingling, or aching	Angina: 5–15 min	Angina: Physical exertion, emotional upset, eating large meal, or exposure to extremes in temperature	Angina: Rest, nitroglycerin, oxygen
	ACS: Same as angina pectoris Pain or discomfort ranges from mild to severe Associated with shortness of breath, diaphoresis, palpitations, unusual fatigue, and nausea or vomiting	ACS: >15 min	ACS: Emotional upset or unusual physical exertion occurring within 24 h of symptom onset Can occur at rest or while asleep	ACS: Morphine, reperfusion of coronary artery with thrombolytic (fibrinolytic) agent or percutaneous coronary intervention
Pericarditis 	Sharp, severe substernal or epigastric pain Can radiate to neck, arms, and back Associated symptoms include fever, malaise, dyspnea, cough, nausea, dizziness, and palpitations	Intermittent	Sudden onset Pain increases with inspiration, swallowing, coughing, and rotation of trunk	Sitting upright, analgesia, anti-inflammatory medications
Pulmonary Disorders (pneumonia, pulmonary embolism) 	Sharp, severe substernal or epigastric pain arising from inferior portion of pleura (referred to as pleuritic pain) Patient may be able to localize the pain	≥30 min	Follows an infectious or noninfectious process (MI, cardiac surgery, cancer, immune disorders, uremia) Pleuritic pain increases with inspiration, coughing, movement, and supine positioning Occurs in conjunction with community- or hospital-acquired lung infections (pneumonia) or venous thromboembolism (pulmonary embolism)	Treatment of underlying cause



ACS, acute coronary syndrome; MI, myocardial infarction.
Adapted from Bickley, L. S. (2013). Bates' guide to physical examination and history taking (11th ed.). Philadelphia, PA: Lippincott Williams & Wilkins; Radeva, S., & Cannon, M. J. (2018). Chest pain. If it is not the heart, what is it? Nursing Clinics of North America, 53(3), 421–431; Zipes, D. P., Libby, P., Bonow, R. O., et al. (2019). Braunwald's heart disease: A textbook of cardiovascular medicine (11th ed.). Philadelphia, PA: Elsevier.

Patients recovering from ACS, including coronary stent placement or coronary artery bypass graft (CABG), are commonly prescribed dual antiplatelet therapy (DAPT). DAPT means that two antiplatelet drugs are prescribed for the patient. Aspirin, an OTC antiplatelet medication, is often prescribed for life. In addition, a second antiplatelet P2Y12 inhibitor medication (clopidogrel, prasugrel, or ticagrelor) is prescribed for 1 to 12 months, depending upon a variety of factors, including the patient's diagnosis and the type of procedure done (see Chapter 23 for further discussion of ACS treatment and pharmacologic management) (Levine, Bates, Bittl, et al., 2016). During a careful medication history, the nurse reinforces the necessity for adherence to the medication regimen.

Nutrition

Dietary modifications, exercise, weight loss, and careful monitoring are important strategies for managing three major cardiovascular risk factors: hyperlipidemia, hypertension, and diabetes. Diets that are restricted in sodium,

fat, cholesterol, or calories are commonly prescribed. The nurse obtains the following information:

- The patient's current height and weight (to determine body mass index [BMI]); waist measurement; BP; and any laboratory test results such as blood glucose, glycosylated hemoglobin (diabetes), total blood cholesterol, HDL and LDL levels, and triglyceride levels (hyperlipidemia)
- How often the patient self-monitors BP, blood glucose, and weight as appropriate to the medical diagnoses
- The patient's level of awareness regarding their target goals for each of the risk factors and any problems achieving or maintaining these goals
- What the patient normally eats and drinks in a typical day and any food preferences (including cultural or ethnic preferences)
- Eating habits (canned or commercially prepared foods vs. fresh foods, restaurant meals vs. home cooking, assessing for high-sodium foods, dietary intake of fats)
- Who shops for groceries and prepares meals

Chart 21-1 **GENETICS IN NURSING PRACTICE**

Cardiovascular Disorders

Several cardiovascular disorders are associated with genetic abnormalities. Some examples are:

- Arrhythmogenic right ventricular dysplasia (ARVD)
- Brugada syndrome
- Familial hypercholesterolemia
- Hypertrophic cardiomyopathy
- Long QT syndrome
    - Jervell and Lange-Nielsen syndrome (autosomal recessive form)
    - Romano–Ward syndrome (autosomal dominant form)
    - Genetic connective tissue disorders that impact the cardiovascular system:
- Ehlers–Danlos syndrome
- Loeys–Dietz syndrome
- Marfan syndrome

Genetic blood disorders that can impair the function of the cardiovascular system:

- Factor V Leiden
- Hemochromatosis
- Sickle cell disease

Nursing Assessments

Refer to Chapter 4, Chart 4-2: Genetics in Nursing Practice: Genetic Aspects of Health Assessment

Family History Assessment Specific to Cardiovascular Disorders

- Assess all patients with cardiovascular symptoms for coronary artery disease, regardless of age.
- Inquire about a family history of sudden death or unexplained death.
- Ask about other family members with biochemical or neuromuscular conditions (e.g., hemochromatosis or muscular dystrophy).

Patient Assessment Specific to Cardiovascular Disorders

- Assess for signs and symptoms of hyperlipidemias (xanthomas, corneal arcus, or abdominal pain of unexplained

origin).
- Obtain an electrocardiogram and an echocardiogram.
- Assess for muscular weakness.
- Assess for episodes of shortness of breath, dizziness, or palpitations.
- Review laboratory data for abnormal values.
- Gather dietary history.
- Assess for secondary risk factors (e.g., diet, smoking, overweight, high stress, alcohol use).

Elimination

Typical bowel and bladder habits need to be identified. Nocturia (awakening at night to urinate) is common in patients with HF. Fluid collected in gravity-dependent tissues (extremities) during the day (i.e., edema) redistributes into the circulatory system once the patient is recumbent at night. The increased circulatory volume is excreted by the kidneys (increased urine production).

When straining during defecation, the patient bears down (the Valsalva maneuver), which momentarily increases pressure on the baroreceptors. This triggers a vagal response, causing the heart rate to slow and resulting in syncope in some patients. Straining during urination can produce the same response.

Because many cardiac medications can cause gastrointestinal side effects or bleeding, the nurse asks about bloating, diarrhea, constipation, stomach upset, heartburn, loss of appetite, nausea, and vomiting. Screening for bloody urine or stools should be done for patients taking antiplatelet medications (aspirin, clopidogrel, prasugrel, ticagrelor), platelet aggregation inhibitors (abciximab, eptifibatide, tirofiban), or anticoagulants (low-molecular-weight heparins such as dalteparin or enoxaparin; heparin; or oral anticoagulants such as warfarin, rivaroxaban, or apixaban).

Activity and Exercise

Changes in the patient's activity tolerance are often gradual and may go unnoticed. The nurse determines if there are recent changes by comparing the patient's current activity level with that performed in the past 6 to 12 months. New symptoms or a change in the usual symptoms during activity is a significant finding. Activity-induced angina or shortness of breath may indicate CAD. These CAD-related symptoms occur when myocardial ischemia is present, due to an inadequate arterial blood supply to the myocardium, in the setting of increased demand (e.g., exercise, stress, or anemia). Patients experiencing these kinds of symptoms need to seek medical attention. Fatigue, associated with a low left ventricular ejection fraction (less than 40%) and

certain medications (e.g., beta-adrenergic–blocking agents), can result in activity intolerance. Patients with fatigue may benefit from having their medications adjusted and learning energy conservation techniques.

Additional areas to explore include the presence of architectural barriers in the home (stairs, multilevel home); the patient's participation in cardiac rehabilitation; and his or her current exercise pattern including intensity, duration, and frequency.

Sleep and Rest

Clues to worsening cardiac disease, especially HF, can be revealed by sleep-related events. Patients with worsening HF often experience *orthopnea,* a term used to indicate the need to sit upright or stand to avoid feeling short of breath. Patients experiencing orthopnea will report that they need to sleep upright in a chair or add extra pillows to their bed. Sudden awakening with shortness of breath, called *paroxysmal nocturnal dyspnea,* is an additional symptom of worsening HF. This nighttime symptom is caused by the reabsorption of fluid from dependent areas of the body (arms and legs) back into the circulatory system within hours of lying in bed. This sudden fluid shift increases preload and places increased demand on the heart of patients with HF, causing sudden pulmonary congestion.

Sleep-disordered breathing (SDB) is an abnormal respiratory pattern due to intermittent episodes of upper airway obstruction causing apnea and hypopnea (shallow respirations) during sleep. These abnormal sleep events cause intermittent hypoxemia, sympathetic nervous system activation, and increased intrathoracic pressure that puts mechanical stress on the heart and large artery walls. SDB impacts the length and quality of sleep. Short sleep duration (less than 7 hours per night) and poor sleep quality (interrupted sleep) are associated with the cardiovascular risks of hypertension, atherosclerosis, CAD, and stroke (Domínguez, Fuster, Fernández-Alvira, et al., 2019). Untreated SDB is also linked to HF and arrhythmias. Obstructive sleep apnea (OSA) is a type of SDB that is treated by the use of continuous positive airway pressure (CPAP), although many patients have difficulty with CPAP adherance. Other treatment options include weight loss, positional therapy, mandibular advancement devices (MADs), oral appliances, or surgery (Won, Mohsenin, & Kryger, 2018; see Chapter 18 for further discussion of OSA, including risks).

During the health history, the nurse assesses for SDB by asking patients at risk if they snore loudly, have frequent bouts of awaking from sleep, awaken with a headache, or experience hypersomnolence (severe daytime sleepiness). For patients with a diagnosis of SDB or OSA, the nurse determines if the patient has been prescribed a CPAP, MAD, or oral appliance, and the frequency of its use. Patients who are being admitted to the hospital or going for an ambulatory surgical procedure should be instructed to bring their sleep aid devices with them.

Self-Perception and Self-Concept

Self-perception and self-concept are both related to the cognitive and emotional processes that people use to formulate their beliefs and feelings about themselves. Having a chronic cardiac illness, such as HF, or experiencing an acute cardiac event, such as an MI, can alter a person's self-perception and self-concept. Patients' beliefs and feelings about their health are key determinants of adherence to self-care recommendations and recovery after an acute cardiac event. To reduce the risk of future cardiovascular-related health problems, patients are asked to make difficult lifestyle changes, such as quitting smoking. Patients who have misperceptions about the health consequences of their illness are at risk for nonadherence to these recommended lifestyle changes. The health history is used to discover how patients perceive their health by asking questions that may include the following:

- What is your cardiac condition?
- How has this illness changed your feelings about your health?
- What do you think caused this illness?
- What consequences do you think this illness will have on your physical activity, work, social relationships, and role in your family?
- How much of an influence do you think you have on controlling this illness?

The patient's responses to these questions can guide the nurse in planning interventions to ensure that the patient is prepared to manage the illness and that adequate services are in place to support the patient's recovery and self-care needs.

Roles and Relationships

Patients with CVD are being managed with complex medical regimens and sophisticated technology, such as implantable cardioverter defibrillators (ICDs) and left ventricular assist devices. Hospital stays for cardiac disorders have shortened. Many invasive diagnostic cardiac procedures, such as cardiac catheterization, are being performed in the ambulatory setting. Support from family members helps to lessen the patient's burden of managing self-care for cardiac illnesses. Social support is closely linked to patient depression and CVD outcomes. Patients who are depressed and who have poor social support have an increased risk of poor cardiac outcomes (Kim, Kang, Bae, et al., 2019).

To assess patients' roles in their families and their relationships, both components of social support, the nurse asks each patient: Who do you live with? Who is your primary caregiver at home? Who helps you manage your health? The nurse also assesses for any significant effects that the cardiac illness has had on the patient's role in the family. Are there adequate finances

and health insurance? The answers to these questions help the nurse determine if consultation with social services or others is necessary to tailor the plan of care to meet the patient's self-care needs.

Sexuality and Reproduction

Sexual dysfunction affects twice as many people with CVD compared with the general population. Depression, anxiety, erectile dysfunction, and major cardiac events such as an MI are common reasons that patients report decreased sexual activity. Patients and their partners are concerned about the effects of physical exertion on the heart and if the activity may cause another heart attack, sudden death, or untoward symptoms such as angina, dyspnea, or palpitations. Couples often lack adequate information about the physical demands related to sexual activity, which is considered a low-intensity exercise. The nurse can help patients by initiating discussions about sexuality and encouraging them to discuss problems with their primary provider or cardiologist. The exercise and counseling provided in cardiac rehabilitation programs may also improve sexual activity (Boothby, Dada, Rabi, et al., 2018).

Chart 21-2 **NURSING RESEARCH PROFILE**

Depression, Self-Efficacy, and Physical Activity among Patients with Coronary Artery Disease

Siow, E., Leung, D. Y., Wong, E. M., et al. (2018). Do depressive symptoms moderate the effects of exercise self-efficacy on physical activity among patients with coronary heart disease? *Journal of Cardiovascular Nursing*, *33*(4), e26–e34.

Purpose

Physical activity and exercise can reduce cardiac complications in patients with coronary artery disease (CAD). Patients with higher levels of self-efficacy are more likely to start and maintain an exercise program. Patients with CAD are also at risk for developing depression, which can lead to isolation and low activity levels. Therefore, the purpose of this study was to examine the relationship between the symptoms of depression, exercise self-efficacy, and physical activity among patients with CAD. The nurse researchers also explored if depression could impact the relationship between exercise self-efficacy and physical activity in this population.

Design

A cross-sectional, exploratory study was conducted with adult participants with CAD who were hospitalized in an emergency medicine or general medical unit. This study was performed at two hospitals in Hong Kong. The nurse researchers conducted a survey interview with 149 participants before discharge from the hospital. Participants completed a survey with questions about their socioeconomic status, current level of physical activity, self-efficacy about exercise, and symptoms of depression. Participants were then asked about their physical activity using the Godin–Shephard Leisure-Time Physical Activity questionnaire, about exercise self-efficacy using the Self-Efficacy for Exercise scale, and about depression using the Centre for Epidemiological Studies-Depression tool. Other information such as body mass index (BMI), medical diagnosis, and how many times participants were admitted to the hospital was obtained from the hospital records.

Findings

Most participants in this study were older adults with a mean age of 73 ±13 years, were male, married, living with family, and had a lower socioeconomic status. Approximately 50% of this sample had a normal BMI, and over half did some level of exercise. Participants with greater exercise self-efficacy were more likely to engage in physical activity. However, this relationship was stronger among participants with symptoms of depression. Participants who were depressed reported lower levels of self-efficacy and engaging in less physical activity.

Nursing Implications

The results of this study demonstrate the importance of assessing self-efficacy, physical activity, and depression among patients with CAD. It is

important to intervene and educate patients about lifestyle changes that improve exercise self-efficacy. Improving this level of confidence can help patients who are depressed start or increase their level of physical activity, which may improve cardiovascular health.

A reproductive history is necessary for women of childbearing age, particularly those with seriously compromised cardiac function. The reproductive history includes information about previous pregnancies, plans for future pregnancies, oral contraceptive use (especially in women older than 35 years who smoke), menopausal status, and the use of HT. Women who have a history of preeclampsia during pregnancy, preterm labor, or giving birth to an infant that was small for gestational age have a higher risk for developing CVD (Lane-Cordova, Khan, Grobman, et al., 2019).

Coping and Stress Tolerance

Anxiety, depression, and stress are known to influence both the development of and recovery from CAD and HF. Depression is twice as prevalent in women compared to men and has a negative impact on quality of life and overall prognosis. Patients who are depressed are more likely to be readmitted to the hospital after having a heart attack. The risk of depression is lower if the patient has relationship and work stability, a higher educational level, a healthy lifestyle, and the absence of comorbidities such as diabetes. Although the association between depression and CAD is not completely understood, biologic factors (e.g., platelet abnormalities, inflammatory responses, insulin resistance), lifestyle factors (e.g., diet, exercise, smoking), and behavioral factors (e.g., substance abuse, unemployment, social isolation) contribute to this link. Patients who are depressed are less motivated to adhere to follow-up appointments, take prescribed medications, or make recommended lifestyle changes such as smoking cessation, losing weight, exercising, or participating in cardiac rehabilitation (Jha, Qamar, Vaduganathan, et al., 2019; Vaccarino, Badimon, Bremner, et al., 2019; Yuan, Fang, Liu, et al., 2019). See Chart 21-2 for a Nursing Research Profile on depression, self-efficacy, and physical activity.

Patients with CAD or HF should be assessed for depression. Patients who have depression exhibit common signs and symptoms, such as feelings of worthlessness or guilt, problems falling asleep or staying asleep, having little interest or pleasure in doing things that they usually enjoy, having difficulty concentrating, restlessness, and recent changes in appetite or weight. The Patient Health Questionnaire (PHQ-2) is a two-question self-reported patient assessment tool recommended by the AHA. The nurse asks the patient:

- *Do you have little interest or pleasure in doing things over the last 2 weeks?*
- *Are you feeling down, depressed or hopeless over the last 2 weeks?*

The nurse scores the patient's responses to each question by assigning 0 for "not at all," 1 for "several days," 2 for "more than half the days," or 3 for "nearly every day." The PHQ-2 score ranges from 0 to 6. Patients with a positive score greater than or equal to 3 complete a focused screening called the PHQ-9 and are referred to their primary providers for further evaluation (Jha et al., 2019).

Stress initiates a variety of responses, including increased levels of catecholamines and cortisol, and has been strongly linked to cardiovascular events, such as an MI. Therefore, patients need to be assessed for sources of stress; the nurse asks about recent or ongoing stressors, previous coping styles and effectiveness, and the patient's perception of their current mood and coping ability. A widely used tool used to measure life stress is the Social Readjustment Rating Scale (Homes & Rahe, 1967). Examples of items on this scale include death of a spouse, divorce, and change in responsibilities at work. Each item is assigned a score of 11 to 100. Patients identify the items that happened to them in the previous year. Patients with a score less than 150 have a slight risk for future illness, whereas a score of 150 to 299 indicates a moderate risk. A score of 300 or higher indicates a high risk for future illness. Consultation with a psychiatric advanced practice nurse, psychologist, psychiatrist, or social worker is indicated for patients who are anxious or depressed or for patients who are having difficulty coping with their cardiac illness.

Physical Assessment

Physical assessment is conducted to confirm information obtained from the health history, to establish the patient's current or baseline condition, and, in subsequent assessments, to evaluate the patient's response to treatment. Once the initial physical assessment is completed, the frequency of future assessments is determined by the purpose of the encounter and the patient's condition. For example, a focused cardiac assessment may be performed each time the patient is seen in the outpatient setting, whereas patients in the acute care setting may require a more extensive assessment at least every 8 hours. During the physical assessment, the nurse evaluates the cardiovascular system for any deviations from normal with regard to the following (examples of abnormalities are in parentheses):

- The heart as a pump (reduced pulse pressure, displaced PMI from fifth intercostal space midclavicular line, gallop sounds, murmurs)
- Atrial and ventricular filling volumes and pressures (elevated jugular venous distention, peripheral edema, ascites, crackles, postural changes in BP)

- Cardiac output (reduced pulse pressure, hypotension, tachycardia, reduced urine output, lethargy, or disorientation)
- Compensatory mechanisms (peripheral vasoconstriction, tachycardia)

General Appearance

This part of the assessment evaluates the patient's level of consciousness (alert, lethargic, stuporous, comatose) and mental status (oriented to person, place, time; coherence). Changes in level of consciousness and mental status may be attributed to inadequate perfusion of the brain from a compromised cardiac output or thromboembolic event (stroke). Patients are observed for signs of distress, which include pain or discomfort, shortness of breath, or anxiety.

The nurse notes the size of the patient (normal, overweight, underweight, or cachectic). The patient's height and weight are measured to calculate BMI, as well as the waist circumference (see Chapter 4). These measures are used to determine if obesity (BMI greater than 30 kg/m^2) and abdominal fat (males: waist greater than 40 inches; females: waist greater than 35 inches) are placing the patient at risk for CAD.

Assessment of the Skin and Extremities

Examination of the skin includes all body surfaces, starting with the head and finishing with the lower extremities. Skin color, temperature, and texture are assessed for acute and chronic problems with arterial or venous circulation. Table 21-3 summarizes common skin and extremity assessment findings in patients with CVD. The most noteworthy changes include the following:

- Signs and symptoms of acute obstruction of arterial blood flow in the extremities, referred to as the six *P*s, are *p*ain, *p*allor, *p*ulselessness, *p*aresthesia, *p*oikilothermia (coldness), and *p*aralysis. During the first few hours after invasive cardiac procedures (e.g., cardiac catheterization, percutaneous coronary intervention [PCI], or cardiac electrophysiology testing), affected extremities should be assessed frequently for these acute vascular changes.
- Major blood vessels of the arms and legs may be used for catheter insertion. During these procedures, systemic anticoagulation with heparin is necessary, and bruising or small hematomas may occur at the catheter access site. However, large hematomas are a serious complication that can compromise circulating blood volume and cardiac output. Patients who have undergone these procedures must have catheter access sites frequently observed until hemostasis is adequately achieved.
- Edema of the feet, ankles, or legs is called *peripheral edema.* Edema can be observed in the sacral area of patients on bed rest. The nurse assesses the patient for edema by using the thumb to place firm

pressure over the dorsum of each foot, behind each medial malleolus, over the shins or sacral area for 5 seconds. *Pitting edema* is the term used to describe an indentation in the skin created by this pressure (see Chapter 25, Fig. 25-2). The degree of pitting edema relies on the clinician's judgment of depth of edema and time the indentation remains after release of pressure. Pitting edema is graded as absent (0) or as present on a scale from trace (1+ ≤0.25 inch) to severe (4+ ≥1 inch) (Urden, Stacy, & Lough, 2017). It is important that clinicians use a consistent scale in order to ensure reliable clinical measurements and management. Peripheral edema is a common finding in patients with HF and peripheral vascular diseases, such as deep vein thrombosis or chronic venous insufficiency.

  - Prolonged capillary refill time indicates inadequate arterial perfusion to the extremities. To test capillary refill time, the nurse compresses the nail bed briefly to occlude perfusion and the nail bed blanches. Then, the nurse releases pressure and determines the time it takes to restore perfusion. Normally, reperfusion occurs within 2 seconds, as evidenced by the return of color to the nail bed. Prolonged capillary refill time indicates compromised arterial perfusion, a problem associated with cardiogenic shock and HF.
  - Clubbing of the fingers and toes indicates chronic hemoglobin desaturation and is associated with congenital heart disease.

- Hair loss, brittle nails, dry or scaling skin, atrophy of the skin, skin color changes, and ulcerations are indicative of chronically reduced oxygen and nutrient supply to the skin observed in patients with arterial or venous insufficiency (see Chapter 26 for a complete description of these conditions) (Weber & Kelley, 2018).

TABLE 21-3 Common Assessment Findings Associated with Cardiovascular Disease

Assessment Findings	Associated Causes and Conditions
Clubbing of the fingers or toes (thickening of the skin under the fingers or toes)	Chronic hemoglobin desaturation most often due to congenital heart disease, advanced pulmonary diseases
Cool/cold skin and diaphoresis	Low cardiac output (e.g., cardiogenic shock, acute myocardial infarction) causing sympathetic nervous system stimulation with resultant vasoconstriction
Cold, pain, pallor of the fingertips or toes	Intermittent arteriolar vasoconstriction (Raynaud disease). Skin may change in color from white, blue, and red accompanied by numbness, tingling, and burning pain
Cyanosis, central (a bluish tinge observed in the tongue and buccal mucosa)	Serious cardiac disorders (pulmonary edema, cardiogenic shock, congenital heart disease) result in venous blood passing through the pulmonary circulation without being oxygenated
Cyanosis, peripheral (a bluish tinge, most often of the nails and skin of the nose, lips, earlobes, and extremities)	Peripheral vasoconstriction, allowing more time for the hemoglobin molecules to become desaturated. It can be caused by exposure to cold environment, anxiety, or ↓ cardiac output
Ecchymosis or bruising (a purplish-blue color fading to green, yellow, or brown)	Blood leaking outside of the blood vessels Excessive bruising is a risk for patients on anticoagulants or platelet-inhibiting medications
Edema, lower extremities (collection of fluid in the interstitial spaces of the tissues)	Heart failure and vascular problems (PAD, chronic venous insufficiency, deep vein thrombosis, thrombophlebitis)
Hematoma (localized collection of clotted blood in the tissue)	Bleeding after catheter removal/tissue injury in patients on anticoagulant/antithrombotic agents
Pallor (↓ skin color in fingernails, lips, oral mucosa, and lower extremities)	Anemia or ↓ arterial perfusion. Suspect PAD if feet develop pallor after elevating legs 60 degrees from a supine position
Rubor (a reddish-blue discoloration of the legs, seen within 20 s to 2 min after placing in a dependent position)	Filling of dilated capillaries with deoxygenated blood, indicative of PAD
Ulcers, feet and ankles: Superficial, irregular ulcers at medial malleolus. Red to yellow granulation tissue	Rupture of small skin capillaries from chronic venous insufficiency
Ulcers, feet and ankles: Painful, deep, round ulcers on feet or from exposure to pressure. Pale to black wound base	Prolonged ischemia to tissues due to PAD. Can lead to gangrene
Thinning of skin around a cardiac implantable electronic device	Erosion of the device through the skin

Xanthelasma (yellowish, raised plaques observed along nasal portion of eyelids)	Elevated cholesterol levels (hypercholesterolemia)

PAD, peripheral arterial disease.

Adapted from Bickley, L. S. (2017). *Bates' guide to physical examination and history taking* (12th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Blood Pressure

Systemic arterial BP is the pressure exerted on the walls of the arteries during ventricular systole and diastole. It is affected by factors such as cardiac output; distention of the arteries; and the volume, velocity, and viscosity of the blood. A normal adult BP is considered a systolic BP less than 120 mm Hg over a diastolic BP less than 80 mm Hg. High BP, called **hypertension,** is defined in two stages and is based upon BP taken on at least two instances. Stage 1 hypertension is a systolic BP between 130 and 139 mm Hg or a diastolic BP between 80 and 89 mm Hg. Stage 2 hypertension is a systolic BP over 140 mm Hg or a diastolic over 90 mm Hg (Whelton, Carey, Aronow, et al., 2018). **Hypotension** refers to an abnormally low systolic and diastolic BP that can result in lightheadedness or fainting. (See Chapter 27 for additional definitions, measurement, and management.)

Pulse Pressure

The difference between the systolic and the diastolic pressures is called the *pulse pressure.* A normal pulse pressure is 40 mm Hg. A narrow pulse pressure (e.g., BP of 92/74 mm Hg and pulse pressure of 18 mm Hg) occurs when there is vasoconstriction that is compensating for a low stroke volume and ejection velocity (shock, HF, hypovolemia, mitral regurgitation) or obstruction to blood flow during systole (mitral or aortic stenosis). This compensation allows for adequate organ perfusion. A wide pulse pressure (e.g., BP of 88/38 mm Hg and pulse pressure of 50 mm Hg) is associated with conditions that elevate the stroke volume (anxiety, exercise, bradycardia), or cause vasodilation (fever, septic shock). Abnormal pulse pressures require further cardiovascular assessment (Urden et al., 2017).

Orthostatic (Postural) Blood Pressure Changes

There is a gravitational redistribution of approximately 500 mL of blood into the lower extremities immediately upon standing. This venous pooling reduces blood return to the heart, compromising preload that ultimately reduces stroke volume and cardiac output. As a consequence, the autonomic nervous system is activated. The sympathetic nervous system increases heart rate and enhances peripheral vasoconstriction, whereas parasympathetic activity of the heart via the vagus nerve is decreased. This stabilization occurs within 1 minute (Ricci, De Caterina, & Fedorowski, 2015).

Normal postural responses that occur when a person moves from a lying to a standing position include (1) a heart rate increase of 5 to 20 bpm above the resting rate; (2) an unchanged systolic pressure, or a slight decrease of up to 10 mm Hg; and (3) a slight increase of 5 mm Hg in diastolic pressure.

Orthostatic (postural) hypotension is a sustained decrease of at least 20 mm Hg in systolic BP or 10 mm Hg in diastolic BP within 3 minutes of moving from a lying or sitting to a standing position. It is usually accompanied by dizziness, lightheadedness, or syncope. The risk of orthostatic hypotension increases with age and is associated with fall risk (Ricci et al., 2015).

Orthostatic hypotension in patients with CVD is most often due to a significant reduction in preload, which compromises cardiac output. Reduced preload, which is reflective of intravascular volume depletion, is caused by dehydration from overdiuresis, bleeding (due to antiplatelet or anticoagulant medications or post intravascular procedures), or medications that dilate the blood vessels (e.g., nitrates and antispasmodic agents). In these situations, the usual mechanisms needed to maintain cardiac output (increased heart rate and peripheral vasoconstriction) cannot compensate for the significant loss in intravascular volume. As a result, the BP drops and heart rate increases with changes from lying or sitting to upright positions (Chart 21-3).

The following is an example of BP and heart rate measurements in a patient with orthostatic hypotension:

Supine: BP 120/70 mm Hg, heart rate 70 bpm
Sitting: BP 100/55 mm Hg, heart rate 90 bpm
Standing: BP 98/52 mm Hg, heart rate 94 bpm

Arterial Pulses

The arteries are palpated to evaluate the pulse rate, rhythm, amplitude, contour, and obstruction to blood flow.

Pulse Rate

The normal pulse rate varies from a low of 50 bpm in healthy, athletic young adults to rates well in excess of 100 bpm after exercise or during times of excitement. Anxiety can raise the pulse rate during the physical examination. If the rate is higher than expected, the nurse should reassess the pulse near the end of the physical examination, when the patient may be more relaxed.

Chart 21-3 **ASSESSMENT**

Assessing Patients for Orthostatic Hypotension

The following steps are recommended when assessing patients for orthostatic hypotension:

- Position the patient supine for 10 minutes before taking the initial blood pressure (BP) and heart rate measurements.
- Reposition the patient to a sitting position with legs in the dependent position, wait 2 minutes, then reassess both BP and heart rate measurements.
- If the patient is symptom free or has no significant decreases in systolic or diastolic BP, assist the patient into a standing position, obtain measurements immediately, and recheck in 2 minutes; continue measurements every 2 minutes for a total of 10 minutes to rule out orthostatic hypotension.
- Return the patient to a supine position if orthostatic hypotension is detected or if the patient becomes symptomatic.
- Document heart rate and BP measured in each position (e.g., supine, sitting, standing) and any signs or symptoms that accompany the postural changes.

Adapted from Momeyer, M. A., & Mion, L. C. (2018). Orthostatic hypotension: An often overlooked risk factor for falls. *Geriatric Nursing*, *39*(4), 483–486; Urden, L. D., Stacy, K. M., & Lough, M. E. (2017). *Critical care nursing: Diagnosis and management* (8th ed.). St. Louis, MO: Elsevier Mosby.

Pulse Rhythm

The rhythm of the pulse is normally regular. Minor variations in regularity of the pulse may occur with respirations. The pulse rate may increase during inhalation and slow during exhalation due to changes in blood flow to the heart during the respiratory cycle. This phenomenon, called *sinus arrhythmia,* occurs most commonly in children and young adults.

For the initial cardiac examination, or if the pulse rhythm is irregular, the heart rate should be counted by auscultating the apical pulse, located at the PMI, for a full minute while simultaneously palpating the radial pulse. Any discrepancy between contractions heard and pulses felt is noted. Disturbances of rhythm (arrhythmias) often result in a **pulse deficit,** which is a difference between the apical and radial pulse rates. Pulse deficits commonly occur with atrial fibrillation, atrial flutter, and premature ventricular contractions. These arrhythmias stimulate the ventricles to contact prematurely, before diastole is finished. As a result, these early ventricular contractions produce a smaller stroke volume, which can be heard during auscultation but do not produce a palpable pulse (see Chapter 22 for a detailed discussion of these arrhythmias).

Pulse Amplitude

The pulse amplitude, indicative of the BP in the artery, is used to assess peripheral arterial circulation. The nurse assesses pulse amplitude bilaterally and describes and records the amplitude of each artery. The simplest method characterizes the pulse as absent, diminished, normal, or bounding. Scales are also used to rate the strength of the pulse. The following is an example of a 0 to 4 scale:

0: Not palpable or absent
+1: Diminished—weak, thready pulse; difficult to palpate; obliterated with pressure
+2: Normal—cannot be obliterated
+3: Moderately increased—easy to palpate, full pulse; cannot be obliterated
+4: Markedly increased—strong, bounding pulse; may be abnormal

The numerical classification is subjective; therefore, when documenting the pulse amplitude, specify location of the artery and scale range (e.g., "left radial +3/+4") (Weber & Kelley, 2018).

If the pulse is absent or difficult to palpate, the nurse can use a continuous wave Doppler. This portable ultrasound device has a transducer that is placed over the artery. The transducer emits and receives ultrasound beams. Rhythmic changes are heard as blood cells flow through patent arteries, whereas obstruction to blood flow is evidenced by no changes in sound. (Ultrasound techniques are discussed in more detail in Chapter 26.)

Pulse Contour

The contour of the pulse conveys important information. In patients with stenosis of the aortic valve, the valve opening is narrowed, reducing the amount of blood ejected into the aorta. The pulse pressure is narrow, and the pulse feels feeble. In aortic insufficiency, the aortic valve does not close completely, allowing blood to flow back from the aorta into the left ventricle. The rise of the pulse wave is abrupt and strong, and its fall is precipitous—a "collapsing" or "water hammer" pulse. The true contour of the pulse is best appreciated by palpating over the carotid artery rather than the distal radial artery, because the dramatic characteristics of the pulse wave may be distorted when the pulse is transmitted to smaller vessels.

Palpation of Arterial Pulses

To assess peripheral circulation, the nurse locates and evaluates all arterial pulses. Arterial pulses are palpated at points where the arteries are near the skin surface and are easily compressed against bones or firm musculature. Pulses are detected over the right and left temporal, common carotid, brachial, radial, femoral, popliteal, dorsalis pedis, and posterior tibial arteries (see Chapter 26, Fig. 26-2). A reliable assessment of the pulses depends on accurate identification of the location of the artery and careful palpation of the

area. Light palpation is essential; firm finger pressure can obliterate the temporal, dorsalis pedis, and posterior tibial pulses and confuse the examiner. In approximately 10% of patients, the dorsalis pedis pulses are not palpable (Sidawy & Perler, 2019). In such circumstances, both are usually absent and the posterior tibial arteries alone provide adequate blood supply to the feet. Arteries in the extremities are often palpated simultaneously to facilitate comparison of quality.

Quality and Safety Nursing Alert

Do not simultaneously palpate both the temporal and carotid arteries, because it is possible to decrease the blood flow to the brain.

Jugular Venous Pulsations

Right-sided heart function can be estimated by observing the pulsations of the jugular veins of the neck, which reflects central venous pressure (CVP). CVP is the pressure in the right atria or the right ventricle at the end of diastole. If the internal jugular pulsations are difficult to see, pulsations of the external jugular veins may be noted. These veins are more superficial and are visible just above the clavicles, adjacent to the sternocleidomastoid muscles.

In patients with euvolemia (normal blood volume), the jugular veins are normally visible in the supine position with the head of the bed elevated to 30 degrees (Bickley, 2017). Obvious distention of the veins with the patient's head elevated 45 to 90 degrees indicates an abnormal increase in CVP. This abnormality is observed in patients with right-sided HF, due to hypervolemia, pulmonary hypertension, and pulmonary stenosis; less commonly with obstruction of blood flow in the superior vena cava; and rarely with acute massive pulmonary embolism.

Heart Inspection and Palpation

The heart is examined by inspection, palpation, and auscultation of the precordium or anterior chest wall that covers the heart and lower thorax. A systematic approach is used to examine the precordium in the following six areas. Figure 21-5 identifies these important landmarks:

1. *Aortic area*—second intercostal space to the right of the sternum. To determine the correct intercostal space, the nurse first finds the angle of Louis by locating the bony ridge near the top of the sternum, at the junction of the sternum and the manubrium. From this angle, the second intercostal space is located by sliding one finger to the left or right of the

sternum. Subsequent intercostal spaces are located from this reference point by palpating down the rib cage.

2. *Pulmonic area*—second intercostal space to the left of the sternum
3. *Erb point*—third intercostal space to the left of the sternum
4. *Tricuspid area*—fourth and fifth intercostal spaces to the left of the sternum
5. *Mitral (apical) area*—left fifth intercostal space at the midclavicular line
6. *Epigastric area*—below the xiphoid process

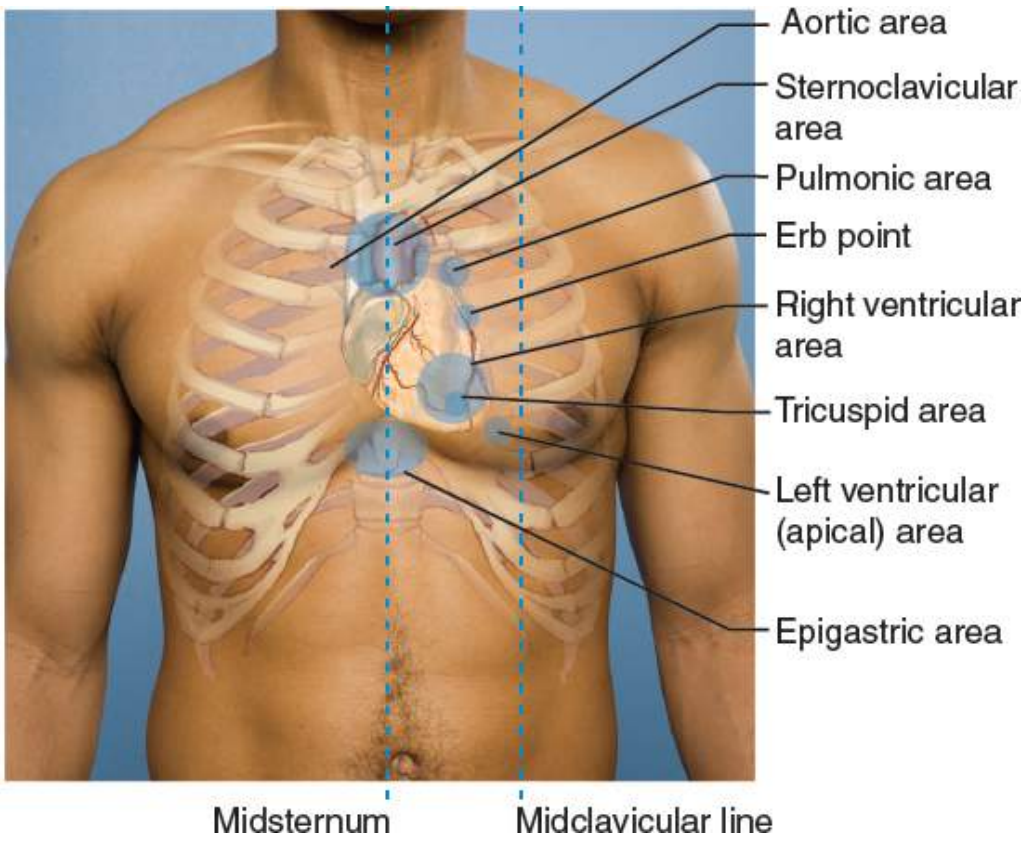


Figure 21-5 • Areas of the precordium to be assessed when evaluating heart function.

Figure 21-6 • Palpating the apical impulse. **A.** Remain on the patient's right side, and ask the patient to remain supine. Use the finger pads to palpate the apical impulse in the mitral area (fifth intercostal space at the midclavicular line). **B.** You may ask the patient to roll to the left side to better feel the impulse using the palmar surfaces of your hand. Photos used with permission from Weber, J. R., & Kelley, J. H. (2018). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

For most of the examination, the patient lies supine, with the head of the bed or the examination table slightly elevated. A right-handed examiner stands at the right side of the patient, a left-handed examiner at the left side.

Each area of the precordium is inspected for pulsations and is then palpated. An apical impulse is a normal finding observed in young patients and adults who have thin chest walls.

The apical impulse may be felt as a light pulsation, 1 to 2 cm in diameter. It is felt at the onset of the first heart sound and lasts for only half of ventricular systole (see the next section for a discussion of heart sounds). The nurse uses the palm of the hand to locate the apical impulse initially and the finger pads to assess its size and quality. Palpation of the apical pulse may be facilitated by repositioning the patient to the left lateral position, which puts the heart in closer contact with the chest wall (Fig. 21-6).

There are several abnormalities that the nurse may find during palpation of the precordium. Normally, the apical impulse is palpable in only one intercostal space; palpability in two or more adjacent intercostal spaces indicates left ventricular enlargement. An apical impulse below the fifth intercostal space or lateral to the midclavicular line usually denotes left ventricular enlargement from left ventricular HF. If the apical impulse can be palpated in two distinctly separate areas and the pulsation movements are paradoxical (not simultaneous), a ventricular aneurysm may be suspected. A broad and forceful apical impulse is known as a left ventricular heave or lift because it appears to lift the hand from the chest wall during palpation.

A vibration or purring sensation may be felt over areas where abnormal, turbulent blood flow is present. It is best detected by using the palm of the

hand. This vibration is called a *thrill* and is associated with a loud murmur. Depending on the location of the thrill, it may be indicative of serious valvular heart disease; an atrial or ventricular septal defect (abnormal opening); or stenosis of a large artery, such as the carotid artery.

Heart Auscultation

A stethoscope is used to auscultate each of the locations identified in Figure 21-5, with the exception of the epigastric area. The purpose of cardiac auscultation is to determine heart rate and rhythm and evaluate heart sounds. The apical area is auscultated for 1 minute to determine the apical pulse rate and the regularity of the heartbeat. Normal and abnormal heart sounds detected during auscultation are described next.

Normal Heart Sounds

Normal heart sounds, referred to as **S_1** and **S_2**, are produced by closure of the AV valves and the semilunar valves, respectively. The period between S_1 and S_2 corresponds with ventricular systole (Fig. 21-7). When the heart rate is within the normal range, systole is much shorter than the period between S_2 and S_1 (diastole). However, as the heart rate increases, diastole shortens.

Normally, S_1 and S_2 are the only sounds heard during the cardiac cycle (Bickley, 2017).

S_1—First Heart Sound

Tricuspid and mitral valve closure creates the first heart sound (S_1). The word "lub" is used to replicate its sound. S_1 is usually heard the loudest at the apical area. S_1 is easily identifiable and serves as the point of reference for the remainder of the cardiac cycle.

The intensity of S_1 increases during tachycardias or with mitral stenosis. In these circumstances, the AV valves are wide open during ventricular contraction. The accentuated S_1 occurs as the AV valves close with greater force than normal. Similarly, arrhythmias can vary the intensity of S_1 from beat to beat due to lack of synchronized atrial and ventricular contraction.

S_2—Second Heart Sound

Closure of the pulmonic and aortic valves produces the second heart sound (S_2), commonly referred to as the "dub" sound. The aortic component of S_2 is heard the loudest over the aortic and pulmonic areas. However, the pulmonic component of S_2 is a softer sound and is heard best over the pulmonic area.

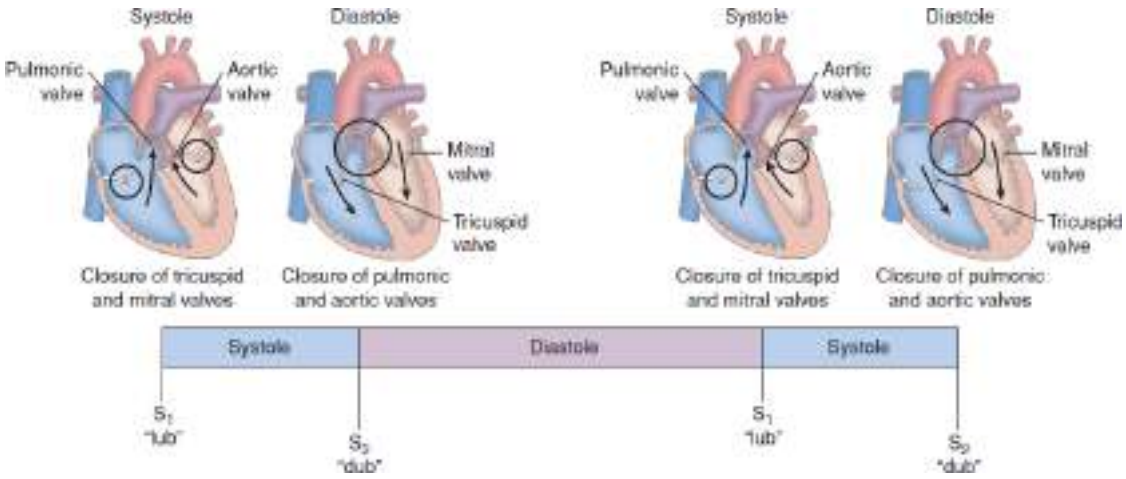


Figure 21-7 • Normal heart sounds. The first heart sound (S_1) is produced by closure of the mitral and tricuspid valves ("lub"). The second heart sound (S_2) is produced by closure of the aortic and pulmonic valves ("dub"). *Arrows* represent the direction of blood flow.

Although these valves close almost simultaneously, the pulmonic valve lags slightly behind the aortic valve. In some individuals, it is possible to distinguish between the closure of the aortic and pulmonic valves. When this situation occurs, the patient is said to have a split S_2. Normal physiologic splitting of S_2 is accentuated on inspiration and disappears on expiration. During inspiration, there is a decrease in intrathoracic pressure and subsequent increase in venous return to the right atrium and ventricle. The right ventricle takes a little longer to eject this extra volume, which causes the pulmonic valve to close a little later than normal. Splitting of S_2 that remains constant during inspiration and expiration is an abnormal finding. Abnormal splitting of the second heart sound can be caused by a variety of disease states (valvular heart disease, septal defects, bundle branch blocks). Splitting of S_2 is best heard over the pulmonic area.

Abnormal Heart Sounds

Abnormal sounds develop during systole or diastole when structural or functional heart problems are present. These sounds are called **S_3** or **S_4** gallops, opening snaps, systolic clicks, and murmurs. S_3 and S_4 gallop sounds are heard during diastole. These sounds are created by the vibration of the ventricle and surrounding structures as blood meets resistance during ventricular filling. The term *gallop* evolved from the cadence that is produced by the addition of a third or fourth heart sound, similar to the sound of a galloping horse. Gallop sounds are very low-frequency sounds and are heard with the bell of the stethoscope placed very lightly against the chest.

S_3—Third Heart Sound

An S_3 ("DUB") is heard early in diastole during the period of rapid ventricular filling as blood flows from the atrium into a noncompliant ventricle. It is heard immediately after S_2. "Lub-dub-DUB" is used to imitate the abnormal sound of a beating heart when an S_3 is present. It represents a normal finding in children and adults up to 35 or 40 years of age. In these cases, it is referred to as a physiologic S_3 (Fig. 21-8). In older adults, an S_3 is a significant finding, suggesting HF. It is best heard with the bell of the stethoscope. If the right ventricle is involved, a right-sided S_3 is heard over the tricuspid area with the patient in a supine position. A left-sided S_3 is best heard over the apical area with the patient in the left lateral position.

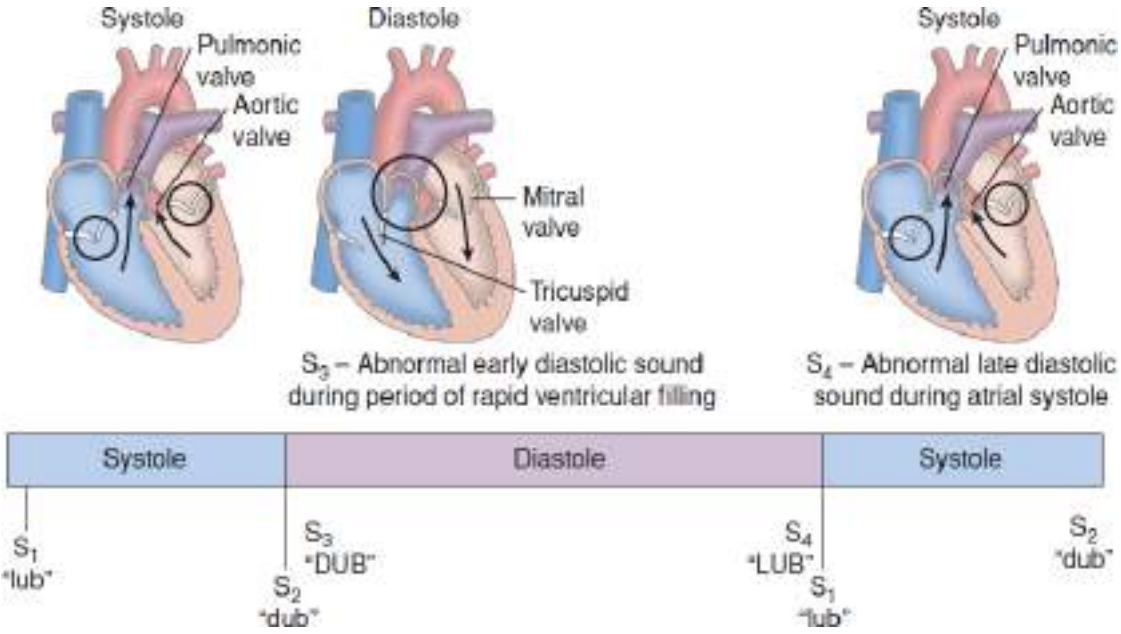


Figure 21-8 • Gallop sounds. An S_3 ("DUB") is an abnormal sound heard immediately following S_2 (closure of semilunar valves). This sound is generated very early in diastole as blood flowing into the right or left ventricle is met with resistance. S_4 ("LUB") is an abnormal sound created during atrial systole as blood flowing into the right or left ventricle is met with resistance. *Arrows* represent the direction of blood flow.

S_4—Fourth Heart Sound

S_4 ("LUB") occurs late in diastole (see Fig. 21-8). S_4 heard just before S_1 is generated during atrial contraction as blood forcefully enters a noncompliant ventricle. This resistance to blood flow is due to ventricular hypertrophy caused by hypertension, CAD, cardiomyopathies, aortic stenosis, and numerous other conditions. "LUB lub-dub" is the mnemonic used to imitate

this gallop sound. S_4, produced in the left ventricle, is auscultated using the bell of the stethoscope over the apical area with the patient in the left lateral position. A right-sided S_4, although less common, is heard best over the tricuspid area with the patient in supine position. There are times when both S_3 and S_4 are present, creating a quadruple rhythm, which sounds like "LUB lub-dub DUB." During tachycardia, all four sounds combine into a loud sound, referred to as a **summation gallop**.

Opening Snaps and Systolic Clicks

Normally, no sound is produced when valves open. However, diseased valve leaflets create abnormal sounds as they open during diastole or systole. **Opening snaps** are abnormal diastolic sounds heard during opening of an AV valve. For example, mitral stenosis can cause an opening snap, which is an unusually high-pitched sound very early in diastole. This sound is caused by high pressure in the left atrium that abruptly displaces or "snaps" open a rigid valve leaflet. Timing helps to distinguish an opening snap from the other gallop sounds. It occurs too long after S_2 to be mistaken for a split S_2 and too early in diastole to be mistaken for an S_3. The high-pitched, snapping quality of the sound is another way to differentiate an opening snap from an S_3. Hearing a murmur or the sound of turbulent blood flow is expected following the opening snap. An opening snap is heard best using the diaphragm of the stethoscope placed medial to the apical area and along the lower left sternal border.

In a similar manner, stenosis of one of the semilunar valves creates a short, high-pitched sound in early systole, immediately after S_1. This sound, called a **systolic click**, is the result of the opening of a rigid and calcified aortic or pulmonic valve during ventricular contraction. Mid to late systolic clicks may be heard in patients with mitral or tricuspid valve prolapse as the malfunctioning valve leaflet is displaced into the atrium during ventricular systole. Murmurs are expected to be heard following these abnormal systolic sounds. These sounds are the loudest in the areas directly over the malfunctioning valve.

Murmurs

Murmurs are created by turbulent flow of blood in the heart. The causes of the turbulence may be a critically narrowed valve, a malfunctioning valve that allows regurgitant blood flow, a congenital defect of the ventricular wall, a defect between the aorta and the pulmonary artery, or an increased flow of blood through a normal structure (e.g., with fever, pregnancy, hyperthyroidism). Murmurs are characterized and consequently described by several characteristics, including their timing in the cardiac cycle, location on the chest wall, intensity, pitch, quality, and pattern of radiation (Chart 21-4).

Friction Rub

A harsh, grating sound that can be heard in both systole and diastole is called a *friction rub*. It is caused by abrasion of the inflamed pericardial surfaces from pericarditis. Because a friction rub may be confused with a murmur, care should be taken to identify the sound and to distinguish it from murmurs that may be heard in both systole and diastole. A pericardial friction rub can be heard best using the diaphragm of the stethoscope, with the patient sitting up and leaning forward.

Auscultation Procedure

During auscultation, the patient remains supine and the examining room is as quiet as possible. A stethoscope with both diaphragm and bell functions is necessary for accurate auscultation of the heart.

Using the diaphragm of the stethoscope, the examiner starts at the apical area and progresses upward along the left sternal border to the pulmonic and aortic areas. Alternatively, the examiner may begin the examination at the aortic and pulmonic areas and progress downward to the apex of the heart. Initially, S_1 is identified and evaluated with respect to its intensity and splitting. Next, S_2 is identified, and its intensity and any splitting are noted. After concentrating on S_1 and S_2, the examiner listens for extra sounds in systole and then in diastole.

Sometimes it helps to ask the following questions: Do I hear snapping or clicking sounds? Do I hear any high-pitched blowing sounds? Is this sound in systole, or diastole, or both? The examiner again proceeds to move the stethoscope to all of the designated areas of the precordium, listening carefully for these sounds. Finally, the patient is turned on the left side and the stethoscope is placed on the apical area, where an S_3, an S_4, and a mitral murmur are more readily detected.

Once an abnormality is heard, the entire chest surface is reexamined to determine the exact location of the sound and its radiation. The patient may be concerned about the prolonged examination and must be supported and reassured. The auscultatory findings, particularly murmurs, are documented by identifying the following characteristics (see Chart 21-4): location on chest wall, timing, intensity, pitch, quality, and radiation.

Interpretation of Heart Sounds

Interpreting heart sounds requires detailed knowledge of cardiac physiology and pathophysiology. However, all nurses should have adequate knowledge and skill to recognize normal heart sounds (S_1, S_2) and the presence of abnormal sounds. When assessment is at this very basic level of practice, abnormal findings are reported for further evaluation and treatment. More advanced skills are required of nurses caring for critically ill patients with

CVD or those nurses functioning in advanced practice roles. Nurses in these roles readily identify abnormal heart sounds, recognize the diagnostic significance of their findings, and use their assessment skills to evaluate patients' responses to medical interventions. For example, these highly skilled nurses monitor heart sounds in patients with HF to detect the resolution of an S_3 after treatment with a diuretic.

Chart 21-4

Characteristics of Heart Murmurs

Heart murmurs are described in terms of location, timing, intensity, pitch, quality, and radiation. These characteristics provide information needed to determine the cause of the murmur and its clinical significance.

Location

Pinpointing the location of the murmur helps to determine the underlying structures that are involved in generating the abnormal sounds. The locations described in Figure 21-5 are used to identify where the loudest sounds are detected. The description should include the exact location from which the sound emanates, such as the location of the intercostal space and other important landmarks (right or left sternal border; midsternal, midclavicular, anterior axillary, or midaxillary lines). For example, a ventricular septal defect can be located at the left sternal border in the third and fourth intercostal spaces.

Timing

A murmur is described in terms of when it occurs during the cardiac cycle (systole or diastole). Murmurs are further differentiated by identifying exactly when during systole or diastole they are heard. A skilled clinician can detect that the murmur is occurring during early, mid, or late systole or diastole. Some murmurs have sounds that occur in both systole and diastole.

Intensity

A grading system is used to describe the intensity or loudness of a murmur.

Grade 1: Very faint and difficult for the inexperienced clinician to hear
Grade 2: Quiet but readily perceived by the experienced primary provider
Grade 3: Moderately loud
Grade 4: Loud and may be associated with a thrill
Grade 5: Very loud; heard when stethoscope is partially off the chest; associated with a thrill
Grade 6: Extremely loud; detected with the stethoscope off the chest; associated with a thrill

Pitch

Pitch describes the sound frequency, identified as high, medium, or low pitched. High-pitched murmurs are heard best with the stethoscope's diaphragm, whereas low-pitched sounds are detected using the bell of the stethoscope placed lightly on the chest wall.

Quality

Quality describes the sound that the murmur resembles. Murmurs can produce a rumbling, blowing, whistling, harsh, or musical sound. For

example, murmurs caused by mitral or tricuspid regurgitation have a blowing quality, whereas mitral stenosis generates a rumbling sound.

Radiation

Radiation refers to the transmission of the murmur from the point of maximal intensity to other areas in the upper chest. The examiner determines if radiation is present by listening carefully to areas of the heart adjacent to the point where the murmur is the loudest. If radiation is present, the exact location is described. A murmur associated with aortic stenosis, for example, can radiate into the neck, down the left sternal border, and into the apical area.

Adapted from Bickley, L. S. (2017). *Bates' guide to physical examination and history taking* (12th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Assessment of Other Systems

Lungs

The details of respiratory assessment are described in Chapter 17. Findings frequently exhibited by patients with cardiac disorders include the following:

Hemoptysis: Pink, frothy sputum is indicative of acute pulmonary edema.

Cough: A dry, hacking cough from irritation of small airways is common in patients with pulmonary congestion from HF.

Crackles: HF or atelectasis associated with bed rest, splinting from ischemic pain, or the effects of analgesic, sedative, or anesthetic agents often results in the development of crackles. Typically, crackles are first noted at the bases (because of gravity's effect on fluid accumulation and decreased ventilation of basilar tissue), but they may progress to all portions of the lung fields.

Wheezes: Compression of the small airways by interstitial pulmonary edema may cause wheezing. Beta-adrenergic–blocking agents (beta-blockers), particularly noncardioselective beta-adrenergic–blocking agents such as propranolol, may cause airway narrowing, especially in patients with underlying pulmonary disease.

Abdomen

For the patient with CVD, several components of the abdominal examination are relevant:

Abdominal distention: A protuberant abdomen with bulging flanks indicates ascites. Ascites develops in patients with right ventricular or biventricular HF (both right- and left-sided HF). In the failing right heart, abnormally high chamber pressures impede the return of venous blood. As a result, the liver and spleen become engorged with excessive venous blood (hepatosplenomegaly). As pressure in the portal system rises, fluid shifts

from the vascular bed into the abdominal cavity. Ascitic fluid, found in the dependent or lowest points in the abdomen, will shift with position changes.

Hepatojugular reflux: This test is performed when right ventricular or biventricular HF is suspected. The patient is positioned so that the jugular venous pulse is visible in the lower part of the neck. While observing the jugular venous pulse, firm pressure is applied over the right upper quadrant of the abdomen for 30 to 60 seconds. An increase of 1 cm or more in jugular venous pressure is indicative of a positive hepatojugular reflux. This positive test aids in confirming the diagnosis of HF.

Bladder distention: Urine output is an important indicator of cardiac function. Reduced urine output may indicate inadequate renal perfusion or a less serious problem such as one caused by urinary retention. When urine output is decreased, the patient must be assessed for a distended bladder or difficulty voiding. The bladder may be assessed with an ultrasound scanner (see Chapter 47, Fig. 47-8) or the suprapubic area palpated for an oval mass and percussed for dullness, indicative of a full bladder.

Gerontologic Considerations

When performing a cardiovascular examination on an older patient, the nurse may note such differences as more readily palpable peripheral pulses because of decreased elasticity of the arteries and a loss of adjacent connective tissue. Palpation of the precordium in older adults is affected by the changes in the shape of the chest. For example, a cardiac impulse may not be palpable in patients with chronic obstructive pulmonary disease, because these patients usually have an increased anterior–posterior chest diameter. Kyphoscoliosis, a spinal deformity that occurs in many older adult patients, may move the cardiac apex downward so that palpation of the apical impulse is obscured.

Hypertension affects 46% of adults. The prevalence increases with age and is also impacted by race and ethnicity. The risk of a middle-age adult developing hypertension is over 90% for African Americans and Hispanic/Latino Americans. Untreated hypertension is associated with significant cardiovascular morbidity and mortality, including stroke (Whelton et al., 2018). Isolated systolic hypertension is of concern in adults over 55 year of age, and occurs because of stiffening of the vasculature and a decrease in vascular elasticity due to the aging process (Zipes et al., 2019). Another common BP problem in the older adult is orthostatic hypotension, which is a result of impaired baroreceptor function necessary to regulate BP. Other factors that heighten the risk for orthostatic hypotension include prolonged bed rest, dehydration, and many cardiovascular medications (e.g., beta-blockers,

angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, diuretics, nitrates).

An S_4 that is associated with hypertension is common in older adults. It is thought to be due to a decrease in compliance of the left ventricle. The S_2 is usually split. At least 60% of older patients have murmurs, the most common being a soft systolic ejection murmur resulting from sclerotic changes of the aortic leaflets (Bickley, 2017) (see Table 21-1).

Diagnostic Evaluation

A wide range of diagnostic studies may be performed in patients with cardiovascular conditions. The nurse should educate the patient on the purpose, what to expect, and any possible side effects related to these examinations prior to testing. The nurse should note trends in results because they provide information about disease progression as well as the patient's response to therapy.

Laboratory Tests

Samples of the patient's blood are sent to the laboratory for the following reasons:

- To screen for risk factors associated with CAD
- To establish baseline values before initiating other diagnostic tests, procedures, or therapeutic interventions
- To monitor response to therapeutic interventions
- To assess for abnormalities in the blood that affect prognosis

Normal values for laboratory tests may vary depending on the laboratory and the health care institution. This variation is due to the differences in equipment and methods of measurement across organizations.

Cardiac Biomarker Analysis

The diagnosis of MI is made by evaluating the history and physical examination, the 12-lead ECG, and the results of laboratory tests that measure serum cardiac biomarkers. Myocardial cells that become necrotic from prolonged ischemia or trauma release specific enzymes (creatine kinase [CK]), CK isoenzymes (CK-MB), and proteins (myoglobin, troponin T, and troponin I). These substances leak into the interstitial spaces of the myocardium and are carried by the lymphatic system into general circulation. As a result, abnormally high levels of these substances can be detected in serum blood samples. (See Chapter 23 for further discussion of cardiac biomarker analysis.)

Blood Chemistry, Hematology, and Coagulation Studies

Table 21-4 provides information about some common serum laboratory tests and the implications for patients with CVD. Discussion of lipid, brain (B-type) natriuretic peptide (BNP), C-reactive protein (CRP), and homocysteine measurements follows.

Lipid Profile

Cholesterol, triglycerides, and lipoproteins are measured to evaluate a person's risk of developing CAD, especially if there is a family history of premature heart disease, or to diagnose a specific lipoprotein abnormality. Cholesterol and triglycerides are transported in the blood by combining with plasma proteins to form lipoproteins called LDL and HDL. Although cholesterol levels remain relatively constant over 24 hours, the blood specimen for the lipid profile should be obtained after a 12-hour fast.

Cholesterol Levels

Cholesterol is a lipid required for hormone synthesis and cell membrane formation. It is found in large quantities in brain and nerve tissue. Two major sources of cholesterol are diet (animal products) and the liver, where cholesterol is synthesized. Factors that contribute to variations in cholesterol levels include age, gender, diet, exercise patterns, genetics, menopause, tobacco use, and stress levels. Total cholesterol level is calculated by adding the HDL, LDL, and 20% of the triglyceride level.

High cholesterol levels increase the risk of CVD regardless of the patient's age. Lifestyle changes are recommended to lower cholesterol levels. After determining a person's 10-year risk for atherosclerotic vascular disease, medication is prescribed if necessary. Statins, a class of cholesterol-lowering medications, are often prescribed. Other nonstatins may be added to medication management to further reduce cholesterol; these include ezetimibe, bile acid sequestrants, and PCSK9 inhibitors (Grundy, Stone, Bailey, et al., 2019) (see Chapter 23 for more details).

TABLE 21-4 Common Serum Laboratory Tests and Implications for Patients with Cardiovascular Disease

Laboratory Test Reference Range	Implications
Blood Chemistries	
Blood urea nitrogen (BUN): 8–20 mg/dL	BUN and creatinine are end products of protein metabolism excreted by the kidneys. Elevated BUN reflects reduced renal perfusion from decreased cardiac output or intravascular fluid volume deficit as a result of diuretic therapy or dehydration.
Calcium (Ca^{++}): 8.8–10.4 mg/dL	Calcium is necessary for blood coagulability, neuromuscular activity, and automaticity of the nodal cells (sinus and atrioventricular nodes). *Hypocalcemia:* Decreased calcium levels slow nodal function and impair myocardial contractility. The latter effect increases the risk for heart failure. *Hypercalcemia:* Increased calcium levels can occur with the administration of thiazide diuretics because these medications reduce renal excretion of calcium. Hypercalcemia potentiates digitalis toxicity, causes increased myocardial contractility, and increases the risk for varying degrees of heart block and sudden death from ventricular fibrillation.
Creatinine *Male:* 0.6–1.2 mg/dL *Female:* 0.4–1.0 mg/dL	Both BUN and creatinine are used to assess renal function, although creatinine is a more sensitive measure. Renal impairment is detected by an increase in both BUN and creatinine. A normal creatinine level and an elevated BUN suggest an intravascular fluid volume deficit.
Magnesium (Mg^{++}): 1.8–2.6 mg/dL	Magnesium is necessary for the absorption of calcium, maintenance of potassium stores, and metabolism of adenosine triphosphate. It plays a major role in protein and carbohydrate synthesis and muscular contraction. *Hypomagnesemia:* Decreased magnesium levels are due to enhanced renal excretion of magnesium from the use of diuretic or digitalis therapy. Low magnesium levels predispose patients to atrial or ventricular tachycardias. *Hypermagnesemia:* Increased magnesium levels are commonly caused by the use of cathartics or antacids containing magnesium. Increased magnesium levels depress contractility and excitability of the myocardium, causing heart block and, if severe, asystole.
Potassium (K^{+}): 3.5–5 mEq/L	Potassium has a major role in cardiac electrophysiologic function. *Hypokalemia:* Decreased potassium levels due to administration of potassium-excreting diuretics can cause many forms of arrhythmias, including life-threatening ventricular tachycardia or ventricular fibrillation, and predispose patients taking digitalis preparations to digitalis toxicity.

	Hyperkalemia: Increased potassium levels can result from an increased intake of potassium (e.g., foods high in potassium or potassium supplements), decreased renal excretion of potassium, the use of potassium-sparing diuretics (e.g., spironolactone), or the use of angiotensin-converting enzyme inhibitors that inhibit aldosterone function. Serious consequences of hyperkalemia include heart block, asystole, and life-threatening ventricular arrhythmias.
Sodium (Na^+): 135–145 mEq/L	Low or high serum sodium levels do not directly affect cardiac function. *Hyponatremia:* Decreased sodium levels indicate fluid excess and can be caused by heart failure or administration of thiazide diuretics. *Hypernatremia:* Increased sodium levels indicate fluid deficits and can result from decreased water intake or loss of water through excessive sweating or diarrhea.
Coagulation Studies	Injury to a vessel wall or tissue initiates the formation of a thrombus. This injury activates the coagulation cascade, the complex interactions among phospholipids, calcium, and clotting factors that convert prothrombin to thrombin. The coagulation cascade has two pathways: the intrinsic and extrinsic pathways. Coagulation studies are routinely performed before invasive procedures, such as cardiac catheterization, electrophysiology testing, and cardiac surgery.
Activated partial thromboplastin time (aPTT) *Lower limit of normal:* 21–35 s	aPTT measures the activity of the intrinsic pathway and is used to assess the effects of unfractionated heparin. A therapeutic range is 1.5–2.5 times baseline values. Adjustment of heparin dose is required for aPTT <50 s (↑ dose) or >100 s (↓ dose).
Prothrombin time (PT) *Lower limit of normal:* 11–13 s	PT measures the extrinsic pathway activity and is used to monitor the level of anticoagulation with warfarin.
International normalized ratio (INR): 0.8–1.2	The INR, reported with the PT, provides a standard method for reporting PT levels and eliminates the variation of PT results from different laboratories. The INR, rather than the PT alone, is used to monitor the effectiveness of warfarin. The therapeutic range for INR is 2–3.5, although specific ranges vary based on diagnosis.
Hematologic Studies	
Complete blood count (CBC)	The CBC identifies the total number of white and red blood cells and platelets, and measures hemoglobin and hematocrit. The CBC is carefully monitored in patients with cardiovascular disease.
Hematocrit *Male:* 42–52% *Female:* 36–48%	The hematocrit represents the percentage of red blood cells found in 100 mL of whole blood. The red blood cells contain hemoglobin, which transports oxygen to the cells.

Hemoglobin *Male:* 14–17.4 g/dL *Female:* 12–16 g/dL	Low hemoglobin and hematocrit levels have serious consequences for patients with cardiovascular disease, such as more frequent angina episodes or acute myocardial infarction.
Platelets: 140,000–400,000/mm^3	Platelets are the first line of protection against bleeding. Once activated by blood vessel wall injury or rupture of atherosclerotic plaque, platelets undergo chemical changes that form a thrombus. Several medications inhibit platelet function, including aspirin, clopidogrel, and intravenous glycoprotein IIb/IIIa inhibitors (abciximab, eptifibatide, and tirofiban). When these medications are given, it is essential to monitor for thrombocytopenia (low platelet counts).
White blood cell (WBC) count: 4500–11,000/mm^3	WBC counts are monitored in patients who are immunocompromised, including patients with heart transplants or in situations where there is concern for infection (e.g., after invasive procedures or surgery).

Adapted from Fischbach, F. T., & Fischbach, M. A. (2018). *A manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Wolters Kluwer; Urden, L. D., Stacy, K. M., & Lough, M. E. (2017). *Critical care nursing: Diagnosis and management* (8th ed.). St. Louis, MO: Elsevier Mosby.

LDL is the primary transporter of cholesterol and triglycerides into the cell. One harmful effect of LDL is the deposition of these substances in the walls of arterial vessels. HDL has a protective action because it transports cholesterol away from the tissue and cells of the arterial wall to the liver for excretion (Grundy et al., 2019).

Triglycerides

Triglycerides, composed of free fatty acids and glycerol, are stored in the adipose tissue and are a source of energy. Triglyceride levels increase after meals and are affected by stress. Diabetes, alcohol use, and obesity can elevate triglyceride levels. These levels have a direct correlation with LDL and an inverse one with HDL.

Brain (B-Type) Natriuretic Peptide

BNP is a neurohormone that helps regulate BP and fluid volume. It is primarily secreted from the ventricles in response to increased preload with resulting elevated ventricular pressure. The level of BNP in the blood increases as the ventricular walls expand from increased pressure, making it a helpful diagnostic, monitoring, and prognostic tool in the setting of HF. Because this serum laboratory test can be quickly obtained, BNP levels are useful for prompt diagnosis of HF in settings such as the ED. Elevations in BNP can occur from a number of other conditions such as pulmonary embolus, MI, and ventricular hypertrophy. Therefore, the primary provider correlates BNP levels with abnormal physical assessment findings and other diagnostic tests before

making a definitive diagnosis of HF. A BNP level greater than 100 pg/mL is suggestive of HF.

C-Reactive Protein

CRP is a protein produced by the liver in response to systemic inflammation. Inflammation is thought to play a role in the development and progression of atherosclerosis. The high-sensitivity CRP (hs-CRP) test is used as an adjunct to other tests to predict CVD risk. People with high hs-CRP levels (3 mg/L or greater) may be at greatest risk for CVD compared to people with moderate (1 to 3 mg/L) or low (less than 1 mg/L) hs-CRP levels (Sidawy & Perler, 2019).

Homocysteine

Homocysteine, an amino acid, is linked to the development of atherosclerosis because it can damage the endothelial lining of arteries and promote thrombus formation. Therefore, an elevated blood level of homocysteine is thought to indicate a high risk for CAD, stroke, and peripheral vascular disease, although it is not an independent predictor of CAD. Genetic factors and a diet low in folate, vitamin B_6, and vitamin B_{12} are associated with elevated homocysteine levels. A 12-hour fast is necessary before drawing a blood sample for an accurate serum measurement. Test results are interpreted as optimal (less than 12 mcmol/L), borderline (12 to 15 mcmol/L), and high risk (greater than 15 mcmol/L) (Zipes et al., 2019).

Chest X-Ray and Fluoroscopy

A chest x-ray is obtained to determine the size, contour, and position of the heart. It reveals cardiac and pericardial calcifications and demonstrates physiologic alterations in the pulmonary circulation. Although it does not help diagnose acute MI, it can help diagnose some complications (e.g., HF). Correct placement of pacemakers and pulmonary artery catheters is also confirmed by chest x-ray.

Fluoroscopy is an x-ray imaging technique that allows visualization of the heart on a screen. It shows cardiac and vascular pulsations and unusual cardiac contours. This technique uses a movable x-ray source, which makes it a useful aid for positioning transvenous pacing electrodes and for guiding the insertion of arterial and venous catheters during cardiac catheterization and other cardiac procedures.

Electrocardiography

The ECG is a graphic representation of the electrical currents of the heart. The ECG is obtained by placing disposable electrodes in standard positions on the skin of the chest wall and extremities. Recordings of the electrical current

flowing between two electrodes are made on graph paper or displayed on a monitor. Several different recordings can be obtained by using a variety of electrode combinations, called *leads*. Simply stated, a lead is a specific view of the electrical activity of heart. The standard ECG is composed of 12 leads or 12 different views, although it is possible to record 15 or 18 leads.

The 12-lead ECG is used to diagnose arrhythmias, conduction abnormalities, and chamber enlargement, as well as myocardial ischemia, injury, or infarction. It can also suggest cardiac effects of electrolyte disturbances (high or low calcium and potassium levels) and the effects of antiarrhythmic medications. A 15-lead ECG adds three additional chest leads across the right precordium and is used for early diagnosis of right ventricular and left posterior (ventricular) infarction. The 18-lead ECG adds three posterior leads to the 15-lead ECG and is useful for early detection of myocardial ischemia and injury. To enhance interpretation of the ECG, the patient's age, gender, BP, height, weight, symptoms, and medications (especially digitalis and antiarrhythmic agents) are noted on the ECG requisition. (See Chapter 22 for a more detailed discussion of ECG.)

Continuous Electrocardiographic Monitoring

Continuous ECG monitoring is the standard of care for patients who are at high risk for arrhythmias. This form of cardiac monitoring detects abnormalities in heart rate and rhythm. Many systems have the capacity to monitor for changes in ST segments, which are used to identify the presence of myocardial ischemia or injury (see Chapter 23). Two types of continuous ECG monitoring techniques are used in health care settings: hardwire cardiac monitoring, found in EDs, critical care units, and progressive care units; and telemetry, found in general nursing care units or outpatient cardiac rehabilitation programs. Hardwire cardiac monitoring and telemetry systems vary in sophistication; however, most systems have the following features in common:

- Monitor more than one ECG lead simultaneously.
- Monitor ST segments (ST-segment depression is a marker of myocardial ischemia; ST-segment elevation provides evidence of an evolving MI).
- Provide graded visual and audible alarms (based on priority, asystole merits the highest grade of alarm).
- Interpret and store alarms.
- Trend data over time.
- Print a copy of rhythms from one or more specific ECG leads over a set time (called a *rhythm strip*).
- Save electronic copies of cardiac rhythms into the electronic health record (EHR).

Quality and Safety Nursing Alert

Patients placed on continuous ECG monitoring must be informed of its purpose and cautioned that it does not detect shortness of breath, chest pain, or other ACS symptoms. Thus, patients are instructed to report new or worsening symptoms immediately.

Hardwire Cardiac Monitoring

Hardwire cardiac monitoring is used to continuously observe the heart for arrhythmias and conduction disorders using one or two ECG leads. A real-time ECG is displayed on a bedside monitor and at a central monitoring station. In critical care units, additional components can be added to the bedside monitor to continuously monitor hemodynamic parameters (noninvasive BP, arterial pressures, pulmonary artery pressures), respiratory parameters (respiratory rate, oxygen saturation), and ST segments for myocardial ischemia. The nurse must know the specific indication for each patient's ECG monitoring.

Telemetry

In addition to hardwire cardiac monitoring, the ECG can be continuously observed by **telemetry**—the transmission of radio waves from a battery-operated transmitter to a central bank of monitors. The primary benefit of using telemetry is that the system is wireless, which allows patients to ambulate while one or two ECG leads are monitored. The patient has electrodes placed on the chest with a lead cable that connects to the transmitter. The transmitter can be placed in a disposable pouch and worn around the neck, or simply secured to the patient's clothing. Most transmitter batteries are changed every 24 to 48 hours.

Lead Systems

The number of electrodes needed for hardwire cardiac monitoring and telemetry is dictated by the lead system used in the clinical setting. Electrodes need to be securely and correctly placed on the chest wall to accurately capture arrhythmias (Sandau, Funk, Auerbach, et al., 2017). Chart 21-5 provides helpful hints on how to apply these electrodes. There are three-, four-, or five-lead systems available for ECG monitoring. The type of lead system used determines the number of lead options for monitoring. For example, the five-lead system provides up to seven different lead selections. Unlike the other two systems, the five-lead system can monitor the activity of the anterior wall of the left ventricle. Figure 21-9 presents diagrams of electrode placement.

The two ECG leads most often selected for continuous ECG monitoring are leads II and V_1. Lead II provides the best visualization of atrial depolarization (represented by the P wave). Lead V_1 best records ventricular depolarization and is most helpful when monitoring for certain arrhythmias (e.g., premature ventricular contractions, tachycardias, bundle branch blocks) (see Chapter 22). In addition to proper lead and electrode placement, it is important for the nurse to review and customize alarm settings for each patient to reduce false alarms and alarm fatigue (Jepsen, Sendelbach, Ruppel, et al., 2018).

Chart 21-5

Applying Electrodes

The monitoring system requires an adequate electrical signal to analyze the patient's cardiac rhythm. Proper use of this technology includes the correct application of electrodes to reduce false alarms on the cardiac monitor. When applying electrodes, the recommendations below should be followed to optimize skin adherence and conduction of the heart's electrical current:

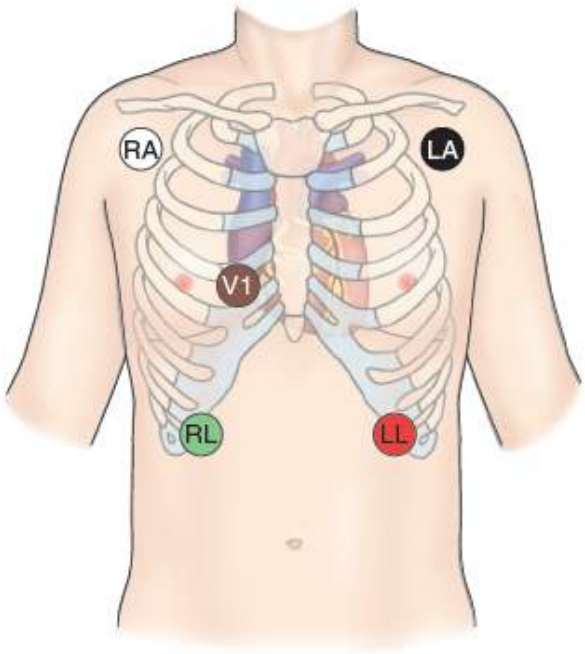
- Débride the skin surface of dead cells with soap and water; dry well using a wash cloth or gauze.
- Clip (do not shave) hair from around the electrode site, if needed.
- Connect the electrodes to the lead wires prior to placing them on the chest (connecting lead wires when electrodes are in place may be uncomfortable for some patients).
- Peel the backing off the electrode, and check to make sure the center is moist with electrode gel.
- Locate the appropriate lead placement, and apply the electrode to the skin, securing it in place with light pressure.
- Change the electrodes every 24 hours, examine the skin for irritation, and apply the electrodes to different locations.
- If the patient is sensitive to the electrodes, use hypoallergenic electrodes.

Adapted from Jepsen, S., Sendelbach, S., Ruppel, H., et al. (2018). AACN Practice Alert: Managing alarms in acute care across the life span: Electrocardiography and pulse oximetry. *Critical Care Nurse*, *38*(2), e16–e20.

Ambulatory Electrocardiography

Ambulatory electrocardiography is a form of continuous or intermittent ECG home monitoring. It is used for longer-term monitoring, since some arrhythmias occur intermittently and are difficult to capture with a 12-lead ECG in the office setting. This monitoring can help to identify the etiology of chest pain, syncope or palpitation caused by arrhythmias, detect episodes of

myocardial ischemia, evaluate effectiveness of treatment of HF and arrhythmias, and evaluate the functioning of ICDs and pacemakers. Several types of devices are available and are worn either externally or implanted under the skin. The ECG is transmitted to a centralized monitoring station via telephone or wireless technology to a secure Web site (Sampson, 2019).



RA – Right arm (white)
LA – Left arm (black)
RL – Right leg (green)
LL – Left leg (red)
V_1 – Chest or precordium (brown)

Figure 21-9 • Electrode placement used in continuous electrocardiographic monitoring for three-lead system, placement on RA, LA, and LL; four-lead system, placement on RA, LA, RL, and LL; five-lead system, placement on RA, LA, RL, LL, and V_1.

Continuous Monitors

Commonly called Holter monitors, these small portable recorders are connected to chest electrodes (number varies based on model used) that record all ECG activity using two or more leads onto a digital memory device. The patient usually wears the recorder for 24 to 48 hours. The patient is also asked to keep a diary to note the date and time of symptoms and activities. The diary is used by the primary provider to correlate symptoms with detected arrhythmias. Once monitoring is completed, the patient returns the device and diary to the primary provider's office. Data from the digital memory device are then uploaded into a computer for analysis, and rhythms that need further

evaluation by the primary provider are identified. Therefore, Holter monitors do not provide real-time ECG recordings or analysis. The effectiveness of this form of monitoring is dependent upon the patient's adherence with wearing the monitor, keeping an accurate diary, and if an arrhythmia occurred during the monitoring period (Sampson, 2019; Urden et al., 2017).

A novel alternative to the use of the Holter monitor is ECG patch monitoring, which uses Bluetooth technology. An ECG patch with adhesive backing is placed over the left pectoral area, eliminating the need for multiple ECG electrodes, wires, and recorders. The patch is single use, waterproof, and easily concealed under clothing. The patient wears the patch for 7 to 14 days and then returns it to the manufacturer for analysis. This device can detect more arrhythmias compared to the Holter monitor since it is worn by the patient for a longer period of time (Sampson, 2019).

Intermittent Monitors

Intermittent cardiac event monitors are devices that can capture arrhythmias when the patient experiences symptoms such as palpitations, dizziness, or lightheadedness. Patients may need to record events for several days to a month. The recorded ECGs are transmitted to the primary provider by telephone or a wireless transmission. The symptom event monitor and external loop recorder are two common forms of external intermittent cardiac event monitors.

The symptom event monitor is used to record and store the ECG during only during times when the patient is experiencing symptoms. Patients activate the symptom event monitor by pressing a button for devices that are worn on the wrist or by placing a small handheld device over the chest.

The loop recorder, a small battery-operated device, can record and store short periods of ECG activity. The monitor is inserted under the skin or worn on a wrist band. Some loop recorders are programmed to detect bradycardia, tachycardia, and irregular rhythms and do not require patient interaction. Other loop recorders require the patient to activate ECG recordings by pushing a button. The device records the patient's ECG for a predetermined time before and after the device activation. This is a preferred method over the symptom event monitor because it has more monitoring capabilities.

Real-time smart phone monitoring is a novel approach to cardiac event recording. The KardiaMobile® is a small device that connects to a smart phone app. The patient places two fingers on the device which generates a PDF file that can be sent electronically to the provider. Similarly, a patient can place a finger on the digital section of the Apple watch® to generate a rhythm strip. This rhythm is displayed on the watch face and a PDF file is sent to an app on the Apple iPhone® (Sampson, 2019).

Cardiac Implantable Electronic Devices

Cardiac implantable electronic devices include pacemakers and ICDs. These lifesaving devices are used to manage patients with serious cardiac illnesses. The technology available today allows for remote wireless monitoring of these devices to determine battery life, pacing parameters and therapies, and occurrence of serious atrial and ventricular arrhythmias. A transmitter, which is placed in the patient's home, sends device data to a secure data repository on a secure Web portal. A unique feature of these implantable devices is that they have programmable alerts that automatically detect and transmit arrhythmias without the need for patient interaction (see Chapter 22 for further discussion).

An implantable cardiac monitor such as the Reveal LINQ™ is another type of electronic device. This small device is implanted subcutaneously under the skin and has a battery life of 3 years. Recordings are triggered when an arrhythmia is detected by the device. Recordings are sent wirelessly via a home monitoring device for expert evaluation. Compared with event recorders described previously, this device offers advantages such as eliminating the patient's need to change electrodes and wear or carry the monitoring device. This type of monitoring is recommended for patients who have infrequent symptoms or require longer-term ECG monitoring (Sampson, 2019).

Nursing Interventions for Inpatient Cardiac Monitoring

A body of evidence indicates that most alarms occurring during inpatient ECG monitoring are false alarms. Nurses dealing with excessive alarms become desensitized to these sounds and develop alarm fatigue. Alarm fatigue delays response time or results in missed alarms. Several nursing interventions facilitate acquisition of accurate data, reduce risk of alarm fatigue, and ensure patient safety when using cardiac monitoring (Jepsen et al., 2018; Sandau et al., 2017).

To minimize false alarms, the ECG recordings must be free of artifact, which is an abnormal ECG pattern caused by muscular activity, patient movement, electrical interference, or lead cable or electrode malfunction. Artifact can mimic arrhythmias and cause unnecessary false alarms. Key to the elimination of artifact is using proper skin preparation before applying electrodes and changing the electrodes every 24 hours. During electrode changes, the skin should be assessed for allergic responses (itchy, reddened skin) to the adhesive or electrode gel. If present, the electrodes are replaced with hypoallergenic electrodes. Rotation of electrode placement on the skin will reduce the risk for skin breakdown (see Fig. 21-9).

Electrodes and lead connections need to be positioned correctly. Improper positioning can result in artifact that mimics ischemia or arrhythmias. Two leads should be selected that provide the best tracing for arrhythmia monitoring, which are usually lead II and the chest lead V_1. Electrical equipment in use around the patient should be inspected to be certain that it is functioning properly and has been recently checked by the medical

engineering department per organization policy, because improperly functioning equipment may cause false alarms from artifact.

An effort should be made to individualize the ECG alarm parameters to meet the patient's monitoring needs. For example, if the patient has atrial fibrillation, it is appropriate to turn off the irregular heart rate alarm. Keeping it on will create unnecessary alarms, contributing to alarm fatigue. Similarly, the bradycardia and tachycardia alarms should be adjusted, slightly below or above the patient's underlying heart rate (Jepsen et al., 2018; Sandau et al., 2017).

The nurse's role is to respond to and correct all monitor alarms immediately. Inoperative (inop) monitoring alarms—used to communicate that electrodes have fallen off, that leads are loose, or that the system's battery power is low (e.g., telemetry)—are just as significant as arrhythmia alarms indicating that the patient is tachycardic, bradycardic, or experiencing another potentially life-threatening arrhythmia. Timely responses to all alarms can prevent serious consequences, including death.

Hospital-acquired infections can be transmitted through lead wire cables. This may be prevented by using disposable lead wire cables, or by keeping reusable cables and transmitter equipment clean, per organizational policy. A patient should never be connected to monitoring equipment that has not been thoroughly cleaned between patients. If a patient is scheduled for a device implant, such as a pacemaker, electrodes should not be placed over the planned incision site. Likewise, electrodes should never be placed over an incision, implanted device, open wounds, or inflamed skin.

Electrodes should be removed once monitoring is discontinued and skin cleansed to remove excess electrode gel and adhesive. Metal-containing electrodes must be removed before sending a patient for any magnetic resonance scan, including magnetic resonance angiography (MRA).

Telemetry transmitters and other monitoring equipment should be maintained according to the manufacturer's recommendations. Monitoring devices of any type should not be submerged in water. A monitoring device may break if dropped; therefore, it should be secured to the patient's gown or clothing.

Cardiac Stress Testing

Normally, the coronary arteries dilate to four times their usual diameter in response to increased metabolic demands for oxygen and nutrients. However, coronary arteries affected by atherosclerosis dilate less, compromising blood flow to the myocardium and causing ischemia. Therefore, abnormalities in cardiovascular function are more likely to be detected during times of increased oxygen demand, or "stress." The **cardiac stress test** procedures—the exercise stress test, pharmacologic stress test, and radionucleotide imaging

studies—are noninvasive ways to evaluate if there is myocardial ischemia and higher myocardial oxygen requirement during these tests. Cardiac imaging is performed during the resting state and immediately after stress testing. The results can identify specific coronary artery lesions and ischemic areas of the heart (King, 2017). Since complications of stress testing can be life-threatening (MI, cardiac arrest, HF, and bradycardia and tachycardia with hemodynamic compromise), testing facilities must have staff and equipment ready to provide treatment, including advanced cardiac life support.

Exercise Stress Testing

Procedure

During an exercise stress test, the patient walks or runs on a treadmill (most common) or pedals a stationary bicycle. A protocol guides exercise intensity based upon the patient's age and heart rate goal (King, 2017). During the test, the following are monitored: two or more ECG leads for heart rate, rhythm, and ischemic changes; BP; skin temperature; physical appearance; perceived exertion; and symptoms, including chest pain, dyspnea, dizziness, leg cramping, and fatigue. The test is stopped when the target heart rate is achieved or if the patient experiences signs of myocardial ischemia. Abnormal findings include chest pain, ventricular arrhythmia, ST-segment depression, and lack of heart rate or BP elevation with exercise (King, 2017).

Nursing Interventions

In preparation for the exercise stress test, the patient is instructed to fast for several hours before the test and to avoid stimulants such as tobacco and caffeine. Medications may be taken with sips of water. The primary provider may instruct the patient to hold beta-blockers, calcium channel blockers, and digitalis for up to 48 hours before the stress test. Clothes and sneakers or rubber-soled shoes suitable for exercising are to be worn. The nurse prepares the patient for the stress test by describing how the stress test is performed, the type of monitoring equipment used, the rationale for insertion of an IV catheter, and what symptoms to report. The exercise method is reviewed, and patients are asked to put forth their best exercise effort. If the test is to be performed with echocardiography or radionuclide imaging (described in the next section), this information is reviewed as well. After the test, the patient is monitored for 10 to 15 minutes until vital signs and assessment findings return to normal. Once stable, patients may resume their usual activities.

Pharmacologic Stress Testing

Procedure

Patients who are cognitively impaired and unable to follow directions or physically disabled or deconditioned will not be able to achieve their target

heart rate by exercising on a treadmill or bicycle. Vasodilating agents such as dipyridamole, adenosine, or regadenoson given as an IV infusion are used to mimic the effects of exercise by maximally dilating normal coronary arteries and identifying stenotic arteries that cannot vasodilate. The side effects of these agents are related to the vasodilating action and include chest pain, headache, flushing, nausea, heart block, and dyspnea. If necessary the effects of these drugs can be reversed with IV aminophylline. Adenosine has an extremely short half-life (less than 10 seconds), so any severe effects subside rapidly. These vasodilating medications are the agents used in conjunction with radionuclide imaging techniques. Patients undergoing pharmacologic stress tests must avoid xanthine derivatives including theophylline, aminophylline, and caffeine as they block the effects of the vasodilating agents.

Dobutamine is another option for use during a pharmacologic stress test. This medication is a synthetic sympathomimetic agent that increases heart rate, myocardial contractility, and BP, thereby increasing the metabolic demands of the heart. It is the agent of choice when echocardiography is used because of its effects on altering myocardial wall motion (due to enhanced contractility). Dobutamine is also used for patients who have bronchospasm or pulmonary disease and cannot tolerate having doses of theophylline withheld.

Nursing Interventions

In preparation for the pharmacologic stress test, the patient is instructed not to eat or drink anything for at least 3 hours before the test. The patient must also be told to refrain from eating any liquid or food that contain chocolate or caffeine for 24 hours and to avoid taking medications that contain caffeine. This restriction also includes caffeine-free coffee, tea, and carbonated beverages. If caffeine is ingested before a stress test using vasodilating agents, the test will have to be rescheduled. Patients taking aminophylline, theophylline, or dipyridamole are instructed to stop taking these medications for 24 to 48 hours before the test (if tolerated). The patient is informed about the transient sensations that may occur during infusion of the vasodilating agent, such as flushing or nausea, which will disappear quickly. The patient is instructed to report the occurrence of any other symptoms during the test to the cardiologist or nurse. The stress test may take about 1 hour, or up to 3 hours if imaging is performed.

Radionuclide Imaging

Radionuclide imaging studies are noninvasive tests that use radioisotopes to evaluate coronary artery perfusion, detect myocardial ischemia and infarction, and/or assess left ventricular function. **Radioisotopes** are unstable atoms that give off small amounts of energy in the form of gamma rays as they decay. When radioisotopes are injected into the bloodstream, the energy emitted can

be detected by a gamma scintillation camera positioned over the body. These radioisotopes are called tracers.

Myocardial Perfusion Imaging

Myocardial perfusion imaging is performed using two types of techniques: single photon emission computed tomography (SPECT) or positron emission tomography (PET). It is commonly performed after an acute MI to determine if arterial perfusion to the heart is compromised during activity and to evaluate the extent of myocardial damage. It is also used to evaluate if myocardial ischemia from CAD is the cause of chest pain or other CAD-related symptoms.

These imaging techniques are performed in combination with stress testing to compare images obtained when the heart is resting to images of the heart in a stressed state resulting from exercise or medications. An area of the myocardium that shows no perfusion or reduced perfusion is said to have a "defect" present. Comparing resting images with images taken after the stress test helps differentiate ischemic myocardium from infarct-related myocardium. A defect that does not change in size before and after stress is called a fixed defect. Fixed defects indicate that there is no perfusion in that area of the myocardium, which is the case after an MI. Defects that appear or that get larger after the stress test images are taken indicate reduced perfusion to that area of the heart. Because the defect disappears with rest, it is called a reversible defect. Reversible defects constitute positive stress test findings. Typically, cardiac catheterization is recommended after a positive test result to determine the severity of obstructions to blood flow caused by CAD.

The patient undergoing myocardial perfusion imaging with stress testing should be prepared for the type of stressor to be used (exercise or medication) and provided with details of what to expect during imaging. The imaging is performed in two stages. Usually, the resting images are taken first. An IV is inserted to administer the radioisotope, and electrodes are placed on the chest to monitor the heart rate and rhythm. Women who are nursing, pregnant or think they are pregnant should not undergo myocardial perfusion imaging. The nurse alerts the primary provider if any of these conditions are present.

Single Photon Emission Computed Tomography

SPECT is widely available and is the most common technique of myocardial perfusion imaging. In addition, the ability of SPECT to detect myocardial ischemia is between 80% and 90% (King, 2017).

Procedure

SPECT is a painless, noninvasive procedure that involves the injection of the nuclear medicine radionucleotide (technetium-99m [^{99m}Tc]; rubidium-82) and imaging. During SPECT, patients are positioned supine on the table with their

arms over their heads. The gamma camera circles around the chest area converting the signals from the traces into pictures of the heart. The procedure takes approximately 30 minutes. The second scan is repeated after an exercise or pharmacologic stress test.

Nursing Interventions

The nurse's primary role is to prepare the patient for SPECT and insert an IV catheter or assess an existing IV for patency and suitability. The IV is used to inject the tracer. The patient may be concerned about receiving a radioactive substance and needs to be reassured that these tracers are safe—the radiation exposure is similar to that of other diagnostic x-ray studies. No postprocedure radiation precautions are necessary.

Positron Emission Tomography

PET is another noninvasive procedure in which a radioactive tracer chemical is administered to the patient and images are obtained. These images generally have a higher resolution compared to SPECT. PET technology is expensive and is likely to be found at large or academic medical centers.

Procedure

During PET, tracers are given by injection; one compound is used to determine blood flow in the myocardium, and another determines the metabolic function. The PET camera provides detailed three-dimensional images of the distributed compounds. The viability of the myocardium is determined by comparing the extent of glucose metabolism in the myocardium to the degree of blood flow. For example, ischemic but viable tissue will show decreased blood flow and elevated metabolism. For a patient with this finding, revascularization through surgery or angioplasty will probably be indicated to improve heart function. Restrictions of food intake before the test vary among institutions, but because PET evaluates glucose metabolism, the patient's blood glucose level should be within the normal range before testing.

Nursing Interventions

The nurse instructs the patient to refrain from using alcohol and caffeine for 24 hours before undergoing PET because of the stimulating effects they may have on the heart. For patients with diabetes and who are taking insulin, the nurse needs to discuss insulin doses and food restrictions with the primary provider. The nurse assesses patients for fear of closed spaces or claustrophobia. Patients who have this condition are reassured that medications can be given to help them relax. The nurse also reassures patients that radiation exposure is at safe and acceptable levels, similar to those of other diagnostic x-ray studies.

To prepare the patient for PET, the nurse inserts an IV or assesses the existing IV catheter for patency and suitability, and then describes the

procedure to the patient. The patient is positioned on a table with hands above the head. The table then slides into a donut-shaped scanner. While in the scanner, the patient must lie still so that clear images of the heart can be obtained. A baseline scan is performed, which takes about 30 minutes. Then a tracer is injected into the IV and the scan is repeated. The patient's glucose level is monitored throughout the procedure. The scan takes from 1 to 3 hours to complete.

Test of Ventricular Function and Wall Motion

Equilibrium radionuclide angiocardiography (ERNA), also known as multiple-gated acquisition (MUGA) scanning, is a common noninvasive technique that uses a conventional scintillation camera interfaced with a computer to record images of the heart during several hundred heartbeats. The computer processes the data and allows for sequential viewing of the functioning heart. The sequential images are analyzed to evaluate left ventricular function, wall motion, and ejection fraction.

The patient is reassured that there is no known radiation danger and is instructed to remain motionless during the scan.

Additional Imaging

Additional cardiac imaging techniques include computed tomography (CT) and MRA.

Computed Tomography

Procedure

Cardiac CT scanning is a form of cardiac imaging that uses x-rays to provide accurate cross-sectional "virtual" slices of specific areas of the heart and surrounding structures. Complex mathematical and computer algorithms are used to analyze the slices to create three-dimensional images. Multidetector CT (MDCT) is a fast form of CT scanning that takes multiple slices at the same time. This technology produces high-resolution clear images of cardiac anatomy (Liddy, Buckley, Kok, et al., 2018). Two types of cardiac CT scanning include coronary CT angiography and electron beam CT (EBCT) (for coronary calcium scoring).

Coronary CT angiography requires the use of an IV contrast agent to enhance the x-rays and improve visualization of cardiac structures. This test is used to evaluate coronary arteries for stenosis, the aorta for aneurysms or dissections, graft patency after coronary artery bypass grafting, pulmonary veins in patients with atrial fibrillation, and cardiac structures for congenital anomalies. Patients may receive beta-blockers prior to the scan to control heart rate and rhythm and reduce artifact. Another way to minimize artifact is to

have patients hold their breath periodically throughout the scan. Coronary CT angiography is used with caution in patients with renal insufficiency. The contrast agent used during the CT scan is excreted through the kidneys; therefore, renal function should be assessed prior to the scan. It may be necessary to administer IV hydration before and after the scan to minimize the effect of the contrast on renal function. Patients will require premedication with corticosteroids and antihistamines if they experienced a reaction to a contrast agent in the past (Mervak, Cohan, Ellis, et al., 2017).

EBCT is used to calculate a coronary artery calcium score that is based on the amount of calcium deposits in the coronary arteries. This score is used to predict the likelihood of cardiac events, such as MI, or the need for a revascularization procedure in the future. Coronary artery calcium scoring is used for the evaluation of individuals without known CAD and offers limited incremental prognostic value for individuals with known CAD, such as those with stents and bypass grafts. Currently, EBCT is thought to be a reasonable test to consider in patients with low to intermediate risk for future CAD-related events. Results of the test may help to reclassify them to higher risk and thus intensify primary prevention measures (Arnett et al., 2019).

Nursing Interventions

The nurse provides details of the procedure to help prepare the patient for the test. Patients need to be prepared to hold their breath at certain times during the procedure, so it is important for the nurse to practice with the patient before going for CT scan. The patient is positioned on a table, and the scanner rotates around the table during the test. The procedure is noninvasive and painless. However, to obtain adequate images, the patient must lie completely still during the scanning process. An IV is necessary if contrast is to be used to enhance the images. The patient should be told to expect transient flushing, metallic taste, nausea, or bradycardia during the contrast infusion.

Magnetic Resonance Angiography

Procedure

MRA is a noninvasive, painless technique that is used to examine both the physiologic and anatomic properties of the heart. MRA uses a powerful magnetic field and computer-generated pictures to image the heart and great vessels. It is valuable in diagnosing diseases of the aorta, heart muscle, and pericardium, as well as congenital heart lesions. The application of this technique to the evaluation of coronary artery anatomy is limited because the quality of the images is distorted by respirations, the beating heart, and certain implanted devices (stents and surgical clips). In addition, this technique cannot adequately visualize the small distal coronary arteries as accurately as conventional angiography performed during a cardiac catheterization.

Nursing Interventions

Because of the magnetic field used during MRA, patients must be screened for contraindications for its use. Patients with any type of cardiac implantable electronic device need to be screened to see if it is safe for the patient to undergo the test (Indik, Gimbel, Abe, et al., 2017). MRA cannot be performed on patients who have metal plates, prosthetic joints, or other metallic implants that can become dislodged if exposed to MRA. Patients are instructed to remove any jewelry, watches, or other metal items (e.g., ECG leads). Transdermal patches that contain a heat-conducting aluminized layer (e.g., nitroglycerin, clonidine, fentanyl) must be removed before MRA to prevent burning of the skin.

During MRA, the patient is positioned supine on a table that is placed into an enclosed imager or tube containing the magnetic field. A patient who is claustrophobic may need to receive a mild sedative before undergoing an MRA. An intermittent clanking or thumping that can be annoying is generated by the magnetic coils, so the patient may be offered a headset to listen to music. The scanner is equipped with a microphone so that the patient can communicate with the staff. The patient is instructed to remain motionless during the scan.

Echocardiography

Transthoracic Echocardiography

Echocardiography is a noninvasive ultrasound test that is used to measure the ejection fraction and examine the size, shape, and motion of cardiac structures. It is particularly useful for diagnosing pericardial effusions; determining chamber size and the etiology of heart murmurs; evaluating the function of heart valves, including prosthetic heart valves; and evaluating ventricular wall motion.

Procedure

Echocardiography involves transmission of high-frequency sound waves into the heart through the chest wall and the recording of the return signals. With the traditional transthoracic approach, the ultrasound is generated by a handheld transducer applied to the front of the chest. The transducer picks up the echoes and converts them to electrical impulses that are recorded and displayed on a monitor. It creates sophisticated, spatially correct images of the heart. An ECG is recorded simultaneously to assist in interpretation of the echocardiogram.

With the use of Doppler techniques, an echocardiogram can also show the direction and velocity of the blood flow through the heart. These techniques are used to assess for “leaking valves,” conditions referred to as valvular

regurgitation, and will also detect abnormal blood flow between the septum of the left and right heart.

Echocardiography may be performed with an exercise or pharmacologic stress test. Images are obtained at rest and then immediately after the target heart rate is reached. Myocardial ischemia from decreased perfusion during stress causes abnormalities in ventricular wall motion and is easily detected by echocardiography. A stress test using echocardiography is considered positive if abnormalities in ventricular wall motion are detected during stress but not during rest. These findings are highly suggestive of CAD and require further evaluation, such as a cardiac catheterization.

Nursing Interventions

Before transthoracic echocardiography, the nurse informs the patient about the test, explaining that it is painless. Echocardiographic monitoring is performed while a transducer that emits sound waves is moved over the surface of the chest wall. Gel applied to the skin helps transmit the sound waves. Periodically, the patient is asked to turn onto the left side or hold a breath. The test takes about 30 to 45 minutes. If the patient is to undergo an exercise or pharmacologic stress test with echocardiography, information on stress testing is also reviewed with the patient.

Transesophageal Echocardiography

Procedure

A significant limitation of transthoracic echocardiography is the poor quality of the images produced. Ultrasound loses its clarity as it passes through tissue, lung, and bone. An alternative technique involves threading a small transducer through the mouth and into the esophagus. This technique, called *transesophageal echocardiography* (TEE), provides clearer images because ultrasound waves pass through less tissue. A topical anesthetic agent and sedation are used during TEE because of the discomfort associated with the positioning of the transducer in the esophagus (refer to Chapter 15 for further discussion of sedation for procedures). Once the patient is comfortable, the transducer is inserted into the mouth and the patient is asked to swallow several times until it is positioned in the esophagus.

The high-quality imaging obtained during TEE makes this technique an important first-line diagnostic tool for evaluating patients with many types of CVD, including HF, valvular heart disease, arrhythmias, and many other conditions that place the patient at risk for atrial or ventricular thrombi. Pharmacologic stress testing using dobutamine and TEE can also be performed. It is frequently used during cardiac surgery to continuously monitor the response of the heart to the surgical procedure (e.g., valve replacement or coronary artery bypass). Complications are uncommon during TEE; however,

if they do occur, they are serious. These complications are caused by sedation and impaired swallowing resulting from the topical anesthesia (respiratory depression and aspiration) and by insertion and manipulation of the transducer into the esophagus and stomach (vasovagal response or esophageal perforation). The patient must be assessed before TEE for a history of dysphagia or radiation therapy to the chest, which increases the likelihood of complications.

Nursing Interventions

Prior to the test, the nurse provides preprocedure education and ensures that the patient has a clear understanding of what the test entails and why it is being performed, instructs the patient not to eat or drink anything for 6 hours prior to the study, and checks to make sure that informed consent has been obtained. The nurse also inserts an IV line or assesses an existing IV for patency and suitability and asks the patient to remove full or partial dentures. During the test, the nurse provides emotional support and monitors level of consciousness, BP, ECG, respiration, and oxygen saturation (SpO_2). During the recovery period, the patient must maintain bed rest with the head of the bed elevated to 45 degrees. Following the procedural sedation policy of the agency, the nurse monitors the patient for dyspnea and assesses vital signs, SpO_2, level of consciousness, and gag reflex as recommended. Food and oral fluids are withheld until the patient is fully alert and the effects of the topical anesthetic agent are reversed, usually 2 hours after the procedure; if the gag reflex is intact, the nurse begins feeding with sips of water, then advances to the preprocedure diet. Patients are informed that a sore throat may be present for the next 24 hours; they are instructed to report the presence of a persistent sore throat, shortness of breath, or difficulty swallowing to the medical staff. If the procedure is performed in an outpatient setting, a family member or friend must be available to transport the patient home from the test site.

Cardiac Catheterization

Cardiac catheterization is a common invasive procedure used to diagnose structural and functional diseases of the heart and great vessels. The results guide treatment decisions including the need for revascularization (PCI or CABG) and other interventions to manage structural defects of the valves or septum (see Chapter 23).

This procedure involves the percutaneous insertion of radiopaque catheters into a large vein and an artery. Fluoroscopy is used to guide the advancement of the catheters through the right and left heart, referred to as right and left heart catheterizations, respectively. In most situations, patients undergo both right and left heart catheterizations. However, right heart catheterization is performed without a left heart catheterization when patients only need

myocardial biopsies or measurement of pulmonary artery pressures. Of note, left heart catheterization involves the use of a contrast agent. These agents are necessary to visualize patency of the coronary arteries and evaluate left ventricular function.

In preparation for the procedure, patients have blood tests performed to evaluate metabolic function (electrolytes and glucose) and renal function (blood urea nitrogen and creatinine level). Baseline coagulation studies (activated partial thromboplastin time [aPTT], international normalized ratio [INR], and prothrombin time [PT]) are obtained to guide dosing of anticoagulation during the procedure. Because bleeding and hematoma formation are procedural risks, a complete blood cell count (CBC; includes the hematocrit, hemoglobin, and platelets) is necessary to establish baseline values. Later these results are compared with postprocedure results to monitor for blood loss.

A health history is obtained to assess for previous reactions to a contrast agent and determine if the patient has any risk factors for contrast-induced nephropathy (CIN). This uncommon complication is a form of acute kidney injury that is usually reversible. Patients with chronic kidney disease or renal insufficiency, diabetes, HF, hypotension, dehydration, use of nephrotoxic medications, and advanced age are at risk for CIN. CIN is defined as an increase in the baseline serum creatinine by 25% or more or an absolute increase of 0.5 mg/dL within 48 to 72 hours after the administration of contrast (Urden et al., 2017). See Chapter 47, Chart 47-5 for further discussion of nursing care of patient undergoing imaging study with the use of a contrast agent.

During a cardiac catheterization, the patient has one or more IV catheters for administration of fluids, sedatives, heparin, and other medications. The patient is continuously monitored for chest pain or dyspnea and for changes in BP and ECG, which are indicative of myocardial ischemia, hemodynamic instability, or arrhythmias. Resuscitation equipment must be readily available, and staff must be prepared to provide advanced cardiac life support measures as necessary.

Postprocedure, patients remain on bed rest for 2 to 6 hours before they are permitted to ambulate. Variations in time to ambulation are related to the size of the catheters used during the procedure, the site of catheter insertion (femoral or radial artery), the patient's anticoagulation status, and other factors (e.g., advanced age, obesity, bleeding disorder). The use of a radial access site and smaller (4- or 6-Fr) arterial catheters are associated with shorter bed rest restrictions.

Cardiac catheterization may be performed in the ambulatory setting. Unless the results demonstrate the need for immediate treatment, patients are discharged home. Hospitalized patients undergoing cardiac catheterization for

diagnostic and interventional purposes (PCI, valvuloplasty) are returned to their hospital rooms for recovery (see Chapter 23).

Right Heart Catheterization

Right heart catheterization usually precedes left heart catheterization. It is performed to assess the function of the right ventricle and tricuspid and pulmonary valves. The procedure involves the passage of a catheter from a brachial, internal jugular, or femoral vein into the right atrium, right ventricle, pulmonary artery, and pulmonary arterioles. Pressures and oxygen saturations from each of these areas are obtained and recorded. The pulmonary artery pressures are used to diagnose pulmonary hypertension. A biopsy of a small piece of myocardial tissue can also be obtained during a right heart catheterization. The results of the biopsy are used to diagnose the etiology of a cardiomyopathy (abnormality of myocardium) or heart transplant rejection. At the completion of the procedure, the venous catheter is removed and hemostasis of the affected vein is achieved using manual pressure. Although right heart catheterization is considered relatively safe, potential complications include arrhythmias (from contact of the catheter with the endocardium), venous spasm, infection at the insertion site, and right heart perforation.

Left Heart Catheterization

Prior to left heart catheterization, patients who have previously experienced a reaction to a contrast agent are premedicated with antihistamines (e.g., diphenhydramine) and corticosteroids (e.g., prednisone). Patients at risk for CIN receive pre- and postprocedure preventive strategies. IV saline hydration increases vascular volume, facilitates removal of contrast from the kidneys, and reduces the risk of CIN (Liu, Hong, Wang, et al., 2019).

Left heart catheterization is performed to evaluate the aortic arch and its major branches, patency of the coronary arteries, and the function of the left ventricle and mitral and aortic valves. Left heart catheterization is performed by retrograde catheterization of the left ventricle. In this approach, the interventional cardiologist usually inserts the catheter into the right radial or a femoral artery and advances it into the aorta and left ventricle. Potential complications include arrhythmias, MI, perforation of the left heart or great vessels, and systemic embolization.

During a left heart catheterization, angiography is performed. Angiography is an imaging technique that involves the injection of the contrast agent into the arterial catheter. The contrast agent is filmed as it passes through the chambers of the left heart, aortic arch, and its major arteries. Coronary angiography is another technique used to observe the coronary artery anatomy and evaluate the degree of stenosis from atherosclerosis. To perform this test, a catheter is positioned into one of the coronary arteries. Once in position, the

contrast agent is injected directly into the artery and images are obtained. The procedure is then repeated using the opposite coronary artery. Ventriculography is also performed to evaluate the size and function of the left ventricle. For this test, a catheter is positioned in the left ventricle and a large amount of contrast agent (30 mL) is rapidly injected into the ventricle.

The manipulation of catheters in the coronary arteries and left ventricle as well as injection of the contrast agent can cause intermittent myocardial ischemia. Vigilant monitoring throughout left heart catheterization is needed to detect myocardial ischemia, which can trigger chest pain and life-threatening arrhythmias.

Once the procedure is completed, the arterial catheter is withdrawn. There are several options available to achieve arterial hemostasis, including applying manual pressure and hemostatic devices available from numerous vendors. For the radial artery, a compression device, such as the Terumo TR Band®, is positioned over the artery. It has a mechanism that is inflated with air to put pressure against the artery. It remains in place for about 2 hours. A radial approach and a compression device are both common practices and are associated with lower risks for bleeding and vascular complications, as well as a shorter time to ambulation postprocedure (Mason, Shah, Tamis-Holland, et al., 2018).

For the femoral approach, manual pressure may be used alone or in combination with mechanical compression devices such as the FemoStop™. Many types of percutaneously deployed vascular closure devices are also available. These devices are positioned at the femoral arterial puncture site after completion of the procedure. They deploy a saline-soaked gelatin sponge (QUICKSEAL), collagen (VasoSeal), sutures (Perclose ProGlide™), or a combination of both collagen and sutures (Angio-Seal). Other products that expedite arterial hemostasis include external patches (Syvek Patch, Clo-Sur P.A.D.). These products are placed over the puncture site as the catheter is removed and manual pressure is applied for 4 to 10 minutes. Once hemostasis is achieved, the patch is covered with a dressing that remains in place for 24 hours. The interventional cardiologist determines which closure device, if any, will be deployed based on the artery used to insert the catheter, patient's condition, device availability, and personal preference.

Major benefits of the vascular closure devices include reliable, immediate hemostasis and a shorter time on bed rest without a significant increase in bleeding or other complications. Rare complications associated with these devices include bleeding around the closure device, infection, and arterial obstruction.

Nursing Interventions

Nursing responsibilities before cardiac catheterization include:

- Instructing the patient to fast, usually for 8 to 12 hours, before the procedure.
- Informing the patient that if catheterization is to be performed as an outpatient procedure, a friend, family member, or other responsible person must transport the patient home.
- Informing the patient about the expected duration of the procedure and advising that it will involve lying on a hard table for less than 2 hours.
- Reassuring the patient that IV medications are given to maintain comfort.
- Informing the patient about sensations that will be experienced during the catheterization. Knowing what to expect can help the patient cope with the experience. The nurse explains that an occasional pounding sensation (palpitation) may be felt in the chest because of extra heartbeats that almost always occur, particularly when the catheter tip touches the endocardium. The patient may be asked to cough and to breathe deeply, especially after the injection of the contrast agent. Coughing may help disrupt an arrhythmia and clear the contrast agent from the arteries. Breathing deeply and holding the breath help lower the diaphragm for better visualization of heart structures. The injection of a contrast agent into either side of the heart may produce a flushed feeling throughout the body and a sensation similar to the need to void, which subsides in 1 minute or less.
- Encouraging the patient to express fears and anxieties. The nurse provides education and reassurance to reduce apprehension.

Nursing responsibilities after cardiac catheterization are guided by hospital policy and primary provider preferences and may include:

- Observing the catheter access site for bleeding or hematoma formation and assessing peripheral pulses in the affected extremity (dorsalis pedis and posterior tibial pulses in the lower extremity, radial pulse in the upper extremity) every 15 minutes for 1 hour, every 30 minutes for 1 hour, and hourly for 4 hours or until discharge. BP and heart rate are also assessed during these same time intervals.
- Evaluating temperature, color, and capillary refill of the affected extremity during these same time intervals. The patient is assessed for affected extremity pain, numbness, or tingling sensations that may indicate arterial insufficiency. The best technique to use is to compare the examination findings between the affected and unaffected extremities. Any changes are reported promptly.

- Screening carefully for arrhythmias by observing the cardiac monitor or by assessing the apical and peripheral pulses for changes in rate and rhythm. A vasovagal reaction, consisting of bradycardia, hypotension, and nausea, can be precipitated by a distended bladder or by discomfort from manual pressure that is applied during removal of an arterial or venous catheter. The vasovagal response is reversed by promptly elevating the lower extremities above the level of the heart, infusing a bolus of IV fluid, and administering IV atropine to treat the bradycardia.
- Maintaining activity restrictions for 2 to 6 hours after the procedure. The determination of bed rest, chair activity, and time to commence ambulation is dependent upon location of arterial approach, size of the catheter used during the procedure, medications administered, and method used to maintain hemostasis. If manual pressure or a mechanical device was used during a femoral artery approach, the patient remains on bed rest for up to 6 hours with the affected leg straight and the head of the bed elevated no greater than 30 degrees. For comfort, the patient may be turned from side to side with the affected extremity straight. If a percutaneous vascular closure device or patch was deployed, the nurse checks local nursing care standards and anticipates that the patient will have fewer activity restrictions. If the radial closure device was used, the patient can sit up in a chair until the effects of sedation have dissipated, and early ambulation is encouraged. After the vascular closure device removal, a dressing is applied over the catheter access site. Patients can return to normal activities the day after the procedure but must avoid strenuous wrist activities for several days (Mason et al., 2018). Analgesic medication is given as prescribed for discomfort.
- Instructing the patient to report chest pain and bleeding or sudden discomfort from the catheter insertion sites promptly.
- Monitoring the patient for CIN by observing for elevations in serum creatinine levels. IV hydration is used to increase urinary output and flush the contrast agent from the urinary tract; accurate oral and IV intake and urinary output are recorded.
- Ensuring patient safety by instructing the patient to ask for help when getting out of bed the first time after the procedure. The patient is monitored for bleeding from the catheter access site and for orthostatic hypotension, indicated by complaints of dizziness or lightheadedness.

For patients being discharged from the hospital on the same day as the procedure, additional instructions are provided (Chart 21-6).

Electrophysiologic Testing

The electrophysiology study (EPS) is an invasive procedure that plays a major role in the diagnosis and management of serious arrhythmias. EPS may be indicated for patients with syncope, palpitations, or both, and for survivors of cardiac arrest from ventricular fibrillation (sudden cardiac death) (Kusumoto, Schoenfeld, Barrett, et al., 2019). EPS is used to distinguish atrial from ventricular tachycardias when the determination cannot be made from the 12-lead ECG; to evaluate how readily a life-threatening arrhythmia (e.g., ventricular tachycardia, ventricular fibrillation) can be induced; to evaluate AV node function; to evaluate the effectiveness of antiarrhythmic medications in suppressing the arrhythmia; or to determine the need for other therapeutic interventions, such as a cardiac implantable electronic device, or radiofrequency ablation. (See Chapter 22 for a detailed discussion of EPS.)

Chart 21-6 **PATIENT EDUCATION**

Self-Management After Cardiac Catheterization

After discharge from the hospital for cardiac catheterization, patients should follow these guidelines for self-care:

- *If the artery in your wrist artery was used:* Return to normal activities tomorrow. Strenuous activities of the wrist such as manual labor, tennis, or driving may be restricted for a few days per your provider's orders.
- *If the artery in your groin was used:* For the next 24 hours, do not bend at the waist, strain, or lift heavy objects.
- Do not submerge the puncture site in water. Avoid tub baths, but shower as desired.
- Talk with your primary provider about when you may return to work, drive, or resume strenuous activities.
- If bleeding occurs, sit (arm or wrist approach) or lie down (groin approach) and apply firm pressure to the puncture site for 10 minutes. Notify your primary provider as soon as possible and follow instructions. If there is a large amount of bleeding, call 911. Do not drive to the hospital.
- Call your primary provider if any of the following occur: swelling, new bruising or pain from your procedure puncture site, temperature of 101°F or more.
- If test results show that you have coronary artery disease, talk with your primary provider about options for treatment, including cardiac rehabilitation programs in your community.
- Talk with your primary provider about lifestyle changes to reduce your risk for further or future heart problems, such as quitting smoking, lowering your cholesterol level, initiating dietary changes, beginning an exercise program, cardiac rehabilitation, or losing weight.
- Your primary provider may prescribe one or more new medications depending on your risk factors (medications to lower your blood pressure or cholesterol; aspirin or clopidogrel to prevent blood clots). Take all of your medications as instructed. If you feel that any of them are causing side effects, call your primary provider immediately. Do not stop taking any medications before talking to your primary provider.

Adapted from Mason, P. J., Shah, B., Tamis-Holland, J. E., et al. (2018). An update on radial artery access and best practices for transradial coronary angiography and intervention in acute coronary syndrome: A scientific statement from the American Heart Association. *Circulation: Cardiovascular Interventions*. Retrieved on 5/14/2019 at: www.ahajournals.org/toc/circinterventions/11/9

Hemodynamic Monitoring

Critically ill patients require continuous assessment of their cardiovascular system to diagnose and manage their complex medical conditions. This type of assessment is achieved by the use of direct pressure monitoring systems, referred to as hemodynamic monitoring. Common forms include CVP, pulmonary artery pressure, and intra-arterial BP monitoring. Patients requiring hemodynamic monitoring are cared for in critical care units. Some progressive care units also admit stable patients with CVP, pulmonary artery catheters, or intra-arterial BP monitoring. To perform hemodynamic monitoring, a CVP, pulmonary artery, or arterial catheter is introduced into the appropriate blood vessel or heart chamber. It is connected to a pressure monitoring system that has several components, including:

- A disposable flush system, composed of IV normal saline solution, tubing, stopcocks, and a flush device, which provides continuous and manual flushing of the system.
- A pressure bag placed around the flush solution that is maintained at 300 mm Hg of pressure. The pressurized flush system delivers 3 to 5 mL of solution per hour through the catheter to prevent clotting and backflow of blood into the pressure monitoring system.
- A transducer to convert the pressure coming from the artery or heart chamber into an electrical signal.
- An amplifier or monitor, which increases the size of the electrical signal for display on an oscilloscope.

Nurses caring for patients who require hemodynamic monitoring receive training prior to using this sophisticated technology. The nurse helps ensure safe and effective care by adhering to the following guidelines:

- Ensuring that the system is set up and maintained properly. For example, the pressure monitoring system must be kept patent and free of air bubbles.
- Checking that the stopcock of the transducer is positioned at the level of the atrium before the system is used to obtain pressure measurements. This landmark is referred to as the phlebostatic axis (Fig. 21-10). The nurse uses a marker to identify this level on the chest wall, which provides a stable reference point for subsequent pressure readings.
- Establishing the zero reference point in order to ensure that the system is properly functioning at atmospheric pressure. This process is accomplished by placing the stopcock of the transducer at the phlebostatic axis, opening the transducer to air, and activating the zero function key on the bedside monitor. Measurements of CVP, BP, and pulmonary artery pressures can be made with the head of the bed elevated up to 60 degrees;

however, the system must be repositioned to the phlebostatic axis to ensure an accurate reading (Urden et al., 2017).

Complications from the use of hemodynamic monitoring systems are uncommon and can include pneumothorax, infection, and air embolism. The nurse observes for signs of pneumothorax during the insertion of catheters using a central venous approach (CVP and pulmonary artery catheters). The longer any of these catheters are left in place (after 72 to 96 hours), the greater the risk of infection. Air emboli can be introduced into the vascular system if the stopcocks attached to the pressure transducers are mishandled during blood drawing, administration of medications, or other procedures that require opening the system to air. Therefore, nurses handling this equipment must demonstrate competence prior to caring independently for a patient requiring hemodynamic monitoring.

Catheter-related bloodstream infections are the most common preventable complication associated with hemodynamic monitoring systems. The Centers for Disease Control and Prevention (CDC) has published comprehensive guidelines for the prevention of these infections (O'Grady, Alexander, Burns, et al., 2011; Talbot, Stone, Irwin, et al., 2017). To minimize the risk of infection, a group of evidence-based interventions, called a care *bundle,* should be implemented.

The CDC and Infusion Nursing Society have additional infection control guidelines that pertain to the ongoing care of these patients, including skin care, dressing changes, and line and connector care that are outlined in Table 21-5.

Central Venous Pressure Monitoring

CVP is a measurement of the pressure in the vena cava or right atrium. The pressure in the vena cava, right atrium, and right ventricle is equal at the end of diastole; thus, the CVP also reflects the filling pressure of the right ventricle (preload). The normal CVP is 2 to 6 mm Hg. It is measured by positioning a catheter in the vena cava or right atrium and connecting it to a pressure monitoring system. The CVP is most valuable when it is monitored over time and correlated with the patient's clinical status. A CVP greater than 6 mm Hg indicates an elevated right ventricular preload. There are many problems that can cause an elevated CVP, but the most common problem is hypervolemia (excessive fluid circulating in the body) or right-sided HF. In contrast, a low CVP (less than 2 mm Hg) indicates reduced right ventricular preload, which is most often from hypovolemia. Dehydration, excessive blood loss, vomiting or diarrhea, and overdiuresis can result in hypovolemia and a low CVP. This diagnosis can be substantiated when a rapid IV infusion of fluid causes the CVP to increase.

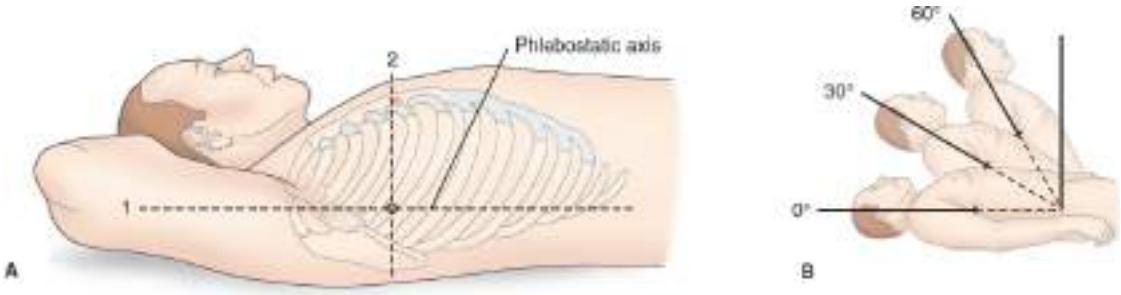


Figure 21-10 • **A.** The phlebostatic axis is the reference point for the atrium when the patient is positioned supine. It is the intersection of two lines on the chest wall: (*1*) the midaxillary line drawn between the anterior and posterior surfaces of the chest and (*2*) the line drawn through the fourth intercostal space. Its location is identified with a skin marker. The stopcock of the transducer used in hemodynamic monitoring is "leveled" at this mark prior to taking pressure measurements. **B.** Measurements can be taken with the head of the bed (HOB) elevated up to 60 degrees. Note the phlebostatic axis changes as the HOB is elevated; thus, the stopcock and transducer must be repositioned after each position change.

TABLE 21-5 Nursing Interventions to Prevent Intravascular Catheter-Related Bloodstream Infections

Topic	Intervention
Hand hygiene	• Wash hands with soap and water or use alcohol-based hand rubs before and after contact with the catheter for any reason.
Dressing	• Wear clean or sterile gloves when changing the dressing. • Cleanse the skin during dressing changes with a >0.5% chlorhexidine preparation with alcohol. • Use a chlorhexidine-impregnated dressing at the catheter insertion site. Do not use topical antibiotic ointment or creams on insertion sites. • Dress the site with sterile gauze or sterile, transparent, semipermeable dressing to cover the catheter site. If the patient is diaphoretic or if the site is bleeding or oozing, use a gauze dressing until it is resolved. • Change gauze dressings every 2 d or transparent dressings at least every 7 d and whenever dressings become damp, loosened, or visibly soiled.
Catheter site	• Assess the site regularly—visually when changing the dressing or by palpation through an intact dressing. Remove the dressing for a thorough assessment if the patient has tenderness at the insertion site, fever without obvious source, or other signs of local or bloodstream infection.
Needleless catheter systems	• Change needleless connectors, administration sets, and pressure tubing per institutional policy, usually every 96 h. • Scrub ports, connectors, and hubs with alcohol, chlorhexidine/alcohol, or povidone–iodine before and after access. • Apply alcohol-impregnated caps to needless connectors between uses.
Bathing	• Clean the skin daily with a 2% chlorhexidine wash. • Do not submerge the catheter or catheter site in water. • Showering is permitted if the catheter and related tubing are placed in an impermeable cover.

Patient education	• Ask patients to report any new discomforts from the catheter site.

Adapted from Gorski, L. A., Hadaway, L., Hagle, M., et al. (2016). Infusion therapy standards of practice. *Journal of Infusion Nursing*, *39*(1 Suppl.), S1–S159; O'Grady, N. P., Alexander, A., Burns, L., et al. (2011). 2017 Update of the guidelines for the prevention of intravascular catheter-related infections, 2011. Retrieved on 5/15/2019 at: www.cdc.gov/infectioncontrol/pdf/guidelines/bsi-guidelines-H.pdf; Talbot, T. R., Stone, E. C., Irwin, K., et al. (2017). 2017 Updated recommendations on the use of chlorhexidine-impregnated dressings for prevention of intravascular catheter-related infections. Retrieved on 5/15/ 2019 at: www.cdc.gov/infectioncontrol/pdf/guidelines/c-i-dressings-H.pdf

Before insertion of a CVP catheter, the site is prepared as recommended by the CDC (see Chapter 11, Chart 11-2). The preferred site is the subclavian vein; the femoral vein is generally avoided (O'Grady et al., 2011). A local anesthetic agent is used. During this sterile procedure, the physician threads a single-lumen or multilumen catheter through the vein into the vena cava just above or within the right atrium. Once the CVP catheter is inserted, it is secured and a dry sterile dressing is applied. Position of the catheter is confirmed by a chest x-ray.

Nursing Interventions

The frequency of CVP measurements is dictated by the patient's condition and the treatment plan. In addition to obtaining pressure readings, the CVP catheter is used for infusing IV fluids, administering IV medications, and drawing blood specimens. Nursing care of the patient with a CVP catheter follows central line and pressure tubing guidelines (see Table 21-5).

Pulmonary Artery Pressure Monitoring

Pulmonary artery pressure monitoring is used in critical care for assessing left ventricular function, diagnosing the etiology of shock, and evaluating the patient's response to medical interventions (e.g., fluid administration, vasoactive medications). A pulmonary artery catheter and a pressure monitoring system are used. A variety of catheters are available for cardiac pacing, oximetry, cardiac output measurement, or a combination of functions. Pulmonary artery catheters are balloon-tipped, flow-directed catheters that have distal and proximal lumens (Fig. 21-11). The distal lumen has a port that opens into the pulmonary artery. Once connected by its hub to the pressure monitoring system, it is used only to continuously measure pulmonary artery pressures. The proximal lumen has a port that opens into the right atrium. It is used to administer IV medications and fluids or to monitor right atrial pressures (i.e., CVP). Each catheter has a balloon inflation hub and valve. A syringe is connected to the hub, which is used to inflate or deflate the balloon

with air (maximum 1.5-mL capacity). The valve opens and closes the balloon inflation lumen.

A pulmonary artery catheter with specialized capabilities has additional components. For example, the thermodilution catheter has three additional features that enable it to measure cardiac output: a thermistor connector attached to the cardiac output computer of the bedside monitor, a proximal injectate port used for injecting fluids when obtaining the cardiac output, and a thermistor (positioned near the distal port) (see Fig. 21-11).

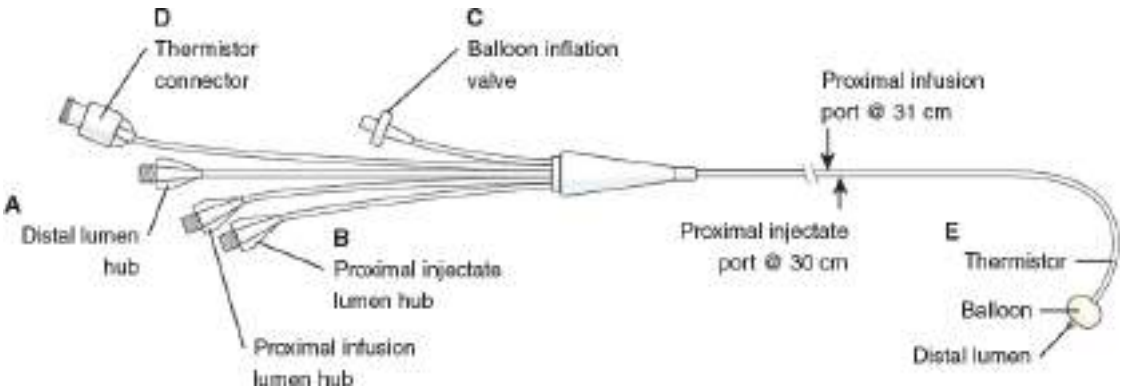


Figure 21-11 • The pulmonary artery catheter used for obtaining pressure measurements and cardiac output. **A.** The pressure monitoring system is connected to the distal lumen hub. **B.** Intravenous solutions are infused through the proximal infusion and injectate lumen hubs. **C.** An air-filled syringe connected to the balloon inflation valve is used for balloon inflation during catheter insertion and pulmonary artery wedge pressure measurements. **D.** To obtain cardiac output, the thermistor connector is inserted into the cardiac output component of the bedside cardiac monitor, and 5 to 10 mL of normal saline is injected in 4 seconds into the proximal injectate port. **E.** The thermistor located near the balloon is used to calculate the cardiac output. Redrawn courtesy of Baxter Healthcare Corporation, Edwards Critical Care Division, Santa Ana, California.

The pulmonary artery catheter, covered with a sterile sleeve, is inserted into a large vein, preferably the subclavian, through a sheath. As noted previously, the femoral vein is avoided; insertion techniques and protocols mirror those used for inserting a CVP catheter (see previous discussion) (O'Grady et al., 2011). The sheath is equipped with a side port for infusing IV fluids and medications. The catheter is then passed into the vena cava and right atrium. In the right atrium, the balloon tip is inflated, and the catheter is carried rapidly by the flow of blood through the tricuspid valve into the right ventricle, through the pulmonic valve, and into a branch of the pulmonary artery. When the catheter reaches the pulmonary artery, the balloon is deflated and the catheter is secured with sutures (Fig. 21-12). Fluoroscopy may be used during

insertion to visualize the progression of the catheter through the right heart chambers to the pulmonary artery. This procedure can be performed in the operating room, in the cardiac catheterization laboratory, or at the bedside in the critical care unit. During insertion of the pulmonary artery catheter, the bedside monitor is observed for pressure and waveform changes, as well as arrhythmias, as the catheter progresses through the right heart to the pulmonary artery.

Once the catheter is in position, the following are measured: right atrial, pulmonary artery systolic, pulmonary artery diastolic, mean pulmonary artery, and pulmonary artery wedge pressures (see Fig. 21-2 for normal chamber pressures). Monitoring of the pulmonary artery diastolic and pulmonary artery wedge pressures is particularly important in critically ill patients because they are used to evaluate left ventricular filling pressures (i.e., left ventricular preload).

It is important to note that the pulmonary artery wedge pressure is achieved by inflating the balloon tip for a maximum of 15 seconds, which causes it to float more distally into a smaller portion of the pulmonary artery until it is wedged into position. This is an occlusive maneuver that impedes blood flow through that segment of the pulmonary artery. Therefore, the wedge pressure is measured immediately and the balloon deflated promptly to restore blood flow.

Quality and Safety Nursing Alert

After measuring the pulmonary artery wedge pressure, the nurse ensures that the balloon is deflated and that the catheter has returned to its normal position. This important intervention is verified by evaluating the return of the pulmonary artery systolic and diastolic waveform displayed on the bedside monitor.

Nursing Interventions

Catheter site care is essentially the same as for a CVP catheter. Similar to CVP measurement, the transducer must be positioned at the phlebostatic axis to ensure accurate readings (see Fig. 21-10). Serious complications include pulmonary artery rupture, pulmonary thromboembolism, pulmonary infarction, catheter kinking, arrhythmias, and air embolism.

Intra-Arterial Blood Pressure Monitoring

Intra-arterial BP monitoring is used to obtain direct and continuous BP measurements in critically ill patients who have severe hypertension or hypotension. Arterial catheters are also useful when arterial blood gas measurements and blood samples need to be obtained frequently.

The radial artery is the usual site selected. However, placement of a catheter into the radial artery can further impede perfusion to an area that has poor circulation. As a result, the tissue distal to the cannulated artery can become ischemic or necrotic. Patients with diabetes, peripheral vascular disease, or hypotension, receiving IV vasopressors, or having had previous surgery are at highest risk for this complication. Before arterial line insertion, two tests may be considered to assess circulation; namely, a Doppler ultrasound or a modified Allen's test. A Doppler ultrasound assesses blood flow of the artery. The modified Allen's test assesses collateral circulation. To perform the Allen's test, the patient's hand is elevated and the patient is asked to make a fist. The nurse compresses the radial and ulnar arteries simultaneously, causing the hand to blanch. After the patient opens the fist, the nurse releases the pressure on the ulnar artery. If blood flow is restored (hand turns pink) within 7 seconds, the circulation to the hand may be adequate enough to tolerate placement of a radial artery catheter (Wiegand, 2017).

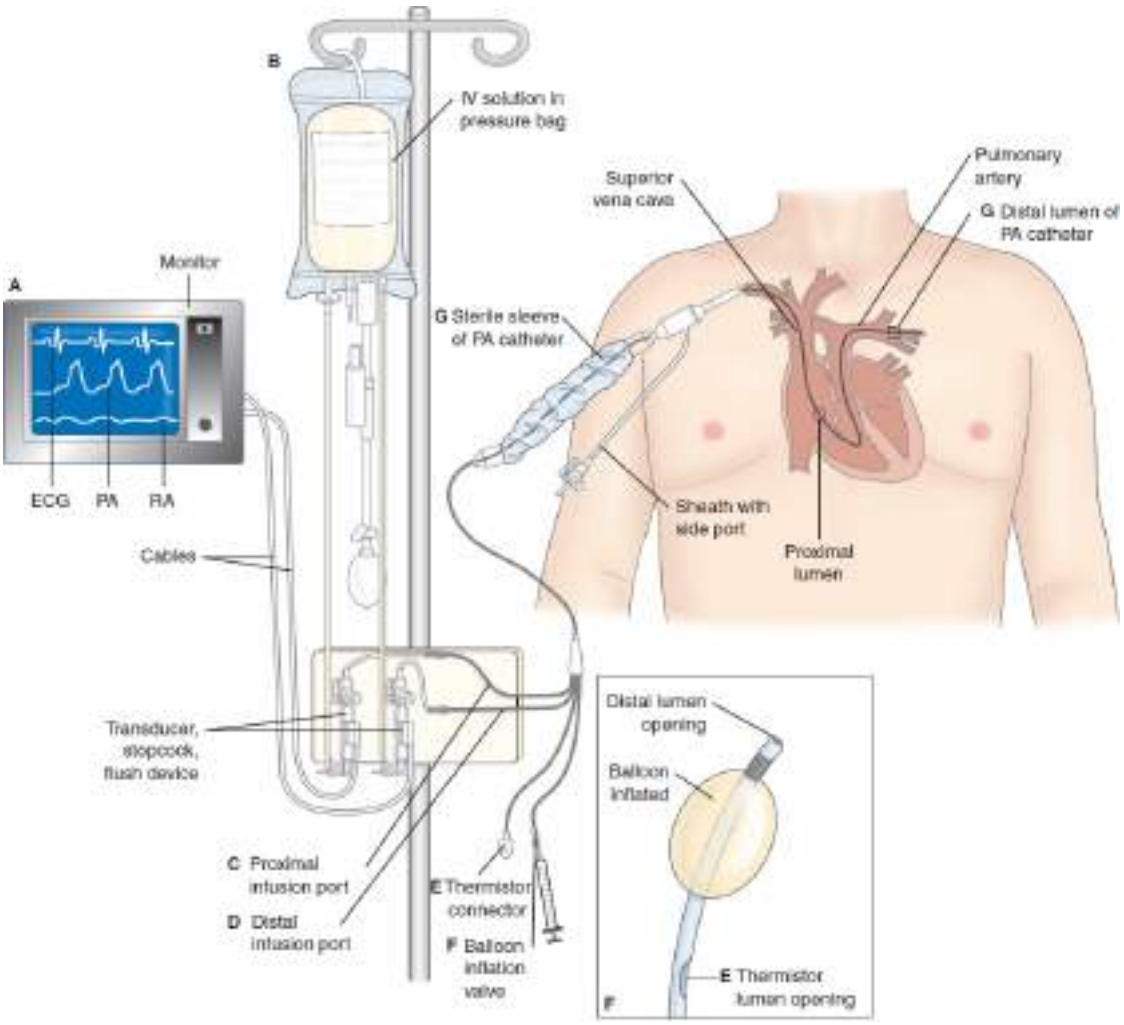


Figure 21-12 • Pulmonary artery (PA) catheter and pressure monitoring systems. Bedside monitor that connects with cables (**A**) to the pressure monitoring systems (includes intravenous [IV] solution in a pressure bag, IV tubing, and two transducers with stopcocks and flush devices) (**B**). This system connects to the proximal infusion port that opens in the right atria (**C**) and is used to infuse fluids or medications and monitor central venous pressures and the distal infusion port (**D**). This port opens in the PA and is used to monitor PA pressures. **E.** The thermistor connector is attached to the bedside cardiac monitor to obtain cardiac output. **F.** An air-filled syringe is attached to the balloon inflation valve during catheter insertion and measurement of PA wedge pressure. **G.** PA catheter positioned in the pulmonary artery. Note the sterile sleeve over the PA catheter. The PA catheter is threaded through the sheath until it reaches the desired position in the PA. The side port on the sheath is used to infuse medications or fluids. ECG, electrocardiogram; RA, right atrium.

Nursing Interventions

Site preparation and care are the same as for CVP catheters. The catheter flush solution is normal saline, which is the same as for CVP and pulmonary artery catheters. A transducer is attached, and pressures are measured in millimeters of mercury (mm Hg). The nurse monitors the patient for complications, which include local obstruction with distal ischemia, external hemorrhage, massive ecchymosis, dissection, air embolism, blood loss, pain, arteriospasm, and infection.

Minimally Invasive Cardiac Output Monitoring Devices

Monitoring cardiac output using the pulmonary artery catheter has been the standard of practice in critical care since its inception over 50 years ago. Its use has diminished recently with the availability of new, less invasive devices. Several types of devices are commercially available. Selection of a specific device for clinical use is determined by availability, provider preferences, and the patient's clinical condition (Urden et al., 2017).

Pulse pressure analysis uses an arterial pressure waveform to continuously estimate the patient's stroke volume. One such device, the Edwards Lifesciences Vigileo monitoring system, is connected to an existing radial or femoral arterial line via its FloTrac transducer. Using age, gender, body surface area, and BP of the patient, this device calculates continuous cardiac output and other parameters used in the management of critically ill patients. The major drawback to this device is that in order for it to capture accurate data, it must first capture optimal arterial waveforms. Therefore, this type of device has limited usefulness in patients with poor waveform signals, some arrhythmias, hemodynamic instability, and those who may be concomitantly using an intra-aortic balloon pump (see Chapter 11).

Esophageal Doppler probes are used to noninvasively estimate cardiac output. The esophageal probe measures blood flow velocity within a cross-sectional area of the descending aorta to calculate cardiac output. The use of this device in the perioperative setting has been shown to improve patient outcomes, including decreased lengths of hospital stay and an overall decrease in rates of complications (Urden et al., 2017).

The Fick method, which uses carbon dioxide (CO_2) measures, is an additional method used to estimate cardiac output. To obtain cardiac output using this method, a rebreathing loop is attached to the ventilator along with an infrared CO_2 sensor, an airflow sensor, and pulse oximeter. Continuous readings of cardiac output may be updated every 3 minutes with the use of this device. As an alternative, a Fick calculation may be done that uses the patient's body surface area and oxygen consumption (arterial and venous saturations and hemoglobin) to determine cardiac output.

CRITICAL THINKING EXERCISES

1 pq You receive report on a 65-year-old male patient being transferred to the cardiac ICU from the cardiac catheterization lab. The nurse reports that the patient has a history of chest pain, ACS, MI, hypertension, and diabetes. An elective right and left heart catheterization was performed and three stents were placed in the coronary arteries. The patient received normal saline IV 250 mL, heparin 4500 units, fentanyl 100 mg, and midazolam 2 mg. A TR Band is in place over the right radial artery which must stay in place for 2 hours. The patient tolerated the procedure well. What are your top nursing priorities when the patient arrives to the unit? Discuss key nursing interventions after cardiac catheterization. Describe how the nursing care of a patient with radial access differs from a patient with femoral access. What education will you provide the patient concerning postprocedure care?

2 ebp You are assigned to care for a 48-year-old female patient with a pulmonary artery (PA) catheter. She has advanced heart failure and is on the transplant waiting list. What cardiac assessment findings do you expect to find? The charge nurse rounds and asks you if a care bundle has been implemented. What is a care bundle? How will you care for the pulmonary artery catheter to reduce the risk of catheter-related bloodstream infections? What is the strength of the evidence that guides these interventions?

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**Double asterisk indicates classic reference.

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22 Management of Patients with Arrhythmias and Conduction Problems

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Correlate the components of the normal electrocardiogram with physiologic events of the heart.
2. Define the electrocardiogram as a waveform that represents the cardiac electrical event in relation to the lead (placement of electrodes).
3. Analyze elements of an electrocardiographic rhythm strip: ventricular and atrial rate, ventricular and atrial rhythm, QRS complex and shape, QRS duration, P wave and shape, PR interval, and P:QRS ratio.
4. Identify the electrocardiographic criteria, causes and management of arrhythmias, and use the nursing process as a framework for care of the patient with an arrhythmia, including conduction disturbances.
5. Compare the different types of pacemakers, their uses, possible complications, and nursing implications.
6. Describe the key points of using a defibrillator; identify the purpose of an implantable cardioverter defibrillator, the types available, and the nursing implications.
7. Describe the nursing management of patients with implantable cardiac devices.

NURSING CONCEPTS

Perfusion

GLOSSARY

ablation: purposeful destruction of heart muscle cells, usually in an attempt to correct or eliminate an arrhythmia

arrhythmia: disorder of the formation or conduction (or both) of the electrical impulse within the heart, altering the heart rate, heart rhythm, or both and potentially causing altered blood flow (also referred to as dysrhythmia)

artifact: distorted, irrelevant, and extraneous electrocardiographic (ECG) waveforms

automaticity: ability of the cardiac cells to initiate an electrical impulse

cardiac resynchronization therapy (CRT): biventricular pacing used to correct interventricular, intraventricular, and atrioventricular conduction disturbances that occur in patients with heart failure

cardioversion: electrical current given in synchrony with the patient's own QRS complex to stop an arrhythmia

chronotropy: rate of impulse formation

conduction: transmission of electrical impulses from one cell to another

defibrillation: electrical current given to stop an arrhythmia, not synchronized with the patient's QRS complex

depolarization: process by which cardiac muscle cells change from a more negatively charged to a more positively charged intracellular state

dromotropy: conduction velocity

electrocardiogram (ECG): a record of a test that graphically measures the electrical activity of the heart, including each phase of the cardiac cycle

implantable cardioverter defibrillator (ICD): a device implanted into the chest wall to treat arrhythmias

inotropy: force of myocardial contraction

P wave: the part of an ECG that reflects conduction of an electrical impulse through the atrium; atrial depolarization

paroxysmal: arrhythmia that has a sudden onset and terminates spontaneously; usually of short duration, but may recur

PP interval: the duration between the beginning of one P wave and the beginning of the next P wave; used to calculate atrial rate and rhythm

PR interval: the part of an ECG that reflects conduction of an electrical impulse from the sinoatrial node through the atrioventricular node

QRS complex: the part of an ECG that reflects conduction of an electrical impulse through the ventricles; ventricular depolarization

QT interval: the part of an ECG that reflects the time from ventricular depolarization through repolarization

repolarization: process by which cardiac muscle cells return to a more negatively charged intracellular condition, their resting state

RR interval: the duration between the beginning of one QRS complex and the beginning of the next QRS complex; used to calculate ventricular rate and rhythm

sinus rhythm: electrical activity of the heart initiated by the sinoatrial node

ST segment: the part of an ECG that reflects the end of the QRS complex to the beginning of the T wave

T wave: the part of an ECG that reflects repolarization of the ventricles

TP interval: the part of an ECG that reflects the time between the end of the T wave and the beginning of the next P wave; used to identify the isoelectric line

U wave: the part of an ECG that may reflect Purkinje fiber repolarization; usually, it is not seen unless a patient's serum potassium level is low

It is essential for the heart to have a regular rate and rhythm to perform efficiently as a pump to circulate oxygenated blood and other life-sustaining nutrients to all of the body's tissues and organs (including the heart itself). With an irregular or erratic rhythm, the heart is considered to be arrhythmic (also called *dysrhythmic*). This is a potentially dangerous condition.

Nurses may encounter patients with arrhythmias in all health care settings, including primary care settings, skilled nursing facilities, rehabilitation settings, hospitals, and the home health care setting. Some arrhythmias are acute and others chronic; some require emergent interventions, while others may not. Because patients with arrhythmias are frequently encountered in many different types of settings, nurses must be able to identify and provide appropriate first-line treatment of arrhythmias.

ARRHYTHMIAS

Arrhythmias are disorders of the formation or conduction (or both) of the electrical impulse within the heart. These disorders can cause disturbances of the heart rate, the heart rhythm, or both. Arrhythmias may initially be evidenced by the hemodynamic effect they cause (e.g., a change in conduction may change the pumping action of the heart and cause decreased blood pressure), and are diagnosed by analyzing the electrocardiographic (ECG) waveform. Their treatment is based on the frequency and severity of symptoms produced. Arrhythmias are named according to the site of origin of the electrical impulse and the mechanism of formation or conduction involved.

For example, an impulse that originates in the sinoatrial (SA) node and at a slow rate is called *sinus bradycardia.*

Normal Electrical Conduction

The electrical impulse that stimulates and paces the cardiac muscle normally originates in the SA node, also called the *sinus node,* an area located near the superior vena cava in the right atrium. In the adult, the electrical impulse usually occurs at a rate of 60 to 100 times a minute. The electrical impulse quickly travels from the SA node through the atria to the atrioventricular (AV) node (see Fig. 22-1); this process is known as **conduction**. The electrical stimulation of the muscle cells of the atria causes them to contract. The structure of the AV node slows the electrical impulse, giving the atria time to contract and fill the ventricles with blood. This part of atrial contraction is frequently referred to as the atrial kick and accounts for nearly one third of the volume ejected during ventricular contraction (Fuster, Harrington, Narula, et al., 2017). The electrical impulse then travels very quickly through the bundle of His to the right and left bundle branches and the Purkinje fibers, located in the ventricular muscle.

The electrical stimulation is called **depolarization**, and the mechanical contraction is called *systole.* Electrical relaxation is called **repolarization**, and mechanical relaxation is called *diastole.* The process from sinus node electrical impulse generation through ventricular repolarization completes the electromechanical circuit, and the cycle begins again. (See Chapter 21 for a more complete explanation of cardiac function.)

Influences on Heart Rate and Contractility

The heart rate is influenced by the autonomic nervous system, which consists of sympathetic and parasympathetic fibers. Sympathetic nerve fibers (also referred to as adrenergic fibers) are attached to the heart and arteries as well as several other areas in the body. Stimulation of the sympathetic system results in positive **chronotropy** (increased heart rate), positive **dromotropy** (increased AV conduction), and positive **inotropy** (increased force of myocardial contraction). Sympathetic stimulation also constricts peripheral blood vessels, therefore increasing blood pressure. Parasympathetic nerve fibers are also attached to the heart and arteries. Parasympathetic stimulation reduces the heart rate (negative chronotropy), AV conduction (negative dromotropy), and the force of atrial myocardial contraction. The decreased sympathetic stimulation results in dilation of arteries, thereby lowering blood pressure.

Manipulation of the autonomic nervous system may increase or decrease the incidence of arrhythmias. Increased sympathetic stimulation (e.g., caused by exercise, anxiety, fever, or administration of catecholamines such as dopamine, aminophylline, or dobutamine) may increase the incidence of arrhythmias. Decreased sympathetic stimulation (e.g., with rest, anxiety reduction methods such as therapeutic communication or meditation, or administration of beta-adrenergic blocking agents) may decrease the incidence of arrhythmias.

The Electrocardiogram

The electrical impulse that travels through the heart can be viewed by means of electrocardiography, the end product of which is an **electrocardiogram (ECG)**. Each phase of the cardiac cycle is reflected by specific waveforms on the screen of a cardiac monitor or on a strip of ECG graph paper.

Obtaining an Electrocardiogram

An ECG is obtained by placing electrodes on the body at specific areas. Biomonitoring electrodes come in various shapes and sizes, but all have two components: (1) an adhesive substance that attaches to the skin to secure the electrode in place and (2) a substance that reduces the skin's electrical impedance, facilitating the transfer of ions from the tissue to electrons in the electrode, enhancing conductivity. Gently abrading the skin with a clean dry gauze pad or sandpaper edge of the electrode helps to expose the inner conductive layer of epidermis, which will reduce skin impedance. Although cleansing the skin with alcohol removes any oily residue from the skin, it also increases the skin's electrical impedance and hinders detection of the cardiac electrical signal. Washing the area with soap and water prior to electrode placement is recommended. If the amount of chest hair prevents the electrode from having good contact with the skin, the hair may need to be clipped (Sendelbach & Jepsen, 2018; see Chapter 21, Chart 21-5: Applying Electrodes). Poor electrode adhesion will cause significant **artifact** (distorted, irrelevant, and extraneous ECG waveforms), which may distort capturing an accurate ECG waveform.

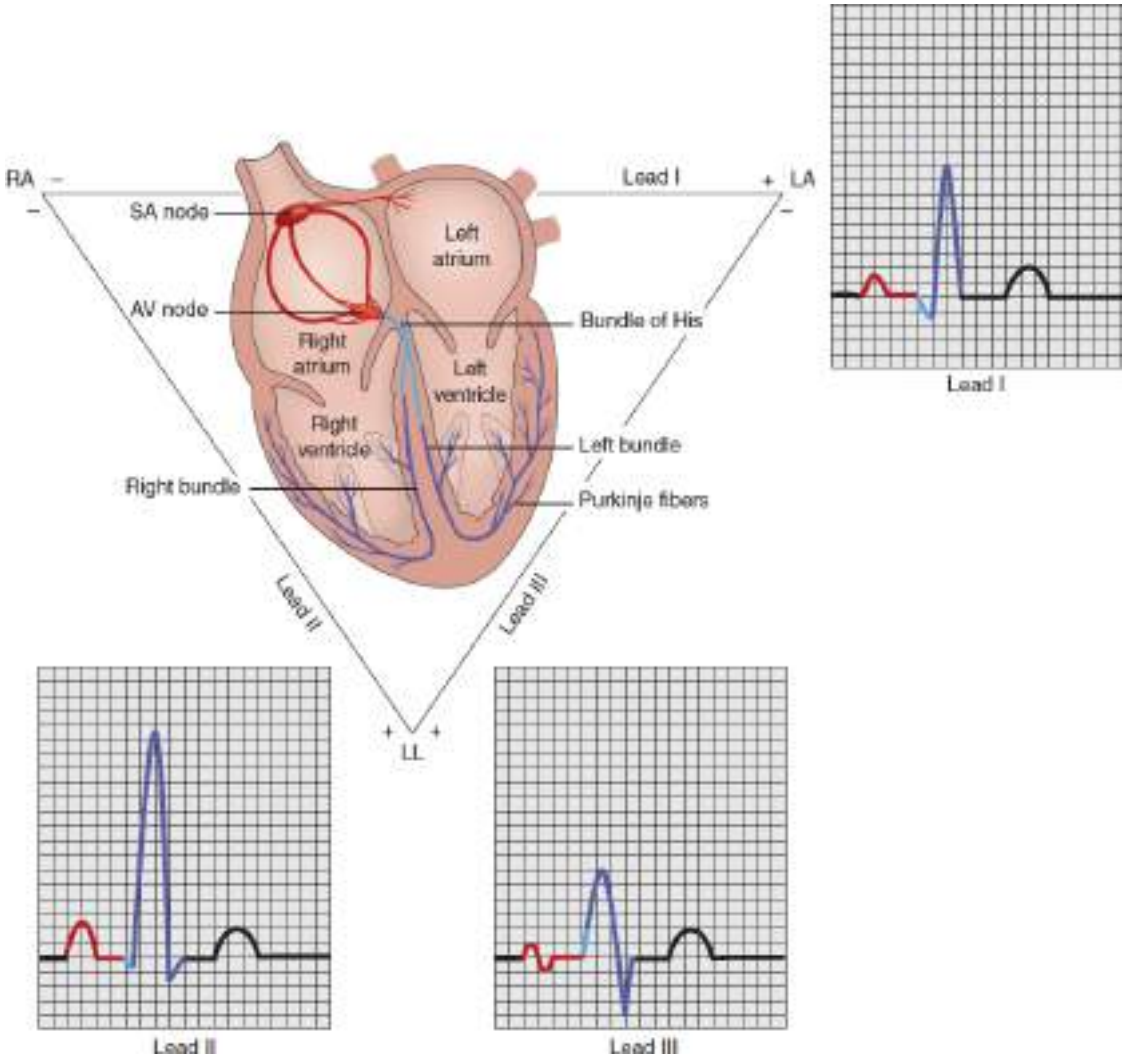

Figure 22-1 • Relationship of electrocardiographic (ECG) complex, lead system, and electrical impulse. The heart conducts electrical activity, which the ECG measures and shows. The configurations of electrical activity displayed on the ECG vary depending on the lead (or view) of the ECG and on the rhythm of the heart. Therefore, the configuration of a normal rhythm tracing from lead I will differ from the configuration of a normal rhythm tracing from lead II, lead II will differ from lead III, and so on. The same is true for abnormal rhythms and cardiac disorders. To make an accurate assessment of the heart's electrical activity or to identify where, when, and what abnormalities occur, the ECG needs to be evaluated from every lead, not just from lead II. Here the different areas of electrical activity are identified by color. RA, right arm; LA, left arm; SA, sinoatrial; AV, atrioventricular; LL, left leg.

The number and placement site of the electrodes depend on the type of ECG being obtained. Most continuous monitors use 2 to 5 electrodes, usually placed on the limbs and the chest. These electrodes create an imaginary line, called a *lead,* which serves as a reference point from which the electrical

activity is viewed. A lead is like an eye of a camera—it has a narrow peripheral field of vision, looking only at the electrical activity directly in front of it. Therefore, the ECG waveforms that appear on the ECG paper and cardiac monitor represent the electrical impulse in relation to the lead (see Fig. 22-1). A change in the waveform can be caused by a change in the electrical impulse (where it originates or how it is conducted) or by a change in the lead. Electrodes are attached to cable wires, which are connected to one of the following:

- An ECG machine placed at the patient's side for an immediate recording (standard 12-lead ECG)
- A cardiac monitor at the patient's bedside for continuous reading; this kind of monitoring, usually called *hardwire monitoring,* is used in intensive care units
- A small box that the patient carries and that continuously transmits the ECG information by radiowaves to a central monitor located elsewhere (called *telemetry*)
- A small, lightweight tape recorder–like machine (called *continuous ECG monitoring*, which might include a *Holter monitor* or a *patch monitor*) that the patient wears for a prescribed period of time and that continuously records the ECG, which is later viewed and analyzed with a scanner
- A very small device inserted under the skin or worn externally on a wrist band (called *intermittent monitoring* using a *looped recorder*) can perform ECG monitoring on demand whenever a patient is symptomatic (see Chapter 21 for further discussion of ECG monitoring systems)

A patient may undergo an electrophysiology study (EPS) in which electrodes are placed inside the heart in order to obtain an intracardiac ECG. This is used not only to diagnose the arrhythmia but also to determine the most effective treatment plan. However, because an EPS is invasive, it is performed in the hospital and may require that the patient be admitted (see later discussion).

During open heart surgery, temporary pacemaker wires may be lightly sutured to the epicardium and brought through the chest wall. These wires may be used not only for temporary pacing but also, when connected to the V lead cable, to obtain an atrial ECG, which can be helpful in the differential diagnosis of tachyarrhythmias (see Chapter 23 for further discussion).

The placement of electrodes for monitoring varies with the type of technology, the purpose of monitoring, and the protocols used in the health care facility. For a standard 12-lead ECG, 10 electrodes (6 on the chest and 4 on the limbs) are placed on the body (see Fig. 22-2). To prevent interference from the electrical activity of skeletal muscle, the limb electrodes are placed

on areas that are not bony and that do not have significant movement. The limb electrodes provide the first six leads: leads I, II, III, aVR (augmented voltage right arm), aVL (augmented voltage left arm), and aVF (augmented voltage left leg/foot). The 6 chest electrodes are applied to the chest at very specific areas. The chest electrodes provide the V or precordial leads, V_1 through V_6. To locate the fourth intercostal space and the placement of V_1, the sternal angle and then the sternal notch, which is about 1 or 2 inches below the sternal angle, are located. When the fingers are moved to the patient's immediate right, the second rib can be palpated. The second intercostal space is the indentation felt just below the second rib. Locating the specific intercostal space is critical for the correct placement of each chest electrode. Errors in diagnosis can occur if electrodes are incorrectly placed. Sometimes, when a patient in the hospital needs to be monitored more closely for ECG changes, the chest electrodes are left in place to ensure the same placement for follow-up 12-lead ECGs.

A standard 12-lead ECG reflects the electrical activity primarily in the left ventricle. Placement of additional electrodes for other leads may be needed to obtain more complete information. For example, in patients with suspected right-sided heart damage, right-sided precordial leads are required to evaluate the right ventricle (see Fig. 22-2).

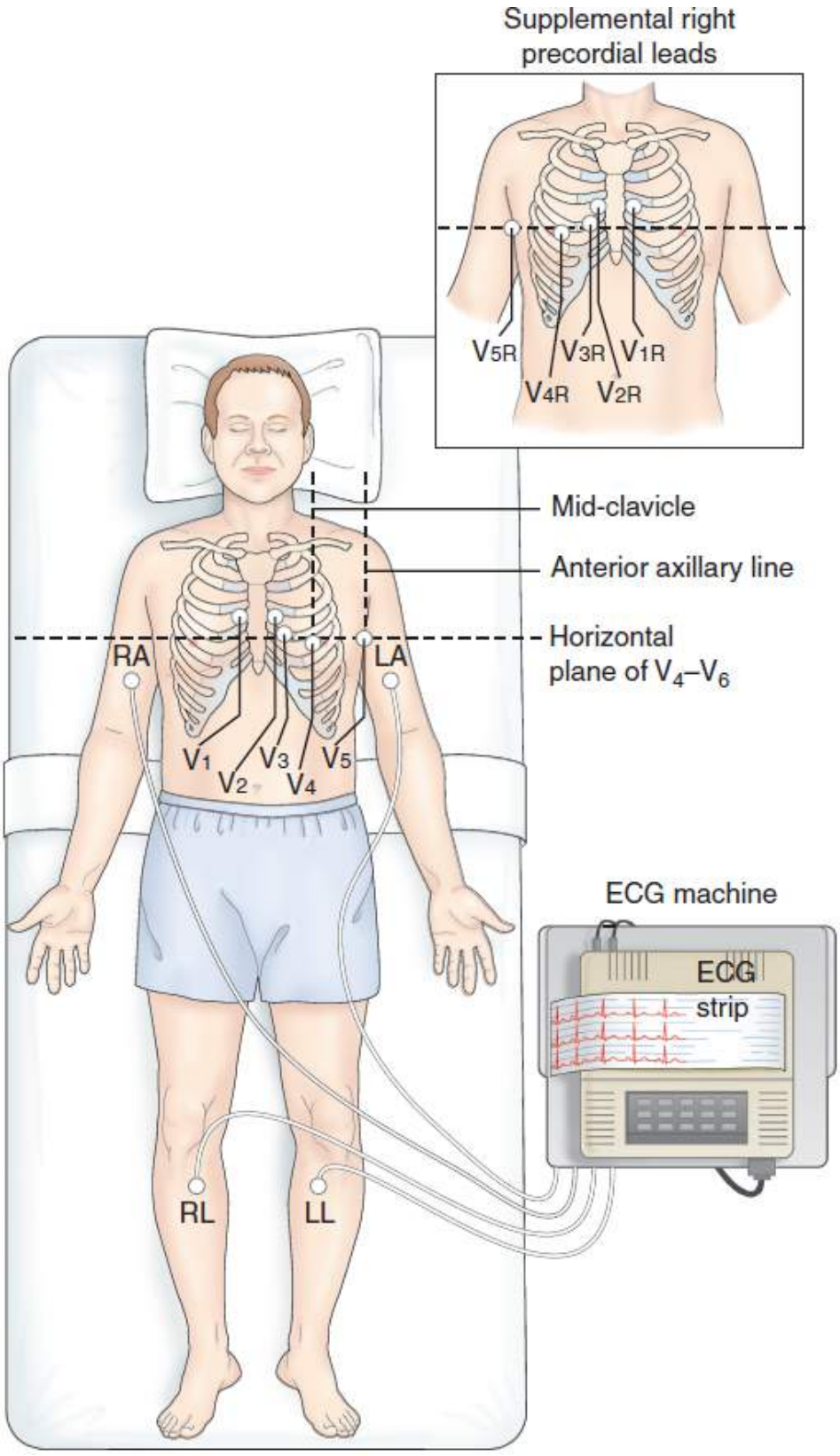

Figure 22-2 • ECG electrode placement. The standard left precordial leads are V_1—fourth intercostal space, right sternal border; V_2—fourth intercostal space, left sternal border; V_3—diagonally between V_2 and V_4; V_4—fifth intercostal space, left

midclavicular line; V_5—same level as V_4, anterior axillary line; V_6 (not illustrated)—same level as V_4 and V_5, midaxillary line. The right precordial leads, placed across the right side of the chest, are the mirror opposite of the left leads. RA, right arm; LA, left arm; RL, right leg; LL, left leg.

Components of the Electrocardiogram

The ECG waveform reflects the function of the heart's conduction system in relation to the specific lead. The ECG offers important information about the electrical activity of the heart and is useful in diagnosing arrhythmias. ECG waveforms are printed on graph paper that is divided by vertical and horizontal lines at standard intervals (see Fig. 22-3). Time and rate are measured on the horizontal axis of the graph, and amplitude or voltage is measured on the vertical axis. When an ECG waveform moves toward the top of the paper, it is called a *positive deflection.* When it moves toward the bottom of the paper, it is called a *negative deflection.* When reviewing an ECG, each waveform should be examined and compared with the others.

Waves, Complexes, and Intervals

The ECG is composed of waveforms (including the P wave, the QRS complex, the T wave, and possibly a U wave) and of segments and intervals (including the PR interval, the ST segment, and the QT interval) (see Fig. 22-3).

The **P wave** represents the electrical impulse starting in the SA node and spreading through the atria. Therefore, the P wave represents atrial depolarization. It is normally 2.5 mm or less in height and 0.11 seconds or less in duration.

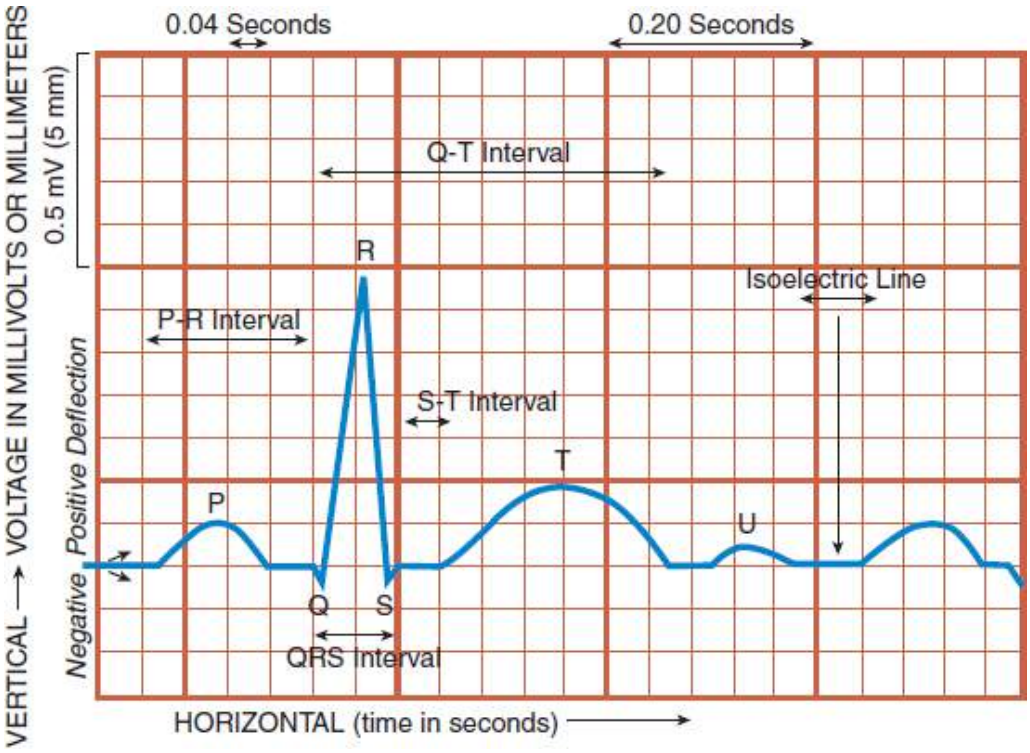

Figure 22-3 • ECG graph and commonly measured components. Each large box represents 0.20 seconds on the horizontal axis and 5 mm or 0.5 millivolt on the vertical axis. Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 17-16). Philadelphia, PA: Wolters Kluwer.

The **QRS complex** represents ventricular depolarization. Not all QRS complexes have all three waveforms. The Q wave is the first negative deflection after the P wave. The Q wave is normally less than 0.04 seconds in duration and less than 25% of the R-wave amplitude. The R wave is the first positive deflection after the P wave, and the S wave is the first negative deflection after the R wave. When a wave is less than 5 mm in height, small letters (q, r, s) are used; when a wave is taller than 5 mm, capital letters (Q, R, S) are used to label the waves. The QRS complex is normally less than 0.12 seconds in duration.

The **T wave** represents ventricular repolarization (when the cells regain a negative charge; also called the *resting state*). It follows the QRS complex and is usually the same direction (deflection) as the QRS complex. Atrial repolarization also occurs but is not visible on the ECG because it occurs at the same time as ventricular depolarization (i.e., the QRS).

The **U wave** is thought to represent repolarization of the Purkinje fibers; although this wave is rare, it sometimes appears in patients with hypokalemia (low potassium levels), hypertension, or heart disease. If present, the U wave

follows the T wave and is usually smaller than the P wave. If larger in amplitude, it may be mistaken for an extra P wave.

The **PR interval** is measured from the beginning of the P wave to the beginning of the QRS complex and represents the time needed for sinus node stimulation, atrial depolarization, and conduction through the AV node before ventricular depolarization. In adults, the PR interval normally ranges from 0.12 to 0.20 seconds in duration.

The **ST segment,** which represents early ventricular repolarization, lasts from the end of the QRS complex to the beginning of the T wave. The beginning of the ST segment is usually identified by a change in the thickness or angle of the terminal portion of the QRS complex. The end of the ST segment may be more difficult to identify because it merges into the T wave. The ST segment is normally isoelectric (see later discussion of TP interval). It is analyzed to identify whether it is above or below the isoelectric line, which may be, among other signs and symptoms, a sign of cardiac ischemia (see Chapter 23).

The **QT interval**, which represents the total time for ventricular depolarization and repolarization, is measured from the beginning of the QRS complex to the end of the T wave. The QT interval varies with heart rate, gender, and age; therefore, the measured interval may be corrected (QT_c) for these variables through specific calculations. The QT_c may be automatically calculated by the ECG technology, or a nurse may manually calculate or use a resource that contains a chart of these calculations. The QT interval is usually 0.32 to 0.40 seconds in duration if the heart rate is 65 to 95 bpm. Many medications commonly given in the hospital can cause prolongation of the QT interval (QT_c), placing the patient at risk for a lethal ventricular arrhythmia called *torsades de pointes.*

The **TP interval** is measured from the end of the T wave to the beginning of the next P wave—an isoelectric period (see Fig. 22-3). When no electrical activity is detected, the line on the graph remains flat; this is called the *isoelectric line.* The ST segment is compared with the TP interval to detect ST segment changes. The PR segment is sometimes used to determine the isoelectric line. However, because the PR segment sometimes is altered due to ischemic conditions, the TP interval is the preferred reference for the isoelectric line.

The **PP interval** is measured from the beginning of one P wave to the beginning of the next P wave. The PP interval is used to determine atrial rate and rhythm. The **RR interval** is measured from one QRS complex to the next QRS complex. The RR interval is used to determine ventricular rate and rhythm (see later discussion).

Analyzing the Electrocardiogram Rhythm Strip

The ECG rhythm strip must be analyzed in a systematic manner to determine the patient's cardiac rate and rhythm, and to detect arrhythmias and conduction disorders, as well as evidence of myocardial ischemia, injury, and infarction.

Determining Heart Rate from the Electrocardiogram

Heart rate can be obtained from the ECG rhythm strip by several methods. A 1-minute rhythm strip contains 300 large boxes and 1500 small boxes. Therefore, an easy and accurate method of determining heart rate with a regular rhythm is to count the number of small boxes within an RR interval and divide 1500 by that number. If, for example, there are 10 small boxes between two R waves, the heart rate is 1500/10, or 150 bpm; if there are 25 small boxes, the heart rate is 1500/25, or 60 bpm (see Fig. 22-4).

An alternative but less accurate method for estimating heart rate, which is usually used when the rhythm is irregular, is to count the number of RR intervals in 6 seconds and multiply that number by 10. The top of the ECG paper is usually marked at 3-second intervals, which is 15 large boxes horizontally. The RR intervals are counted, rather than QRS complexes, because a computed heart rate based on the latter might be inaccurately high.

The same methods may be used for determining atrial rate, using the PP interval instead of the RR interval.

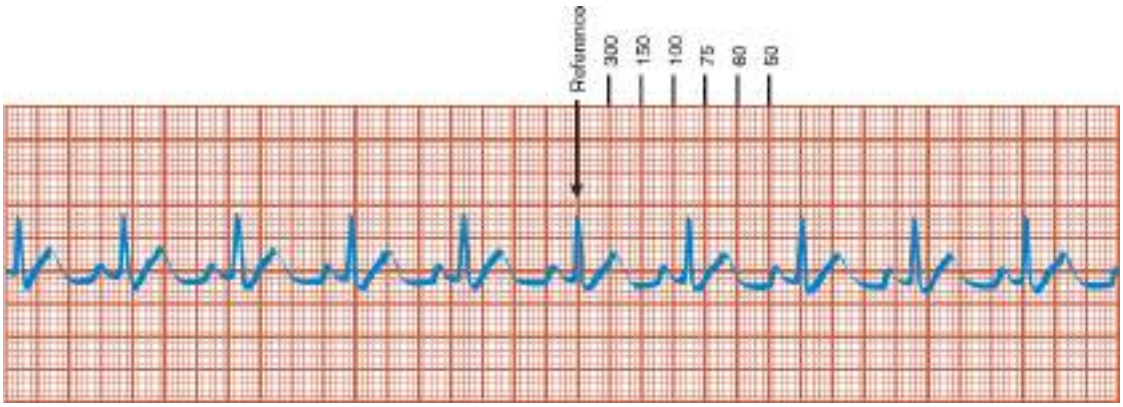

Figure 22-4 • Method for estimating heart rate. The number of small boxes in the RR interval is 17.5; divide this by 1500, and the heart rate is approximately 86 bpm. Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 17-18 (bottom portion)). Philadelphia, PA: Wolters Kluwer.

Determining Heart Rhythm from the Electrocardiogram

The rhythm is often identified at the same time the rate is determined. Chart 22-1 provides an example of a method that can be used to analyze the patient's rhythm. The RR interval is used to determine ventricular rhythm and the PP interval to determine atrial rhythm. If the intervals are the same or if the difference between the intervals is less than 0.8 seconds throughout the strip, the rhythm is called *regular*. If the intervals are different, the rhythm is called *irregular*.

Once the rhythm has been analyzed, the findings are compared with and matched to the ECG criteria for arrhythmias to determine a diagnosis. It is important for the nurse not only to identify the arrhythmia, but also to assess the patient to determine the physiologic effect of the arrhythmia and identify possible causes. Treatment of an arrhythmia is based on clinical evaluation of the patient with identification of the arrhythmia's etiology and physiologic effect, not on its presence on ECG alone.

Chart 22-1

Interpreting Arrhythmias: Systematic Analysis of the Electrocardiogram

When examining an electrocardiogram (ECG) rhythm strip to learn more about a patient's arrhythmia:

1. Determine the ventricular rate.
2. Determine the ventricular rhythm.
3. Determine the QRS duration.
4. Determine whether the QRS duration is consistent throughout the strip. If not, identify other duration.
5. Identify the QRS shape; if not consistent, then identify other shapes.
6. Identify P waves; is there a P in front of every QRS?
7. Identify the P-wave shape; identify whether it is consistent or not.
8. Determine the atrial rate.
9. Determine the atrial rhythm.
10. Determine each PR interval.
11. Determine if the PR intervals are consistent, irregular but with a pattern to the irregularity, or just irregular.
12. Determine how many P waves for each QRS (P:QRS ratio).

In many cases, the nurse may use a checklist and document the findings next to the appropriate ECG criterion.

Most cardiac monitoring has functionality that includes the ability to continuously monitor the rhythm and alert health care personnel with an auditory and visual alarm when a clinically significant change in the rhythm occurs. However, a high rate of triggered, clinically insignificant alarms may lead to alarm fatigue, which has been linked to nurses ignoring, disabling, or

silencing alarms (Sendelbach & Jepsen, 2018)—putting patients at increased risk of adverse events.

Quality and Safety Nursing Alert

It is vital that the nurse assesses the cause(s) of a cardiac monitor's alarm and then adjusts the alarm default settings and individualizes the alarm parameter limits and levels. The assessment should also include an evaluation and discussion with the primary provider to validate that the patient needs to remain on continuous cardiac monitoring.

Normal Sinus Rhythm

Electrical conduction that begins in the SA node generates a **sinus rhythm.** Normal sinus rhythm occurs when the electrical impulse starts at a regular rate and rhythm in the SA node and travels through the normal conduction pathway. Normal sinus rhythm has the following characteristics (see Fig. 22-5):

Ventricular and atrial rate: 60 to 100 bpm in the adult
Ventricular and atrial rhythm: Regular
QRS shape and duration: Usually normal, but may be regularly abnormal
P wave: Normal and consistent shape; always in front of the QRS
PR interval: Consistent interval between 0.12 and 0.20 seconds
P:QRS ratio: 1:1

Normal sinus rhythm is generally indicative of good cardiovascular health. However, an increase of 10 bpm or more in the resting heart rate increases the risk for sudden cardiac death, atrial fibrillation, heart failure, coronary artery disease, stroke, and cardiovascular disease (Aune, Sen, ó'Hartaigh, et al., 2017).

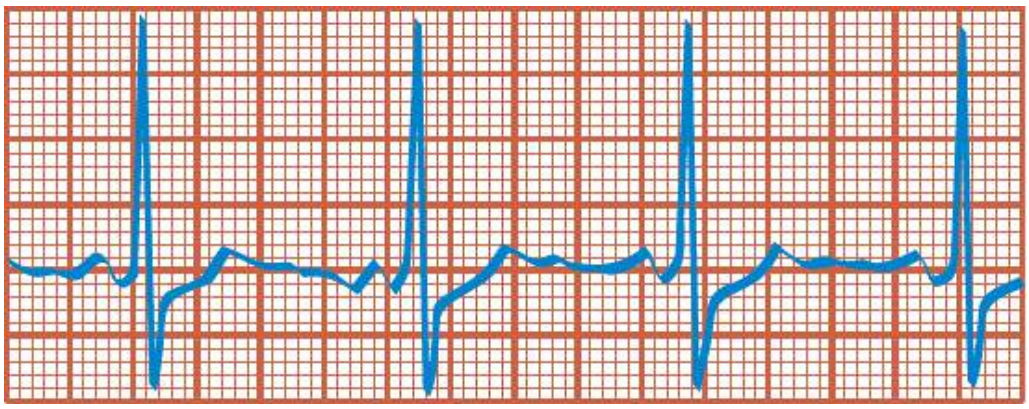

Figure 22-5 • Normal sinus rhythm. Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 17-19A). Philadelphia, PA: Wolters Kluwer.

Types of Arrhythmias

Arrhythmias include sinus, atrial, junctional, and ventricular arrhythmias and their various subcategories, as well as conduction abnormalities.

Sinus Node Arrhythmias

Sinus node arrhythmias originate in the SA node; these include sinus bradycardia, sinus tachycardia, and sinus arrhythmia.

Sinus Bradycardia

Sinus bradycardia occurs when the SA node creates an impulse at a slower-than-normal rate. Causes include lower metabolic needs (e.g., sleep, athletic training, hypothyroidism), vagal stimulation (e.g., from vomiting, suctioning, severe pain), medications (e.g., calcium channel blockers [e.g., nifedipine, amiodarone], beta-blockers [e.g., metoprolol]), idiopathic sinus node dysfunction, increased intracranial pressure, and coronary artery disease, especially myocardial infarction (MI) of the inferior wall. Unstable and symptomatic bradycardia is frequently due to hypoxemia. Other possible causes include acute altered mental status (e.g., delirium) and acute decompensated heart failure (Fuster et al., 2017). Sinus bradycardia has the following characteristics (see Fig. 22-6):

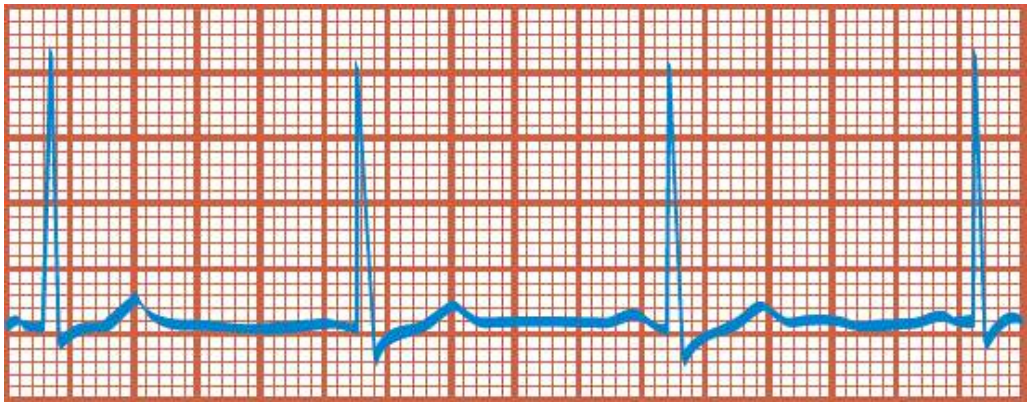

Figure 22-6 • Sinus bradycardia. Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 17-19C). Philadelphia, PA: Wolters Kluwer.

Ventricular and atrial rate: Less than 60 bpm in the adult
Ventricular and atrial rhythm: Regular
QRS shape and duration: Usually normal, but may be regularly abnormal
P wave: Normal and consistent shape; always in front of the QRS
PR interval: Consistent interval between 0.12 and 0.20 seconds
P:QRS ratio: 1:1

All characteristics of sinus bradycardia are the same as those of normal sinus rhythm, except for the rate. The patient is assessed to determine the hemodynamic effect and the possible cause of the arrhythmia. If the decrease in heart rate results from stimulation of the vagus nerve, such as with bearing down during defecation or vomiting, attempts are made to prevent further vagal stimulation. If the bradycardia is caused by a medication such as a beta-blocker, the medication may be withheld. If the slow heart rate causes significant hemodynamic changes resulting in shortness of breath, acute alteration of mental status, angina, hypotension, ST-segment changes, or premature ventricular complexes (PVCs), treatment is directed toward increasing the heart rate. Slow heart rate may be due to sinus node dysfunction (previously known as *sick sinus syndrome*), which has a number of risk factors including increased body mass index, presence of right and left bundle branch block, history of a major cardiovascular event, increased age, and hypertension (Jackson, Rathakrishnan, Campbell, et al., 2017). *Tachy-brady syndrome* is the term used when bradycardia alternates with tachycardia.

Medical Management

Management depends on the cause and symptoms. Resolving the causative factors may be the only treatment needed. If the bradycardia produces signs and symptoms of clinical instability (e.g., acute alteration in mental status, chest discomfort, or hypotension), 0.5 mg of atropine may be given rapidly as

an intravenous (IV) bolus and repeated every 3 to 5 minutes until a maximum dosage of 3 mg is given. Rarely, if the bradycardia is unresponsive to atropine, emergency transcutaneous pacing can be instituted, or medications, such as dopamine, isoproterenol, or epinephrine, are given (Kusumoto, Schoenfeld, Barrett, et al., 2019; see later discussion).

Sinus Tachycardia

Sinus tachycardia occurs when the sinus node creates an impulse at a faster-than-normal rate. Causes may include the following:

- Physiologic or psychological stress (e.g., acute blood loss, anemia, shock, hypervolemia, hypovolemia, heart failure, pain, hypermetabolic states, fever, exercise, anxiety)
- Medications that stimulate the sympathetic response (e.g., catecholamines, aminophylline, atropine), stimulants (e.g., caffeine, nicotine), and illicit drugs (e.g., amphetamines, cocaine, ecstasy)
- Enhanced automaticity of the SA node and/or excessive sympathetic tone with reduced parasympathetic tone that is out of proportion to physiologic demands, a condition called *inappropriate sinus tachycardia*
- Autonomic dysfunction, which results in a type of sinus tachycardia referred to as postural orthostatic tachycardia syndrome (POTS). POTS is characterized by tachycardia without hypotension, and by presyncopal symptoms such as palpitations, lightheadedness, weakness, and blurred vision, which occur with sudden posture changes

Sinus tachycardia has the following characteristics (see Fig. 22-7):

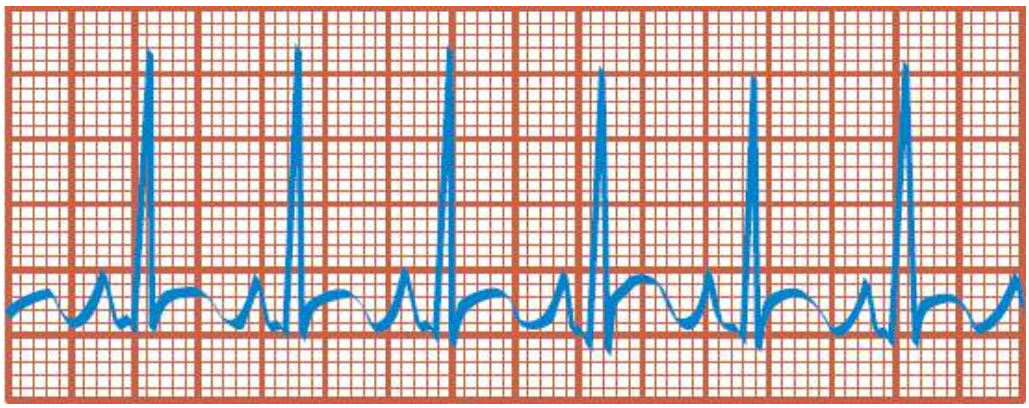

Figure 22-7 • Sinus tachycardia. Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 17-19B). Philadelphia, PA: Wolters Kluwer.

Ventricular and atrial rate: Greater than 100 bpm in the adult, but usually less than 120 bpm

Ventricular and atrial rhythm: Regular

QRS shape and duration: Usually normal, but may be regularly abnormal

P wave: Normal and consistent shape; always in front of the QRS, but may be buried in the preceding T wave

PR interval: Consistent interval between 0.12 and 0.20 seconds

P:QRS ratio: 1:1

All aspects of sinus tachycardia are the same as those of normal sinus rhythm, except for the rate. Sinus tachycardia does not start or end suddenly (i.e., it is nonparoxysmal). As the heart rate increases, the diastolic filling time decreases, possibly resulting in reduced cardiac output and subsequent symptoms of syncope (fainting) and low blood pressure. If the rapid rate persists and the heart cannot compensate for the decreased ventricular filling, the patient may develop acute pulmonary edema.

Medical Management

Medical management of sinus tachycardia is determined by the severity of symptoms and directed at identifying and abolishing its cause. Vagal maneuvers, such as carotid sinus massage, gagging, bearing down against a closed glottis (as if having a bowel movement), forceful and sustained coughing, and applying a cold stimulus to the face (such as applying an ice-cold wet towel to the face), or administration of adenosine should be considered to interrupt the tachycardia. If the tachycardia is persistent and causing hemodynamic instability (e.g., acute alteration in mental status, chest discomfort, hypotension), synchronized **cardioversion** (i.e., electrical current given in synchrony with the patient's own QRS complex to stop an arrhythmia) is the treatment of choice, if vagal maneuvers and adenosine are unsuccessful or not feasible (see later discussion). IV beta-blockers (Class II antiarrhythmic) and calcium channel blockers (Class IV antiarrhythmic) (see Table 22-1) may also be considered in treating hemodynamically stable sinus tachycardia, although synchronized cardioversion may be used if medications are ineffective or contradicted (Page, Joglar, Caldwell, et al., 2016). Catheter ablation (see later discussion) of the SA node may be used in cases of persistent inappropriate sinus tachycardia unresponsive to other treatments. Treatment for POTS often involves a combination of approaches, with treatment targeted at the underlying problem. For example, patients with hypovolemia may be advised to increase their fluid and sodium intake, or use salt tablets if necessary.

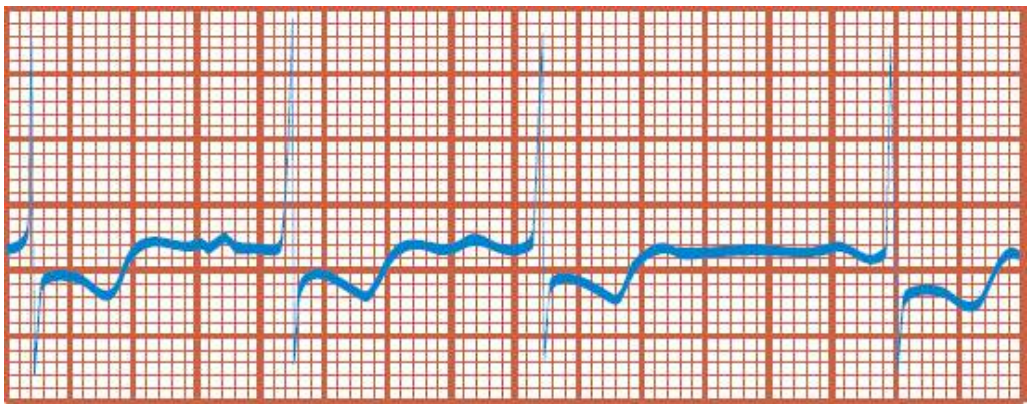

Figure 22-8 • Sinus arrhythmia. Note irregular RR and PP intervals. Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 17-19D). Philadelphia, PA: Wolters Kluwer.

Sinus Arrhythmia

Sinus arrhythmia occurs when the sinus node creates an impulse at an irregular rhythm; the rate usually increases with inspiration and decreases with expiration. Nonrespiratory causes include heart disease and valvular disease, but these are rare. Sinus arrhythmia has the following characteristics (see Fig. 22-8):

Ventricular and atrial rate: 60 to 100 bpm in the adult
Ventricular and atrial rhythm: Irregular
QRS shape and duration: Usually normal, but may be regularly abnormal
P wave: Normal and consistent shape; always in front of the QRS
PR interval: Consistent interval between 0.12 and 0.20 seconds
P:QRS ratio: 1:1

Medical Management

Sinus arrhythmia does not cause any significant hemodynamic effect and therefore is not typically treated.

Atrial Arrhythmias

Atrial arrhythmias originate from foci within the atria and not the SA node. These include aberrancies such as premature atrial complexes (PACs) as well as atrial fibrillation and atrial flutter.

Premature Atrial Complex

A PAC is a single ECG complex that occurs when an electrical impulse starts in the atrium before the next normal impulse of the sinus node. The PAC may be caused by caffeine, alcohol, nicotine, stretched atrial myocardium (e.g., as

in hypervolemia), anxiety, hypokalemia (low potassium level), hypermetabolic states (e.g., with pregnancy), or atrial ischemia, injury, or infarction. PACs are often seen with sinus tachycardia. PACs have the following characteristics (see Fig. 22-9):

Ventricular and atrial rate: Depends on the underlying rhythm (e.g., sinus tachycardia)

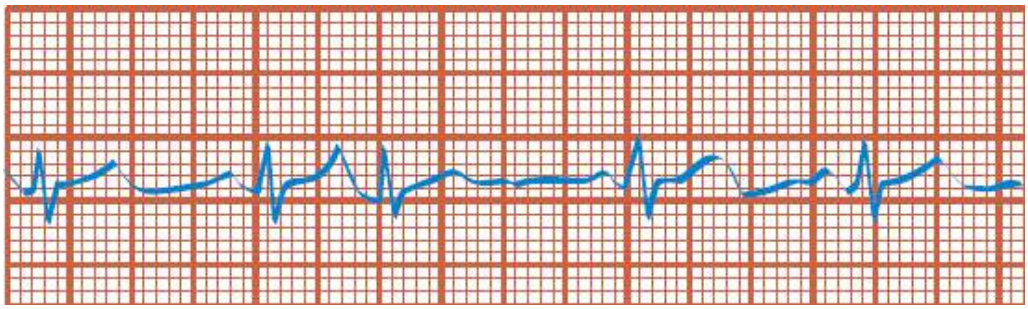

Figure 22-9 • Premature atrial complex (PAC). Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 17-22A). Philadelphia, PA: Wolters Kluwer.

TABLE 22-1 Summary of Antiarrhythmic Medications[a]

Class[b]	Action	Drug Names	Side Effects	Nursing Interventions
IA	Moderate depression of depolarization; prolongs repolarization Treats and prevents atrial and ventricular arrhythmias	quinidine, procainamide, disopyramide	Decreased cardiac contractility Prolonged QRS, QT Proarrhythmic Hypotension with IV administration Diarrhea with quinidine, constipation with disopyramide Cinchonism with quinidine Lupuslike syndrome with procainamide Anticholinergic effects: dry mouth, urinary hesitancy with disopyramide	Observe for HF. Monitor BP with IV administration. Monitor QRS duration for increase >50% from baseline. Monitor for prolonged QT. Monitor *N*-acetyl procainamide (NAPA) laboratory values during procainamide therapy. If given for atrial fibrillation, ensure that the patient has been pretreated with a medication to control AV conduction.
IB	Minimal depression of depolarization; shortened repolarization Treats ventricular arrhythmias	lidocaine, mexiletine	CNS changes (e.g., confusion, lethargy) Bradycardia GI distress Tremors	Monitor for CNS changes and tremors. Discuss with the primary provider decreasing lidocaine dose in older adult patients and patients with cardiac/liver dysfunction.
IC	Marked depression of depolarization; little effect on repolarization Treats atrial and ventricular arrhythmias	flecainide, propafenone	Proarrhythmic HF Dizziness, visual disturbances, dyspnea	Decrease dose with renal dysfunction and strict vegetarian diets. Avoid use in patients with structural heart disease (e.g., coronary artery disease and heart failure).
II	Decreases automaticity and conduction Treats atrial and ventricular arrhythmias	acebutolol[c], atenolol, bisoprolol/HCTZ, esmolol[c], labetalol, metoprolol, nadolol, propranolol[c], sotalol (also has class III actions)[c], timolol	Bradycardia, AV block Decreased contractility Bronchospasm Nausea Asymptomatic and symptomatic hypotension Masks hypoglycemia and thyrotoxicosis CNS disturbances (e.g., confusion, dizziness, fatigue, depression)	Monitor heart rate, PR interval, signs and symptoms of HF, especially in those also taking calcium channel blockers. Monitor blood glucose level in patients with type 2 diabetes. Caution the patient about abrupt withdrawal to avoid tachycardia, hypertension, and myocardial ischemia.
III	Prolongs repolarization Amiodarone treats and prevents ventricular and atrial arrhythmias, especially in patients with ventricular dysfunction. Dofetilide and ibutilide treat and prevent atrial arrhythmias.	amiodarone, dofetilide, chonadarone, ibutilide	Pulmonary toxicity (amiodarone) Corneal microdeposits (amiodarone) Photosensitivity (amiodarone) Bradycardia Hypotension, especially with IV administration Polymorphic ventricular arrhythmias (rare with amiodarone) Nausea and vomiting Potentiates digoxin (amiodarone) See beta-blockers above (sotalol).	Make sure that the patient is sent for baseline pulmonary function tests (amiodarone). Closely monitor the patient. Assess for contraindications prior to administration. Monitor QT duration. Continuous ECG monitoring with initiation of dofetilide and ibutilide. Monitor renal function.
IV	Blocks calcium channel Treats and prevents paroxysmal atrial arrhythmias[d]	verapamil, diltiazem	Bradycardia, AV blocks Hypotension with IV administration HF, peripheral edema Constipation, dizziness, headache, nausea	Monitor heart rate, PR interval. Monitor blood pressure closely with IV administration. Monitor for signs and symptoms of HF. Do not crush sustained-release medications.

[a]Based on Vaughan-Williams classification.
[b]There are other calcium channel blockers, but they are not approved or used for arrhythmias.
[c]Beta-blocker with labeled use for arrhythmias.
AV, atrioventricular; BP, blood pressure; CNS, central nervous system; ECG, electrocardiogram; GI, gastrointestinal; HCTZ, hydrochlorothiazide; HF, heart failure; IV, intravenous.
Adapted from the American Society of Health-System Pharmacists. (2019). AHFS drug information. Bethesda, MD: Author. Foster, V., Harrington, R. A., Narula, J., et al. (Eds.). (2017). Hurst's the heart (15th ed.). New York: McGraw-Hill. Al-Khatib, S. M., Stevenson, W. G., Ackerman, M. J., et al. (2018). 2017 AHA/ACC/HRS guideline for management of patients with ventricular arrhythmias and the prevention of sudden cardiac death: A report of the American College of Cardiology/American Heart Association Task Force on clinical practice guidelines and the Heart Rhythm Society. *Circulation, 138*(13), e272–e391.

Ventricular and atrial rhythm: Irregular due to early P waves, creating a PP interval that is shorter than the others. This is sometimes followed by a longer-than-normal PP interval, but one that is less than twice the normal PP interval. This type of interval is called a *noncompensatory pause*

QRS shape and duration: The QRS that follows the early P wave is usually normal, but it may be abnormal (aberrantly conducted PAC). It may even be absent (blocked PAC)

P wave: An early and different P wave may be seen or may be hidden in the T wave; other P waves in the strip are consistent

PR interval: The early P wave has a shorter-than-normal PR interval, but still between 0.12 and 0.20 seconds

P:QRS ratio: Usually 1:1

PACs are common in normal hearts. The patient may say, "My heart skipped a beat." A pulse deficit (a difference between the apical and radial pulse rate) may exist.

Medical Management

If PACs are infrequent; no treatment is necessary. If they are frequent (more than six per minute), this may herald a worsening disease state or the onset of more serious arrhythmias, such as atrial fibrillation. Medical management is directed toward treating the underlying cause (e.g., reduction of caffeine intake, correction of hypokalemia).

Atrial Fibrillation

Atrial fibrillation is a very common arrhythmia; between 2.7 and 6.1 million Americans are living with atrial fibrillation (Centers for Disease Control and Prevention [CDC], 2017). Atrial fibrillation is a serious public health concern because it is associated with aging, and the older adult population is increasing in the United States (Chen, Chung, Allen, et al., 2018). Atrial fibrillation can result from diverse pathophysiologic etiologies and risks (see Chart 22-2).

Atrial fibrillation results from abnormal impulse formation that occurs when structural or electrophysiologic abnormalities alter the atrial tissue causing a rapid, disorganized, and uncoordinated twitching of the atrial musculature (January, Wann, Alpert, et al., 2014; January, Wann, Calkins, et al., 2019). Both the extrinsic (central) and intrinsic cardiac autonomic nervous systems (CANS) are thought to play an important role in the initiation and continuance of atrial fibrillation (Qin, Zeng, & Liu, 2019). Separate from the extrinsic (central) nervous system, which includes the brain and spinal cord, the CANS consists of a highly interconnected network of autonomic ganglia and nerve cell bodies embedded within the epicardium, largely within the atrial myocardium and great vessels (pulmonary veins). Hyperactive autonomic ganglia in the CANS are thought to play a critical role in atrial fibrillation, resulting in impulses that are initiated from the pulmonary veins and conducted through to the AV node. The ventricular rate of response depends on the conduction of atrial impulses through the AV node, presence of accessory electrical conduction pathways, and therapeutic effect of medications.

Lack of consistency in describing patterns or types of atrial fibrillation has led to the use of numerous labels, such as **paroxysmal** (i.e., sudden onset with

spontaneous termination), persistent, and permanent. The recommended classification system is noted in Chart 22-3. The use of the term "chronic atrial fibrillation" is no longer included in the classification system, due to a lack of consensus on what constitutes chronicity (January et al., 2014, 2019).

Chart 22-2 RISK FACTORS

Atrial Fibrillation

- Increasing age
- Hypertension
- Diabetes
- Obesity
- Valvular heart disease
- Heart failure
- Obstructive sleep apnea
- Alcohol abuse
- Hyperthyroidism
- Myocardial infarction
- Smoking
- Exercise
- Cardiothoracic surgery
- Increased pulse pressure
- European ancestry
- Family history

Adapted from January, C. T., Wann, L. S., Alpert, J. S., et al. (2014). 2014 AHA/ACC/HRS guideline for the management of patients with atrial fibrillation: A report of the ACC/AHA Task Force on practice guidelines and the Heart Rhythm Society. *Circulation, 130*(23), e199–e267; January, C. T., Wann, L. S., Calkins, H., et al. (2019). 2019 AHA/ACC/HRS focused update of the 2014 AHA/ACC/HRS guideline for the management of patients with atrial fibrillation: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society in Collaboration With the Society of Thoracic Surgeons. *Circulation, 140*(2), e125–e151.

Chart 22-3

Atrial Fibrillation Classification System

Type	Description
Paroxysmal	Sudden onset with termination that occurs spontaneously or after an intervention; lasts ≤7 days, but may recur
Persistent	Continuous, lasting >7 days
Long-standing persistent	Continuous, lasting >12 months
Permanent	Persistent, but decision has been made not to restore or maintain sinus rhythm
Nonvalvular	Absence of moderate-to-severe mitral stenosis or mechanical heart valve

Adapted from January, C. T., Wann, L. S., Alpert, J. S., et al. (2014). 2014 AHA/ACC/HRS guideline for the management of patients with atrial fibrillation: A report of the ACC/AHA Task Force on practice guidelines and the Heart Rhythm Society. *Circulation, 130*(23), e199–e267; January, C. T., Wann, L. S., Calkins, H., et al. (2019). 2019 AHA/ACC/HRS Focused Update of the 2014 AHA/ACC/HRS Guideline for the Management of Patients With Atrial Fibrillation: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society in Collaboration With the Society of Thoracic Surgeons. *Circulation, 140*(2), e125–e151.

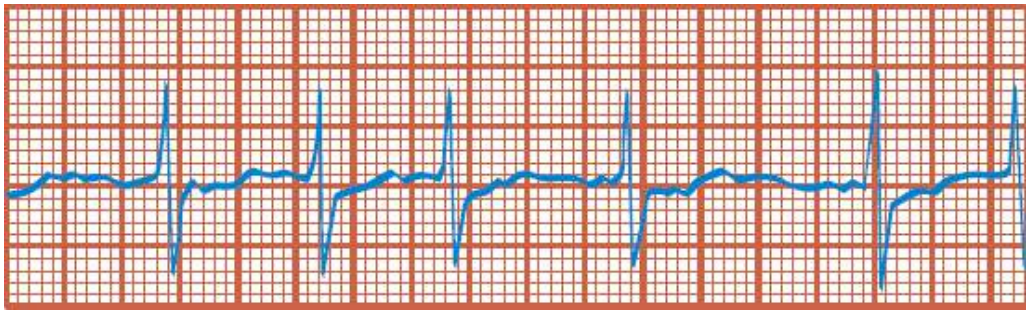

Figure 22-10 • Atrial fibrillation. Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 17-22D). Philadelphia, PA: Wolters Kluwer.

Atrial fibrillation has the following characteristics (Fig. 22-10):

Ventricular and atrial rate: Atrial rate is 300 to 600 bpm; ventricular rate is usually 120 to 200 bpm in untreated atrial fibrillation

Ventricular and atrial rhythm: Highly irregular

QRS shape and duration: Usually normal, but may be abnormal

P wave: No discernible P waves; irregular undulating waves that vary in amplitude and shape are seen and referred to as fibrillatory or f waves

PR interval: Cannot be measured

P:QRS ratio: Many:1

Patients with atrial fibrillation are at increased risk of heart failure, myocardial ischemia, and embolic events such as stroke (January et al., 2014, 2019). A rapid and irregular ventricular response reduces the time for ventricular filling, resulting in a smaller stroke volume. Because atrial fibrillation causes a loss in AV synchrony (the atria and ventricles contract at different times), the atrial kick (the last part of diastole and ventricular filling, which accounts for 25% to 30% of the cardiac output) is also lost. As a consequence, although some patients with atrial fibrillation are asymptomatic, others experience palpitations and clinical manifestations of heart failure (e.g., shortness of breath, hypotension, dyspnea on exertion, fatigue; see Chapter 25). In addition, a high ventricular rate of response during atrial fibrillation (greater than 80 bpm) can eventually lead to mitral valve dysfunction, mitral regurgitation, intraventricular conduction delays, and dilated ventricular cardiomyopathy.

Patients with atrial fibrillation may exhibit a pulse deficit—a numeric difference between apical and radial pulse rates. The shorter time in diastole reduces the time available for coronary artery perfusion, thereby increasing the risk of myocardial ischemia with the onset of anginal symptoms (see Chapter 23). Decreasing the ventricular rate may avoid and correct these effects.

The erratic nature of atrial contraction, alterations in ventricular ejection, and atrial myocardial dysfunction promote the formation of thrombi, especially within the left atrium, increasing the risk of an embolic event. The origin of embolisms resulting in stroke for patients with nonvalvular atrial fibrillation is most often the left atrial appendage (LAA) (Schellinger, Tsivgoulis, Steiner, et al., 2018). A therapeutic approach to addressing the role of the LAA in atrial fibrillation, left atrial appendage occlusion (LAAO), is discussed later in this chapter.

Assessment and Diagnostic Findings

The clinical evaluation of atrial fibrillation should include a history and physical examination that identifies the onset and nature of signs and symptoms, including their frequency, duration and any precipitating factors, and any response to medications. Whether or not the patient has a known history of heart disease or other risks is identified (see Chart 22-2). A 12-lead ECG is performed to verify the atrial fibrillation rhythm, as well as to identify the presence (or absence) of left ventricular (LV) hypertrophy, bundle branch block, prior myocardial ischemia, or other arrhythmias. The RR, QRS, and QT intervals are analyzed to verify the effectiveness of any prescribed antiarrhythmic medications (January et al., 2014, 2019). A transesophageal echocardiogram (TEE) can identify the presence of valvular heart disease, provide information about LV and right ventricular (RV) size and function, RV

pressures (to identify pulmonary hypertension, which may exist concomitant with atrial fibrillation), LV hypertrophy, and presence of left atrial thrombi (January et al., 2014, 2019).

Blood tests to screen for diseases that are known risks for atrial fibrillation (see Chart 22-2), including thyroid, renal, and hepatic function, are assessed in the patient with a new onset of atrial fibrillation, as well as when the ventricular rate is difficult to control (January et al., 2014, 2019). Additional tests may include a chest x-ray (to evaluate pulmonary vasculature in a patient suspected of having pulmonary hypertension), exercise stress test (to exclude myocardial ischemia or reproduce exercise-induced atrial fibrillation), Holter or event monitoring (see Chapter 21), and an EPS (January et al., 2014, 2019; see later discussion).

Medical Management

Treatment of atrial fibrillation depends on the cause, pattern, and duration of the arrhythmia, the ventricular response rate, as well as the presence of structural or valvular heart disease and other cardiac conditions such as coronary artery disease or heart failure. Strategies for both rhythm control (i.e., conversion to sinus rhythm) and rate control are dependent on shared clinical decision making between the patient and primary provider. In some cases, atrial fibrillation spontaneously converts to sinus rhythm within 24 to 48 hours and without treatment. However, in instances where atrial fibrillation is concomitant with significant other morbid conditions (e.g., severe heart failure), the atrial fibrillation may be classified as "permanent," meaning that the patient and primary provider have made a joint decision to stop further attempts to restore or maintain sinus rhythm. Therefore, management of atrial fibrillation may not only be different in different patients, but it also may change over time for any one patient.

Medical management revolves around preventing embolic events such as stroke with anticoagulant medications, controlling the ventricular rate of response with antiarrhythmic agents, and treating the arrhythmia as indicated so that it is converted to a sinus rhythm (i.e., *cardioversion*).

Pharmacologic Therapy

Antithrombotic Medications. Antithrombotic drugs may include anticoagulants and antiplatelet drugs. Oral antithrombotic therapy is indicated for most patients with nonvalvular atrial fibrillation (e.g., absence of mechanical heart valve) because it reduces the risk of stroke (January et al., 2014, 2019). Atrial fibrillation guidelines recommend use of a scoring system to assist in assessment of stroke risk. Antithrombotic therapy is then selected based on risk factors outlined in the mnemonic CHA_2DS_2-VAS_C (see Chart 22-4) with each risk factor assigned points tallied for a total score that indicates an overall risk of stroke (January et al., 2014, 2019).

Chart 22-4

Stroke Risk Assessment for the Patient with Atrial Fibrillation: The CHA_2DS_2-VAS_C Scoring System

Risk Factor		Points
C	Congestive Heart Failure (left ventricular systolic dysfunction)	1
H	Hypertension (BP >130/80 mm Hg)	1
A_2	Age ≥75 years	2
D	Diabetes	1
S_2	Prior Stroke/TIA/Thromboembolism	2
V	Vascular disease (i.e., prior MI, PAD, or aortic plaque)	1
A	Age 65–74 years	1
S_c	Sex category (female gender)	1

MI, myocardial infarction; PAD, peripheral artery disease, TIA; transient ischemic attack.

Adapted from January, C. T., Wann, L. S., Alpert, J. S., et al. (2014). 2014 AHA/ACC/HRS guideline for the management of patients with atrial fibrillation: A report of the ACC/AHA Task Force on practice guidelines and the Heart Rhythm Society. *Circulation, 130*(23), e199–e267; January, C. T., Wann, L. S., Calkins, H., et al. (2019). 2019 AHA/ACC/HRS Focused Update of the 2014 AHA/ACC/HRS Guideline for the Management of Patients With Atrial Fibrillation: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society in Collaboration With the Society of Thoracic Surgeons. *Circulation, 140*(2), e125–e151.

According to pharmacologic treatment guidelines (January et al., 2014, 2019):

- Patients with nonvalvular atrial fibrillation with a CHA_2DS_2-VAS_C score of zero may choose the option of no antithrombotic therapy.
- Patients with nonvalvular atrial fibrillation with a CHA_2DS_2-VAS_C score of one may choose no antithrombotic therapy, treatment with an oral anticoagulant, or aspirin.
- Patients with nonvalvular atrial fibrillation with a CHA_2DS_2-VAS_C score of 2 or higher for men and 3 or higher for women may choose warfarin, or a direct thrombin inhibitor (e.g., dabigatran), or a Factor Xa inhibitor (e.g., rivaroxaban, apixaban, edoxaban).

Patients with atrial fibrillation with valvular heart disease or bioprosthetic heart valves may be prescribed warfarin, or a direct-acting oral anticoagulant, or a Factor Xa inhibitor (Malik, Yandrapalli, Aronow, et al., 2019). For

patients with mechanical heart valves, warfarin is recommended (January et al., 2014, 2019). If immediate or short-term anticoagulation is necessary, the patient may be placed on IV or low–molecular-weight heparin until warfarin therapy can be started and the international normalized ratio (INR) level reaches a therapeutic range consistent with antithrombosis, usually defined as an INR between 2.0 and 3.0 (see Chapter 26 for further discussion).

Medication selection for all patients with atrial fibrillation depends upon stroke and bleeding risks as well as patient preferences and values (January et al., 2014, 2019). For instance, treatment with warfarin will require weekly INR testing during initiation of therapy, as well as ongoing monitoring (see Chapter 26 for further discussion). Home monitoring of therapy is an option for some patients. Direct-acting oral anticoagulants and Factor Xa inhibitors require baseline assessment of hemoglobin and hematocrit, as well as liver and renal function, along with INR. Advantages of these medications include fewer drug–drug interactions and dietary limitations, as well as the elimination of frequent INR testing.

Medications that Control the Heart Rate. A strategy to control the ventricular rate of response so that the resting heart rate is less than 80 bpm is recommended in order to manage symptoms of atrial fibrillation (January et al., 2014, 2019). To decrease the ventricular rate in patients with paroxysmal, persistent, or permanent atrial fibrillation, a beta-blocker (Class II antiarrhythmic, see Table 22-1) or non-dihydropyridine calcium channel blocker (Class IV antiarrhythmic, see Table 22-1) is generally recommended (January et al., 2014, 2019).

Medications that Convert the Heart Rhythm or Prevent Atrial Fibrillation. For patients with atrial fibrillation lasting 48 hours or longer, anticoagulation is recommended prior to attempts to restore sinus rhythm, which may be achieved through pharmacologic or electrical cardioversion (January et al., 2014, 2019). In the absence of therapeutic anticoagulation, TEE may be performed prior to cardioversion to identify left atrial thrombus formation, including in the LAA (January et al., 2014, 2019). If no thrombus is identified, cardioversion can proceed.

Medications that may be given to achieve pharmacologic cardioversion to sinus rhythm include flecainide, dofetilide, propafenone, amiodarone, and IV ibutilide (January et al., 2014, 2019). These medications are most effective if given within 7 days of the onset of atrial fibrillation. It is recommended that patients who were prescribed dofetilide be hospitalized so that the QT interval and renal function both may be monitored. Despite a degree of risk, dofetilide is a preferred medication because it is highly effective at converting atrial fibrillation to sinus rhythm, has fewer drug-to-drug interactions, and is better tolerated by patients than other medications. Some patients with recurrent atrial fibrillation may be prescribed flecainide to self-administer at home, an approach referred to as “pill in the pocket” (January et al., 2014, 2019).

Preoperative administration of beta-blockers (see Table 22-1) has resulted in a significant reduction in atrial fibrillation after cardiac surgery (Burrage, Low, Campbell, et al., 2019). Cholesterol-lowering drugs such as the HMG-CoA reductase inhibitors (also called statins; see Chapter 23, Table 23-1) may also be prescribed to prevent new-onset atrial fibrillation following cardiac surgery (Burrage et al., 2019).

If symptomatic, paroxysmal atrial fibrillation is refractory to at least one Class I or Class III antiarrhythmic medication (see Table 22-1), and rhythm control is desired, catheter ablation may be indicated (January et al., 2014, 2019; see later discussion).

Electrical Cardioversion for Atrial Fibrillation

Electrical cardioversion is indicated for patients with atrial fibrillation who are hemodynamically unstable (e.g., acute alteration in mental status, chest discomfort, hypotension) and do not respond to medications (January et al., 2014, 2019). Flecainide, propafenone, amiodarone, dofetilide, or sotalol may be given prior to cardioversion to enhance the success of cardioversion and maintain sinus rhythm (January et al., 2014, 2019).

Quality and Safety Nursing Alert

The patient with atrial fibrillation is at high risk for thrombus formation. When electrical cardioversion is indicated, the nurse may anticipate that a transesophageal echocardiogram may be performed to evaluate for possible atrial thrombi.

Because atrial function may be impaired for several weeks after cardioversion, antithrombotic therapy (e.g., warfarin) is indicated for at least 4 weeks after the procedure (January et al., 2014, 2019). Repeated attempts at electrical cardioversion may be made, following administration of an antiarrhythmic medication (see later discussion on Electrical Cardioversion).

Cardiac Rhythm Therapies

Atrial fibrillation that does not respond to medications or electrical cardioversion may be treated by cardiac rhythm therapies, including catheter ablation, maze or mini-maze procedure, or convergent procedure.

Catheter Ablation Therapy

Catheter **ablation** destroys specific cells that are the cause of a tachyarrhythmia. Catheter ablation is performed most often today for atrial fibrillation, although it may also be useful in treating atrioventricular nodal reentry tachycardia (AVNRT) and recurrent ventricular tachycardia (VT) (see later discussion of these arrhythmias).

Atrial fibrillation is associated with intrinsic cardiac autonomic nervous system activity to the pulmonary veins. Ablation involves a procedure similar to a cardiac catheterization (see Chapter 21); however, in this instance, a special catheter is advanced at or near the origin of the arrhythmia, where high-frequency, low-energy sound waves are passed through the catheter, causing thermal injury, localized cell destruction, and scarring. The tissue damage is more specific to the arrhythmic tissue, with less trauma to the surrounding cardiac tissue. Ablation may also be accomplished using a special catheter to apply extremely cold temperature to destroy selected cardiac cells, called *cryoablation*. The goal of each of these ablation procedures is to eliminate the arrhythmia, by preventing the ectopic activity arising from the pulmonary veins from reaching the atria, thereby stopping fibrillation (Weber, Sagerer-Gerhardt, & Heinze, 2017).

An EPS (see later discussion) may be performed to induce the arrhythmia prior to the catheter ablation. During the ablation procedure, defibrillation pads, an automatic blood pressure cuff, and a pulse oximeter are used. The patient is usually given moderate sedation (see Chapter 15) and IV heparin to reduce the risk of periprocedural thromboembolism. Immediately postablation, the patient is monitored for another 30 to 60 minutes and then retested to ensure that the arrhythmia does not recur. Successful ablation is achieved when the arrhythmia cannot be induced. Major risks of catheter ablation include pericardial effusion and tamponade, phrenic nerve injury, stroke, hematoma, retroperitoneal bleeding, pulmonary vein stenosis, and atrioesophageal fistulas (Canpolat, Kocyigit, & Aytemir, 2017).

Nursing Management. Postprocedural care on a step-down unit for the patient who has had ablation is similar to the nursing management of a patient who has had a cardiac catheterization (see Chapter 21); the patient is monitored closely to ensure recovery from sedation. Postprocedural nursing interventions include frequent monitoring for arrhythmias and for signs and symptoms of a stroke and vascular access site complications. Because of the prolonged time required for the procedure as well as the time needed in bed to obtain hemostasis at the vascular access site, it is not unusual for the patient to have back discomfort. In addition to administering any pain medications, the nurse may help to alleviate this pain by placing rolled towels under the patient's knees and waist.

Maze and Mini-Maze Procedures

The maze procedure is an open heart surgical procedure for refractory atrial fibrillation. Small transmural incisions are made throughout the atria. The resulting formation of scar tissue prevents reentry conduction of the aberrant electrical impulse. Because the procedure requires significant time and cardiopulmonary bypass, its use is reserved only for those patients undergoing cardiac surgery for another reason (e.g., coronary artery bypass; January et al.,

2014, 2019). Some patients may need a permanent pacemaker after this surgery because of subsequent injury to the SA node.

A modification of the maze procedure, minimally invasive maze surgery, or mini-maze, may be performed by making small incisions between the ribs, through which video-guided instruments are inserted. The pulmonary veins are encircled with surgical incisions within the left atrium. This surgery eliminates the need for opening the sternum, heart–lung bypass, and the use of cardioplegia (see Chapter 23 for further discussion of cardiac surgery). This results in a shorter recovery time and a lower risk of infection (January et al., 2014, 2019).

Convergent Procedure

The convergent procedure utilizes a hybrid approach to ablation, requiring the skills of both a cardiothoracic surgeon and an electrophysiologist, a cardiologist with specialized training. This procedure is associated with lower rates of arrhythmia recurrence than catheter ablation, but more complications within 30 days of the procedure (e.g., infections, bleeding) (Jan, Zizek, Gersak, et al., 2018). The surgeon creates a few small incisions in the abdomen so that a special catheter that allows visualization can be inserted through the diaphragm and toward the posterior wall of the heart. The surgeon performs ablation of the epicardial wall in the area around the pulmonary veins and the electrophysiologist performs ablation around the endocardial area of the pulmonary veins. Because of the incisions, the patient usually has a 3-day hospital length of stay (Elrod, 2014). The patient may experience mild dull chest pain caused by the resulting inflammation from the ablation that usually resolves within a few days (Elrod, 2014). This pain is usually alleviated by treatment with acetaminophen as needed. In addition, if the phrenic nerve was affected, the patient may experience shortness of breath that may take days to weeks to resolve (Elrod, 2014).

Left Atrial Appendage Occlusion

LAAO is an alternative to antithrombotic medications for stroke prevention in patients with nonvalvular atrial fibrillation (Masoudi, Calkins, Kavinsky, et al., 2015). As noted previously, the LAA is the area where the majority of stroke-causing blood clots form in patients with nonvalvular atrial fibrillation. However, concerns about the risk of long-term anticoagulant use and the risk of bleeding can complicate effective management (Ojo, Yandrapalli, Veseli, et al., 2020).

Candidates for LAAO include those patients with increased risk of stroke based on CHA_2DS_2-VAS_C scores of one or higher (see Chart 22-4) and those patients seeking a nonpharmacologic alternative to treatment (Masoudi et al., 2015). Commonly used is the WATCHMAN, a device typically inserted while the patient is under general anesthesia. Similar to a percutaneous coronary

intervention (PCI) procedure (see Chapter 23), a small incision is made in the femoral area and a catheter is then inserted that guides the device into position. The parachute-shaped device is threaded through to the opening of the LAA, sealing it off and preventing it from releasing clots (see Fig. 22-11).

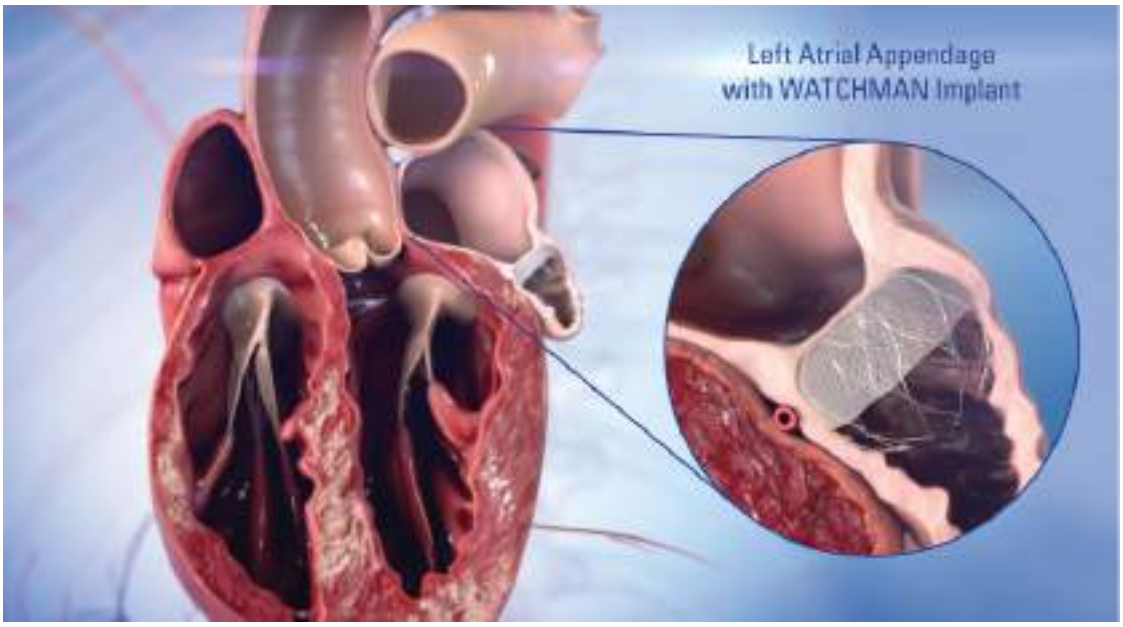

Figure 22-11 • The WATCHMAN device in place over the left atrial appendage. ©2021 Boston Scientific Corporation or its affiliates. All rights reserved.

Patients typically stay in the hospital overnight after placement of a WATCHMAN device. The nursing management of patients who received this device is similar to that of patients post cardiac catheterization (see Chapter 21). Patients are prescribed aspirin and warfarin post procedure; approximately 6 weeks post procedure, they should return to the cardiology clinic for a TEE to confirm that the device has effectively occluded the LAA. If LAAO has occurred, then the patient may stop taking warfarin and is prescribed clopidogrel, an antiplatelet medication. After 6 months, the patient may stop taking clopidogrel but must continue taking daily aspirin indefinitely (Carlson & Doshi, 2017).

Wolff-Parkinson-White Syndrome

In the patient with atrial fibrillation, if the QRS is wide and the ventricular rhythm is very fast and irregular, an accessory pathway should be suspected. An accessory pathway is typically congenital tissue between the atria, bundle of His, AV node, Purkinje fibers, or ventricular myocardium. This anomaly is known as Wolff-Parkinson-White (WPW) syndrome. Electrical cardioversion is the treatment of choice for atrial fibrillation in the presence of WPW syndrome that causes hemodynamic instability. Medications that block AV

conduction (e.g., digoxin, diltiazem, verapamil) should be avoided in WPW because they can increase the ventricular rate. If the patient is hemodynamically stable, procainamide, propafenone, flecainide, or amiodarone are recommended to restore sinus rhythm (January et al., 2014, 2019). Catheter ablation is performed for long-term management (see previous discussion).

Atrial Flutter

Atrial flutter occurs because of a conduction defect in the atrium and causes a rapid, regular atrial impulse at a rate between 250 and 400 bpm. Because the atrial rate is faster than the AV node can conduct, not all atrial impulses are conducted into the ventricle, causing a therapeutic block at the AV node. This is an important feature of this arrhythmia. If all atrial impulses were conducted to the ventricle, the ventricular rate would also be 250 to 400 bpm, which would result in ventricular fibrillation, a life-threatening arrhythmia. Atrial flutter risk factors mirror those for atrial fibrillation (Fuster et al., 2017; see Chart 22-2).

Atrial flutter has the following characteristics (see Fig. 22-12):

Ventricular and atrial rate: Atrial rate ranges between 250 and 400 bpm; ventricular rate usually ranges between 75 and 150 bpm

Ventricular and atrial rhythm: The atrial rhythm is regular; the ventricular rhythm is usually regular but may be irregular because of a change in the AV conduction

QRS shape and duration: Usually normal, but may be abnormal or absent

P wave: Saw-toothed shape; these waves are referred to as F waves

PR interval: Multiple F waves may make it difficult to determine the PR interval

P:QRS ratio: 2:1, 3:1, or 4:1

Medical Management

Atrial flutter can cause serious signs and symptoms, such as chest pain, shortness of breath, and low blood pressure. Medical management involves the use of vagal maneuvers (see previous discussion under Sinus Tachycardia) or a trial administration of adenosine, which causes sympathetic block and slowing of conduction through the AV node. This may terminate the tachycardia; optimally, it will facilitate visualization of flutter waves for diagnostic purposes. Adenosine is given IV by rapid administration, and immediately followed by a 20-mL saline flush and elevation of the arm with the IV line to promote rapid circulation of the medication.

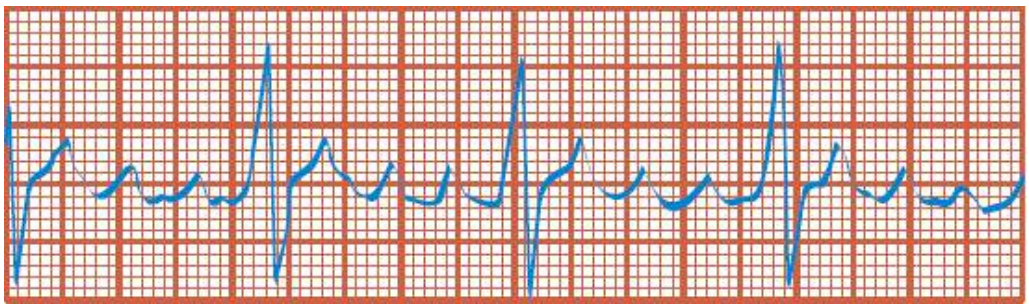

Figure 22-12 • Atrial flutter. Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 17-22C). Philadelphia, PA: Wolters Kluwer.

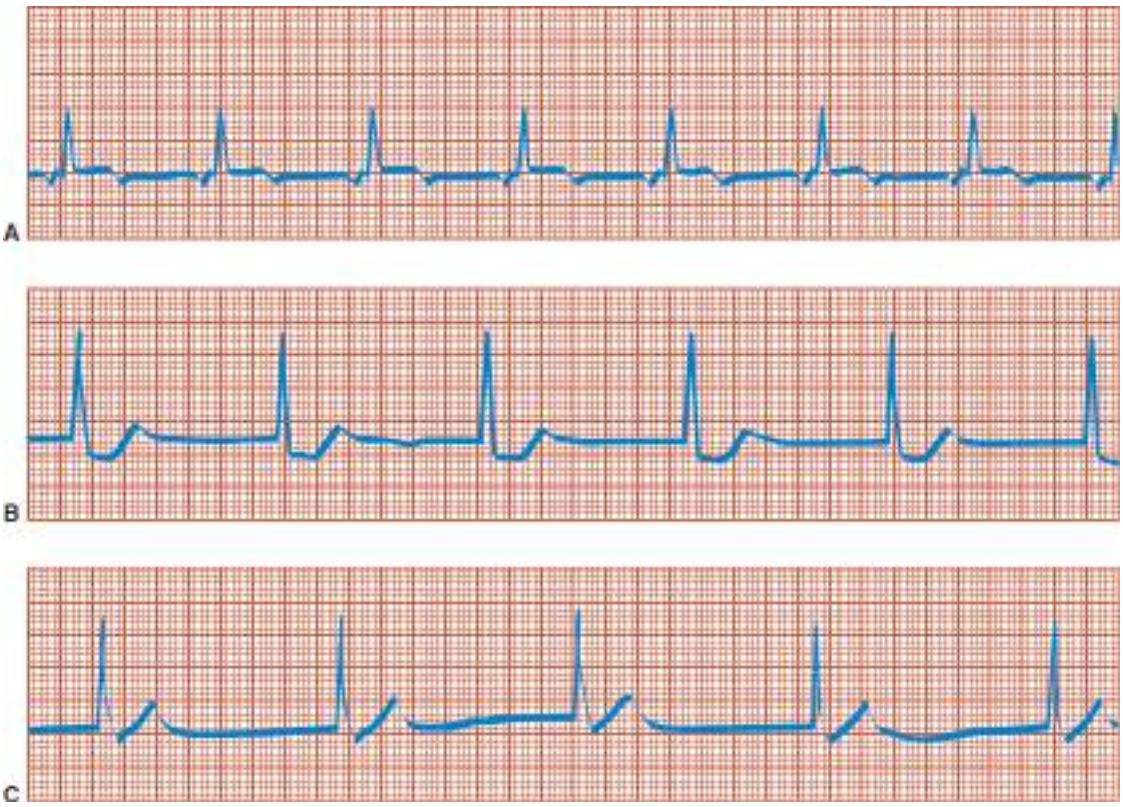

Figure 22-13 • Various types of junctional rhythms. **A.** Note that the inverted P wave appears before the normal QRS complex. **B.** Note that the inverted P wave is buried inside the QRS complex. **C.** Note that the inverted P wave follows the QRS complex. Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 17-23A, B, and C). Philadelphia, PA: Wolters Kluwer.

Atrial flutter is treated with antithrombotic therapy, rate control, and rhythm control in the same manner as atrial fibrillation (January et al., 2014, 2019). Electrical cardioversion is often successful in converting atrial flutter to sinus rhythm (see later discussion).

Junctional Arrhythmias

Junctional arrhythmias originate within AV nodal tissue, and may include premature junctional complexes, junctional rhythms, nonparoxysmal junctional tachycardia, and AV nodal reentry tachycardia.

Premature Junctional Complex

A premature junctional complex is an impulse that starts in the AV nodal area before the next normal sinus impulse reaches the AV node. Premature junctional complexes are less common than PACs. Causes include digitalis toxicity, heart failure, and coronary artery disease. The ECG criteria for premature junctional complex are the same as for PACs, except for the P wave and the PR interval. The P wave may be absent, may follow the QRS, or may occur before the QRS but with a PR interval of less than 0.12 seconds. This arrhythmia rarely produces significant symptoms. Treatment for frequent premature junctional complexes is the same as for frequent PACs.

Junctional Rhythm

Junctional or idionodal rhythm occurs when the AV node, instead of the sinus node, becomes the pacemaker of the heart. When the sinus node slows (e.g., from increased vagal tone) or when the impulse cannot be conducted through the AV node (e.g., because of complete heart block), the AV node automatically discharges an impulse. Junctional rhythm not caused by complete heart block has the following characteristics (see Fig. 22-13):

Ventricular and atrial rate: Ventricular rate 40 to 60 bpm; atrial rate also 40 to 60 bpm if P waves are discernible

Ventricular and atrial rhythm: Regular

QRS shape and duration: Usually normal, but may be abnormal

P wave: May be absent, after the QRS complex, or before the QRS; may be inverted, especially in lead II

PR interval: If the P wave is in front of the QRS, the PR interval is less than 0.12 seconds

P:QRS ratio: 1:1 or 0:1

Medical Management

Junctional rhythm may produce signs and symptoms of reduced cardiac output. If this occurs, the treatment is the same as for sinus bradycardia. Emergency pacing may be needed (see later discussion under Pacemaker Therapy).

Nonparoxysmal Junctional Tachycardia

Junctional tachycardia is caused by enhanced automaticity in the junctional area, resulting in a rhythm similar to junctional rhythm, except at a rate of 70 to 120 bpm. Although this rhythm generally does not have any detrimental hemodynamic effect, it may indicate a serious underlying condition, such as digitalis toxicity, myocardial ischemia, hypokalemia, or chronic obstructive pulmonary disease.

Atrioventricular Nodal Reentry Tachycardia

AVNRT is a common arrhythmia that occurs when an impulse is conducted to an area in the AV node that causes the impulse to be rerouted back into the same area over and over again at a very fast rate. Each time the impulse is conducted through this area, it is also conducted down into the ventricles, causing a fast ventricular rate. AVNRT that has an abrupt onset and an abrupt cessation with a QRS of normal duration has frequently been called *paroxysmal atrial tachycardia (PAT)* and also *paroxysmal supraventricular tachycardia (PSVT)*. AVNRT also occurs when the duration of the QRS complex is 0.12 seconds or greater and a block in the bundle branch is known to be present. This arrhythmia may last for seconds or several hours. Factors associated with the development of AVNRT include caffeine, nicotine, hypoxemia, and stress. Underlying pathologies include coronary artery disease and cardiomyopathy; however, it occurs more often in females and not in association with underlying structural heart disease. AVNRT has the following characteristics (see Fig. 22-14):

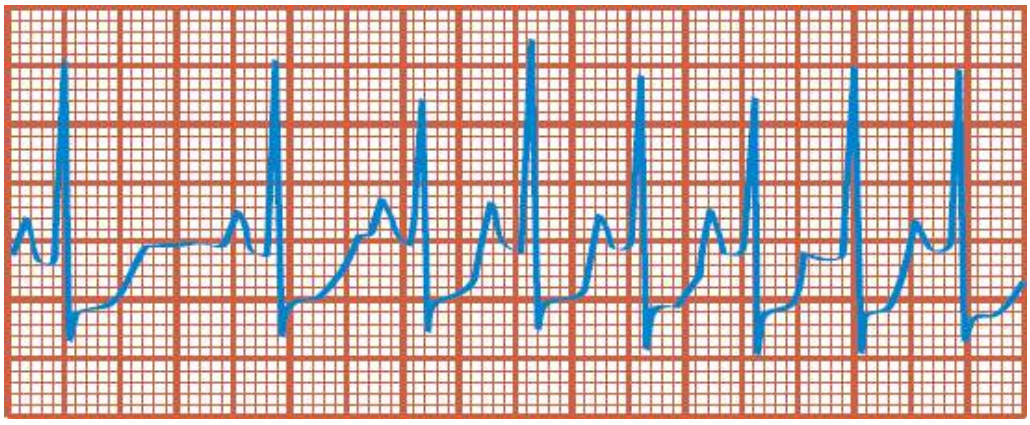

Figure 22-14 • Atrioventricular nodal reentry tachycardia (AVNRT), also called paroxysmal atrial tachycardia (PAT), and paroxysmal supraventricular tachycardia (PSVT). Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 17-22B). Philadelphia, PA: Wolters Kluwer.

Ventricular and atrial rate: Atrial rate usually 150 to 250 bpm; ventricular rate usually 120 to 200 bpm

Ventricular and atrial rhythm: Regular; sudden onset and termination of the tachycardia

QRS shape and duration: Usually normal, but may be abnormal

P wave: Usually very difficult to discern

PR interval: If the P wave is in front of the QRS, the PR interval is less than 0.12 seconds

P:QRS ratio: 1:1, 2:1

Clinical symptoms vary with the rate and duration of the tachycardia and the patient's underlying condition. The tachycardia usually is of short duration, resulting only in palpitations. A fast rate may also reduce cardiac output, resulting in significant signs and symptoms such as restlessness, chest pain, shortness of breath, pallor, hypotension, and loss of consciousness.

Medical Management

Because AVNRT is generally a benign arrhythmia, the goal of medical management is to alleviate symptoms and improve quality of life. Patients who become significantly symptomatic and require emergency department visits to terminate the rhythm may want to initiate therapy immediately. However, those with minimum symptoms with an AVRNT that terminates spontaneously or with minimal treatment may choose just to be monitored and self-treat.

The aim of therapy is to break the reentry of the impulse. Catheter ablation is the initial treatment of choice and is used to eliminate the area that permits the rerouting of the impulse that causes the tachycardia (Katritsis, 2018; see previous discussion of Atrial Fibrillation: Catheter Ablation Therapy). Vagal maneuvers (see previous discussion under Sinus Tachycardia) may be used to interrupt AVNRT. These techniques increase parasympathetic stimulation, causing slower conduction through the AV node and blocking the reentry of the rerouted impulse. Some patients use some of these methods to terminate the episode on their own. Because of the risk of a cerebral embolic event, carotid sinus massage, which may be performed by physicians, is contraindicated in patients with carotid artery disease.

Pharmacologic Therapy

If the vagal maneuvers are ineffective, the patient may then receive a bolus of adenosine to correct the rhythm; this is usually effective in terminating AVNRT. Because the effect of adenosine is so short, AVNRT may recur; the first dose may be followed with two additional doses. If the vagal maneuvers and adenosine are ineffective, IV non-dihydropyridine calcium channel blockers (e.g., verapamil), IV beta-blockers or IV digoxin may be considered (Hafeez & Armstrong, 2019). If the patient is unstable or does not respond to the medications, electrical cardioversion is the treatment of choice (see later discussion).

If P waves cannot be identified, the rhythm may be called supraventricular tachycardia (SVT), or PSVT if it has an abrupt onset, until the underlying rhythm and resulting diagnosis is determined. SVT and PSVT indicate only that the rhythm is not VT. SVT could be atrial fibrillation, atrial flutter, or AVNRT, among others. Vagal maneuvers and adenosine may be used to convert the rhythm or at least slow conduction in the AV node to allow visualization of the P waves.

Ventricular Arrhythmias

Ventricular arrhythmias originate from foci within the ventricles; these may include premature ventricular complexes, VT, ventricular fibrillation, and idioventricular rhythms. Technically, ventricular asystole is characterized by an absence of rhythm formation.

Premature Ventricular Complex

A PVC is an impulse that starts in a ventricle and is conducted through the ventricles before the next normal sinus impulse. PVCs can occur in healthy people, especially with intake of caffeine, nicotine, or alcohol. PVCs may be caused by cardiac ischemia or infarction, increased workload on the heart (e.g., heart failure and tachycardia), digitalis toxicity, hypoxia, acidosis, or electrolyte imbalances, especially hypokalemia.

In a rhythm referred to as bigeminy, every other complex is a PVC. In trigeminy, every third complex is a PVC, and in quadrigeminy, every fourth complex is a PVC. PVCs have the following characteristics (see Fig. 22-15):

Ventricular and atrial rate: Depends on the underlying rhythm (e.g., sinus rhythm)

Ventricular and atrial rhythm: Irregular due to early QRS, creating one RR interval that is shorter than the others. The PP interval may be regular, indicating that the PVC did not depolarize the sinus node

QRS shape and duration: Duration is 0.12 seconds or longer; shape is bizarre and abnormal. When these bizarrely shaped, widened QRS complexes resemble each other, they are called unifocal. When they have at least two different morphologic appearances, they are called multifocal

P wave: Visibility of the P wave depends on the timing of the PVC; may be absent (hidden in the QRS or T wave) or in front of the QRS. If the P wave follows the QRS, the shape of the P wave may be different

PR interval: If the P wave is in front of the QRS, the PR interval is less than 0.12 seconds

P:QRS ratio: 0:1; 1:1

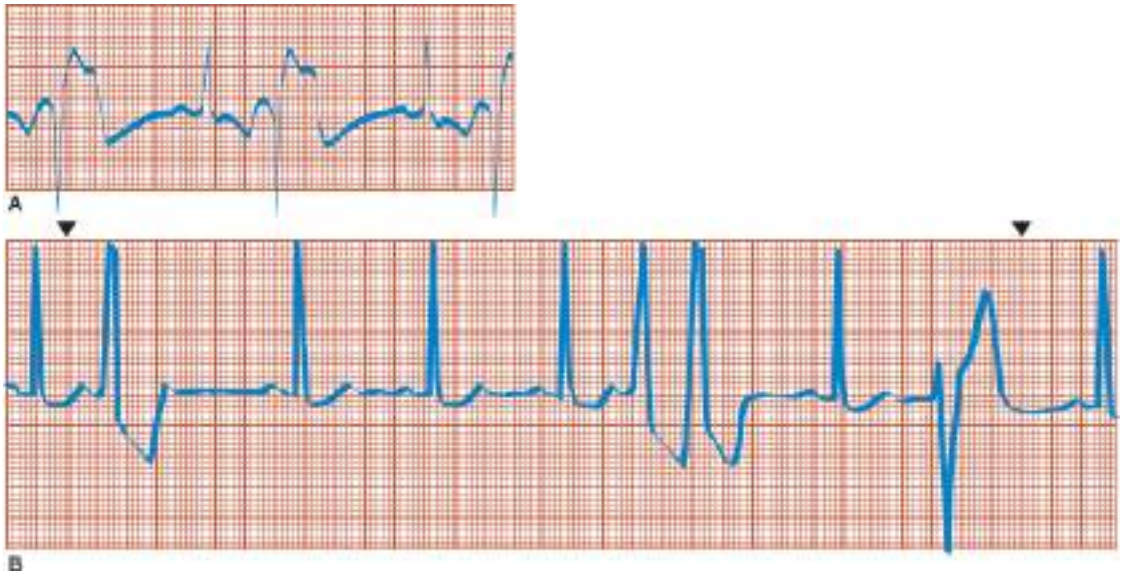

Figure 22-15 • Premature ventricular complexes (PVCs). **A.** Ventricular bigeminy that is unifocal; note that every other beat is a PVC, with the same morphologic appearance. **B.** Multifocal PVCs; note that there are at least two different appearing PVCs. Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 17-25B and C). Philadelphia, PA: Wolters Kluwer.

The patient may feel nothing or may say that the heart "skipped a beat." The effect of a PVC depends on its timing in the cardiac cycle and how much blood was in the ventricles when they contracted. Initial treatment is aimed at correcting the cause.

Medical Management

PVCs are a common occurrence and may increase in frequency with age (Al-khatib, Stevenson, Ackerman, et al., 2018). PVCs that are frequent and persistent may be treated with amiodarone or beta-blockers, but long-term pharmacotherapy for PVCs is not usually indicated. PVCs are not considered a warning for ensuing VT. However, studies have shown an association of PVCs with adverse outcomes; therefore, patients may need to be evaluated for underlying causes (e.g., ischemic heart disease and LV dysfunction) (Al-khatib et al., 2018).

Unfolding Patient Stories: Kenneth Bronson • Part 2

Recall from Chapter 19 Kenneth Bronson, who came to the emergency department with difficulty breathing after a week of flu-like symptoms, productive cough, and high fever. He was diagnosed with a right lower lobe pneumonia. Sinus tachycardia with occasional unifocal premature ventricular contractions (PVCs) is seen on the cardiac monitor. What are potential causes for the tachycardia and PVCs that the nurse should investigate when considering his age of 27 years, symptoms experienced over the last week, and the clinical manifestations associated with his diagnosis?

Care for Kenneth and other patients in a realistic virtual environment: vSim (**thepoint.lww.com/vSimMedicalSurgical**). Practice documenting these patients' care in DocuCare (**thepoint.lww.com/DocuCareEHR**).

Ventricular Tachycardia

VT is defined as three or more PVCs in a row, occurring at a rate exceeding 100 bpm. The causes are similar to those of PVC. Patients with larger MIs and lower ejection fractions are at higher risk of lethal VT. VT is an emergency because the patient is nearly always unresponsive and pulseless. VT has the following characteristics (see Fig. 22-16):

Ventricular and atrial rate: Ventricular rate is 100 to 200 bpm; atrial rate depends on the underlying rhythm (e.g., sinus rhythm)

Ventricular and atrial rhythm: Usually regular; atrial rhythm may also be regular

QRS shape and duration: Duration is 0.12 seconds or more; bizarre, abnormal shape

P wave: Very difficult to detect, so the atrial rate and rhythm may be indeterminable

PR interval: Very irregular, if P waves are seen

P:QRS ratio: Difficult to determine, but if P waves are apparent, there are usually more QRS complexes than P waves

The patient's tolerance or lack of tolerance for this rapid rhythm depends on the ventricular rate and severity of ventricular dysfunction.

Medical Management

Several factors determine the initial treatment, including the following: identifying the rhythm as monomorphic (having a consistent QRS shape and rate) or polymorphic (having varying QRS shapes and rhythms), determining

the existence of a prolonged QT interval before the initiation of VT, any comorbidities, and ascertaining the patient's heart function (normal or decreased). If the patient is stable, continuing the assessment, especially obtaining a 12-lead ECG, may be the only action necessary.

The patient may need antiarrhythmic medications, antitachycardia pacing, or direct cardioversion or defibrillation. Procainamide, amiodarone, sotalol, and lidocaine are all antiarrhythmic medications that may be considered based upon type of VT (e.g., monomorphic or polymorphic), clinical presentation, and patient comorbidities (e.g., impaired cardiac function, acute MI).

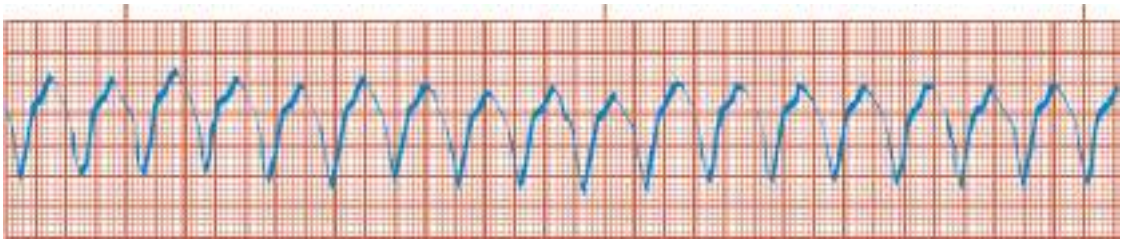

Figure 22-16 • Ventricular tachycardia. Reprinted with permission from Huff, J. (2002). *ECG Workout* (4th ed., p. 197). Philadelphia, PA: Lippincott, Williams & Wilkins.

Cardioversion is the treatment of choice for monophasic VT in a patient who is symptomatic. **Defibrillation**, which uses an electrical current given to stop the arrhythmia that is not set to synchronize with the patient's QRS complex, is the treatment of choice for pulseless VT. Any type of VT in a patient who is unconscious and without a pulse is treated in the same manner as ventricular fibrillation: immediate defibrillation is the action of choice (see later discussion on Cardioversion and Defibrillation).

For long-term management, patients with an ejection fraction less than 35% should be considered for an implantable cardioverter defibrillator (ICD) (see later discussion). Those with an ejection fraction greater than 35% may be managed with antiarrhythmic medication.

Torsades de pointes is a polymorphic VT preceded by a prolonged QT interval, which could be congenital or acquired. Common causes include central nervous system disease; certain medications (e.g., ciprofloxacin, erythromycin, haloperidol, lithium, methadone); or low levels of potassium, calcium, or magnesium. Congenital QT prolongation is another cause. Because this rhythm is likely to cause the patient to deteriorate and become pulseless, immediate treatment is required and includes correction of any electrolyte imbalance, such as administration of IV magnesium, and with IV isoproterenol or pacing if associated with bradycardia (Link, Berkow, Kudenchuk, et al., 2015; Soar, Donnino, Maconochie, et al., 2018).

Ventricular Fibrillation

The most common arrhythmia in patients with cardiac arrest is ventricular fibrillation, which is a rapid, disorganized ventricular rhythm that causes ineffective quivering of the ventricles. No atrial activity is seen on the ECG. The most common cause of ventricular fibrillation is coronary artery disease and resulting acute MI. Other causes include untreated or unsuccessfully treated VT, cardiomyopathy, valvular heart disease, several proarrhythmic medications, acid–base and electrolyte abnormalities, and electrical shock. Another cause is Brugada syndrome, in which the patient (frequently of Asian descent) has a structurally normal heart, few or no risk factors for coronary artery disease, and a family history of sudden cardiac death (Pappone & Santinelli, 2019). Ventricular fibrillation has the following characteristics (see Fig. 22-17):

Ventricular rate: Greater than 300 bpm

Ventricular rhythm: Extremely irregular, without a specific pattern

QRS shape and duration: Irregular, undulating waves with changing amplitudes. There are no recognizable QRS complexes

Medical Management

Ventricular fibrillation is always characterized by the absence of an audible heartbeat, a palpable pulse, and respirations. Because there is no coordinated cardiac activity, cardiac arrest and death are imminent if the arrhythmia is not corrected. Early defibrillation is critical to survival, with administration of immediate bystander cardiopulmonary resuscitation (CPR) until defibrillation is available. For refractory ventricular fibrillation, administration of amiodarone and epinephrine may facilitate the return of a spontaneous pulse after defibrillation (Link et al., 2015; see Chapter 25 for further discussion on interventions during Cardiac Arrest).

Idioventricular Rhythm

Idioventricular rhythm, also called *ventricular escape rhythm,* occurs when the impulse starts in the conduction system below the AV node. When the sinus node fails to create an impulse (e.g., from increased vagal tone) or when the impulse is created but cannot be conducted through the AV node (e.g., due to complete AV block), the Purkinje fibers automatically discharge an impulse. When idioventricular rhythm is not caused by AV block, it has the following characteristics (see Fig. 22-18):

Ventricular rate: Between 20 and 40 bpm; if the rate exceeds 40 bpm, the rhythm is known as accelerated idioventricular rhythm

Ventricular rhythm: Regular

QRS shape and duration: Bizarre, abnormal shape; duration is 0.12 seconds or more

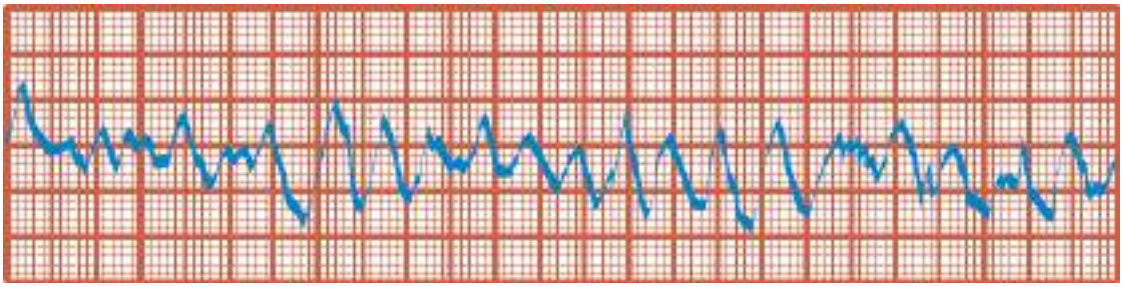

Figure 22-17 • Ventricular fibrillation. Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical Care Nursing: A Holistic Approach* (11th ed., Fig. 17-27C). Philadelphia, PA: Wolters Kluwer.

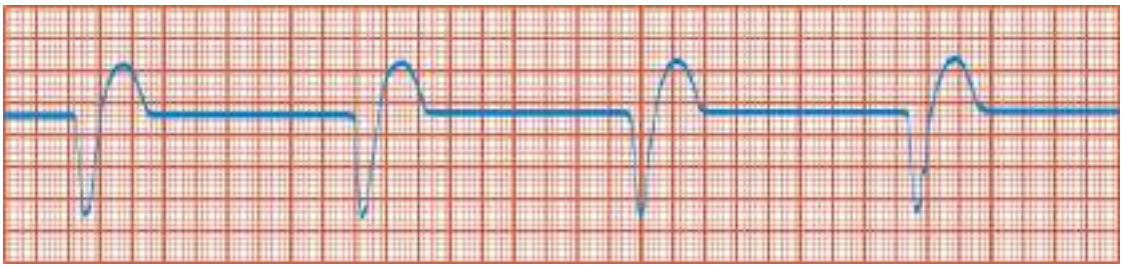

Figure 22-18 • Idioventricular rhythm.

Medical Management

Idioventricular rhythm commonly causes the patient to lose consciousness and experience other signs and symptoms of reduced cardiac output. In such cases, the treatment is the same as for asystole and pulseless electrical activity (PEA) (see Chapter 25) if the patient is in cardiac arrest or for bradycardia if the patient is not in cardiac arrest. Interventions include identifying the underlying cause; administering IV epinephrine, atropine, and vasopressor medications; and initiating emergency transcutaneous pacing. In some cases, idioventricular rhythm may cause no symptoms of reduced cardiac output.

Ventricular Asystole

Commonly called *flatline,* ventricular asystole is characterized by absent QRS complexes confirmed in two different leads, although P waves may be apparent for a short duration. There is no heartbeat, no palpable pulse, and no respiration. Without immediate treatment, ventricular asystole is fatal.

Medical Management

Ventricular asystole is treated the same as PEA, focusing on high-quality CPR with minimal interruptions and identifying underlying and contributing factors. The key to successful treatment is a rapid assessment to identify a possible cause, which is known as the Hs and Ts: hypoxia, hypovolemia, hydrogen ion (acid–base imbalance), hypo- or hyperglycemia, hypo- or hyperkalemia, hypothermia, trauma, toxins, tamponade (cardiac), tension pneumothorax, or thrombus (coronary or pulmonary) (Link et al., 2015). After the initiation of CPR, intubation and establishment of IV access are the next recommended actions, with no or minimal interruptions in chest compressions (see Chapter 25).

Conduction Abnormalities

When assessing the rhythm strip, the underlying rhythm is first identified (e.g., sinus rhythm, sinus arrhythmia). Then, the PR interval is assessed for the possibility of an AV block. AV blocks occur when the conduction of the impulse through the AV node or bundle of His area is decreased or stopped. These blocks can be caused by medications (e.g., digitalis, calcium channel blockers, beta-blockers), Lyme disease, myocardial ischemia and infarction, hypothyroidism, or activities that cause an increase in vagal tone (Kusumoto et al., 2019). If the AV block is caused by increased vagal tone (e.g., long-term athletic training, sleep, coughing, suctioning, pressure above the eyes or on large vessels, anal stimulation), it is commonly accompanied by sinus bradycardia. AV block may be temporary and resolve on its own, or it may be permanent and require permanent pacing.

The clinical signs and symptoms of a heart block vary with the resulting ventricular rate and the severity of any underlying disease processes. Whereas first-degree AV block rarely causes any hemodynamic effect, the other blocks may result in decreased heart rate, causing a decrease in perfusion to vital organs, such as the brain, heart, kidneys, lungs, and skin. A patient with third-degree AV block caused by digitalis toxicity may be stable; another patient with the same rhythm caused by acute MI may be unstable. Health care providers must always keep in mind the need to treat the patient, not the rhythm. The treatment is based on the hemodynamic effect of the rhythm.

First-Degree Atrioventricular Block

First-degree AV block occurs when all the atrial impulses are conducted through the AV node into the ventricles at a rate slower than normal. This conduction disorder has the following characteristics (see Fig. 22-19):

Ventricular and atrial rate: Depends on the underlying rhythm

Ventricular and atrial rhythm: Depends on the underlying rhythm

QRS shape and duration: Usually normal, but may be abnormal

P wave: In front of the QRS complex; shows sinus rhythm, regular shape

PR interval: Greater than 0.20 seconds; PR interval measurement is constant.

P:QRS ratio: 1:1

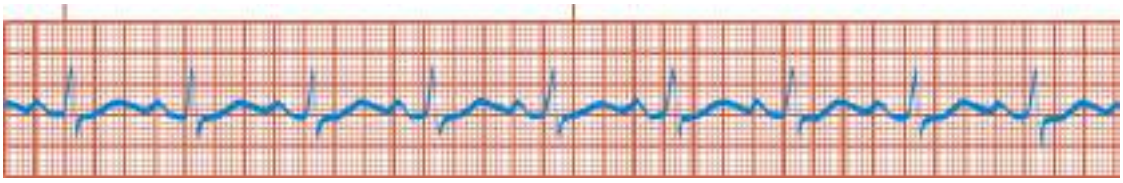

Figure 22-19 • First-degree atrioventricular block. Note that the PR interval is constant but greater than 0.20 seconds. Reprinted with permission from Huff, J. (2002). *ECG Workout* (4th ed., p. 150). Philadelphia, PA: Lippincott, Williams & Wilkins.

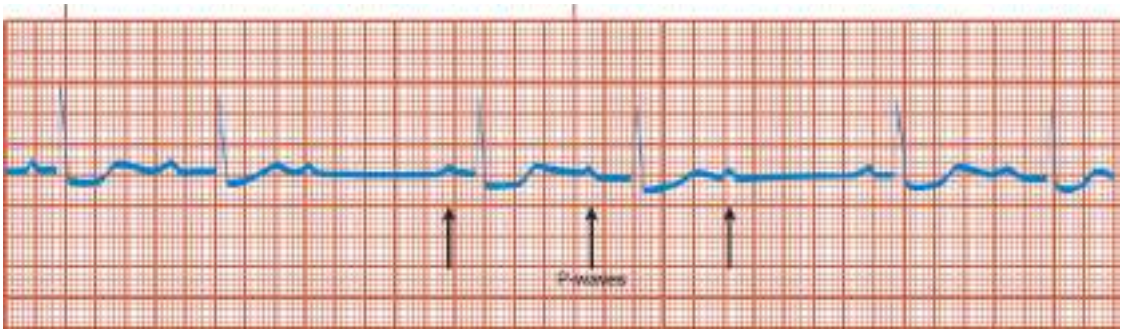

Figure 22-20 • Second-degree atrioventricular block, type I. Note progressively longer PR durations until there is a nonconducted P wave. Reprinted with permission from Huff, J. (2017). *ECG Workout: Exercises in Arrhythmia Interpretation* (7th ed., Fig. 8-20). Philadelphia, PA: Wolters Kluwer.

Second-Degree Atrioventricular Block, Type I (Wenckebach)

Second-degree AV block, type I, occurs when there is a repeating pattern in which all but one of a series of atrial impulses are conducted through the AV node into the ventricles (e.g., every four of five atrial impulses are conducted). Each atrial impulse takes a longer time for conduction than the one before, until one impulse is fully blocked. Because the AV node is not depolarized by the blocked atrial impulse, the AV node has time to fully repolarize so that the next atrial impulse can be conducted within the shortest amount of time. Second-degree AV block, type I, has the following characteristics (see Fig. 22-20):

Ventricular and atrial rate: Depends on the underlying rhythm, but the ventricular rate is lower than the atrial rate

Ventricular and atrial rhythm: The PP interval is regular if the patient has an underlying normal sinus rhythm; the RR interval characteristically reflects a pattern of change. Starting from the RR that is the longest, the RR interval gradually shortens until there is another long RR interval

QRS shape and duration: Usually normal, but may be abnormal

P wave: In front of the QRS complex; shape depends on underlying rhythm.

PR interval: The PR interval becomes longer with each succeeding ECG complex until there is a P wave not followed by a QRS. The changes in the PR interval are repeated between each "dropped" QRS, creating a pattern in the irregular PR interval measurements

P:QRS ratio: 3:2, 4:3, 5:4, and so forth

Second-Degree Atrioventricular Block, Type II

Second-degree AV block, type II, occurs when only some of the atrial impulses are conducted through the AV node into the ventricles. Second-degree AV block, type II, has the following characteristics (see Fig. 22-21):

Ventricular and atrial rate: Depends on the underlying rhythm, but the ventricular rate is lower than the atrial rate

Ventricular and atrial rhythm: The PP interval is regular if the patient has an underlying normal sinus rhythm. The RR interval is usually regular but may be irregular, depending on the P:QRS ratio

QRS shape and duration: Usually abnormal, but may be normal

P wave: In front of the QRS complex; shape depends on underlying rhythm

PR interval: The PR interval is constant for those P waves just before QRS complexes

P:QRS ratio: 2:1, 3:1, 4:1, 5:1, and so forth

Third-Degree Atrioventricular Block

Third-degree AV block occurs when no atrial impulse is conducted through the AV node into the ventricles. In third-degree AV block, two impulses stimulate the heart: one stimulates the ventricles, represented by the QRS complex, and one stimulates the atria, represented by the P wave. P waves may be seen, but the atrial electrical activity is not conducted down into the ventricles to initiate the QRS complex, the ventricular electrical activity. Having two impulses stimulate the heart results in a condition referred to as AV dissociation, which may also occur during VT. Complete block (third-degree AV block) has the following characteristics (see Fig. 22-22):

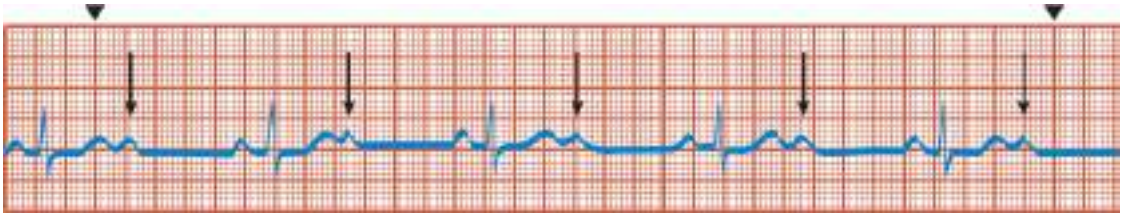

Figure 22-21 • Second-degree atrioventricular block, type II. Note constant PR interval and presence of more P waves than QRS complexes. Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 17-29C). Philadelphia, PA: Wolters Kluwer.

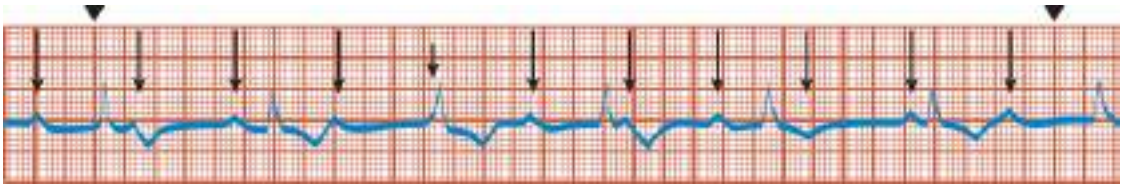

Figure 22-22 • Third-degree atrioventricular block; devoid relationship between P waves and QRS complexes. Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 17-29D). Philadelphia, PA: Wolters Kluwer.

Ventricular and atrial rate: Depends on the escape rhythm (idionodal or idioventricular) and underlying atrial rhythm, but the ventricular rate is lower than the atrial rate

Ventricular and atrial rhythm: The PP interval is regular and the RR interval is regular, but the PP interval is not equal to the RR interval

QRS shape and duration: Depends on the escape rhythm; with junctional rhythm, QRS shape and duration are usually normal; with idioventricular rhythm, QRS shape and duration are usually abnormal

P wave: Depends on underlying rhythm

PR interval: Very irregular

P:QRS ratio: More P waves than QRS complexes

Medical Management of Conduction Abnormalities

Based on the cause of the AV block and the stability of the patient, treatment is directed toward increasing the heart rate to maintain a normal cardiac output. If the patient is stable and has no symptoms, no treatment may be indicated or it may simply consist of decreasing or eliminating the cause (e.g., withholding the medication or treatment). If the causal medication is necessary for treating other conditions and no effective alternative is available, pacemaker implantation may be indicated. The initial treatment of choice is an IV bolus of

atropine, although it is not effective in second-degree AV block, type II, or third-degree AV block. If the patient does not respond to atropine, has advanced AV block, or has had an acute MI, temporary transcutaneous pacing may be started. If the patient has no pulse, treatment is the same as for ventricular asystole (Link et al., 2015; Soar et al., 2018). A permanent pacemaker may be necessary if the block persists (see later discussion).

NURSING PROCESS

The Patient with an Arrhythmia

Assessment

Major areas of assessment include possible causes of the arrhythmia, contributing factors, and the arrhythmia's effect on the heart's ability to pump an adequate blood volume. When cardiac output is reduced, the amount of oxygen reaching the tissues and vital organs is diminished. This diminished oxygenation produces the signs and symptoms associated with arrhythmias. If these signs and symptoms are severe or if they occur frequently, the patient may experience significant distress and disruption of daily life.

A health history is obtained to identify any previous occurrences of decreased cardiac output, such as syncope, lightheadedness, dizziness, fatigue, chest discomfort, and palpitations. Possible causes of the arrhythmia (e.g., heart disease, chronic obstructive pulmonary disease) need to be identified. All medications, prescribed and over-the-counter (including herbs and nutritional supplements), as well as the route of administration, are reviewed. If a patient is taking an antiarrhythmic medication, assessment for treatment adherence, side effects, adverse reactions, and potential contraindications is necessary. For example, some medications (e.g., digoxin) can cause arrhythmias. Laboratory results are reviewed to assess levels of medications as well as factors that could contribute to the arrhythmia (e.g., anemia). A thorough psychosocial assessment is performed to identify the possible effects of the arrhythmia, the patient's perception and understanding of the arrhythmia and its treatment, and whether anxiety is a significant contributing factor.

The nurse conducts a physical assessment to confirm the data obtained from the history and to observe for signs of diminished cardiac output during the arrhythmic event, especially changes in level of consciousness. The nurse assesses the patient's skin, which may be pale and cool. Signs of fluid retention, such as neck vein distention and crackles and wheezes auscultated in the lungs, may be detected. The rate and rhythm of apical and peripheral pulses are also assessed, and any pulse deficit is noted. The nurse auscultates for extra heart sounds (especially S_3 and S_4) and for heart murmurs, measures blood pressure, and determines pulse pressures. A declining pulse pressure indicates reduced cardiac output. One assessment may not disclose significant changes in cardiac output; therefore, the nurse compares multiple assessment findings over time, especially those that occur with and without the arrhythmia.

Diagnosis

Nursing Diagnoses

Based on the assessment data, major nursing diagnoses may include:

- Impaired cardiac output associated with inadequate ventricular filling or altered heart rate
- Anxiety associated with fear of the unknown outcome of altered health state
- Lack of knowledge about the arrhythmia and its treatment

Collaborative Problems/Potential Complications

Potential complications may include the following:

- Cardiac arrest (see Chapter 25)
- Heart failure (see Chapter 25)
- Thromboembolic event, especially with atrial fibrillation (see Chapter 26)

Planning and Goals

The major goals for the patient may include eliminating or decreasing the occurrence of the arrhythmia (by decreasing contributory factors) to maintain cardiac output; verbalizing reduction in anxiety; verbalizing an understanding about the arrhythmia, tests used to diagnose the problem, and its treatment; and developing or maintaining self-management skills.

Nursing Interventions

Monitoring and Managing the Arrhythmia to Maintain Cardiac Output

The nurse evaluates the patient's blood pressure, pulse rate and rhythm, rate and depth of respirations, and breath sounds on an ongoing basis to determine the arrhythmia's hemodynamic effect. The nurse also asks the patient about possible symptoms of the arrhythmia (e.g., episodes of lightheadedness, dizziness, or fainting) as part of the ongoing assessment. If a patient with an arrhythmia is hospitalized, the nurse may obtain a 12-lead ECG, continuously monitor the patient, and analyze rhythm strips to track the arrhythmia.

Control of the occurrence or the effect of the arrhythmia, or both, is often achieved with antiarrhythmic medications. The nurse assesses and observes for the benefits and adverse effects of each medication. The nurse, in collaboration with the primary provider, also manages medication administration carefully so that a constant serum level of the medication is maintained. The nurse may also conduct a 6-minute walk test as prescribed, which is used to identify the patient's ventricular rate in response to exercise. The patient is asked to walk for 6 minutes, covering as much distance as possible (Chen, Chen, Lu, et al., 2018). The nurse monitors the patient for symptoms. At the end, the nurse records the distance covered and the pre- and postexercise heart rate as well as the patient's response.

The nurse assesses for factors that contribute to the arrhythmia (e.g., oxygen deficits, acid–base and electrolyte imbalances, caffeine, or

nonadherence to the medication regimen). The nurse also monitors for ECG changes (e.g., widening of the QRS, prolongation of the QT interval, increased heart rate) that increase the risk of an arrhythmic event.

Reducing Anxiety

When the patient experiences episodes of arrhythmia, the nurse stays with the patient and provides assurance of safety and security while maintaining a calm and reassuring attitude. This assists in reducing anxiety (reducing the sympathetic response) and fosters a trusting relationship with the patient. The nurse seeks the patient's view of the events and discusses the emotional response to the arrhythmia, encouraging verbalization of feelings and fears, providing supportive or empathetic statements, and assisting the patient to recognize feelings of anxiety, anger, or sadness. The nurse emphasizes successes with the patient to promote a sense of self-management of the arrhythmia. For example, if a patient is experiencing episodes of arrhythmia and a medication is given that begins to reduce the incidence of the arrhythmia, the nurse communicates that information to the patient and explores the patient's response to this information. In addition, the nurse can help the patient develop a system to identify possible causative, influencing, and alleviating factors (e.g., keeping a diary). The nursing goal is to maximize the patient's control and to make the episode less threatening.

Promoting Home, Community-based, and Transitional Care

Educating Patients About Self-Care. When educating patients about arrhythmias, the nurse first assesses the patient's understanding, clarifies misinformation, and then shares needed information in terms that are understandable and in a manner that is not frightening or threatening. The nurse clearly explains the etiology of the arrhythmia and treatment options to the patient and family. If necessary, the nurse explains the importance of maintaining therapeutic serum levels of antiarrhythmic medications so that the patient understands why medications should be taken regularly each day and the importance of regular blood testing. If the medication has the potential to alter the heart rate, the patient should be taught how to take their pulse before each dose and to notify the primary provider if the pulse is abnormal. In addition, the relationship between an arrhythmia and cardiac output is explained so that the patient recognizes symptoms of the arrhythmia and the rationale for the treatment regimen. If the patient is prescribed an anticoagulant medication, patient education points about taking anticoagulant medications are summarized in Chapter 26, Chart 26-10. The patient and family need to be educated about measures to take to decrease the risk of recurrence of the arrhythmia. If the patient has a potentially lethal arrhythmia, the nurse establishes with the

patient and family a plan of action to take in case of an emergency and, if appropriate, encourages a family member to obtain CPR training.

The patient and family should also be educated about potential risks of the arrhythmia and their signs and symptoms. For example, the patient with atrial fibrillation should be educated about the possibility of an embolic event.

Continuing and Transitional Care. A referral for home, community-based, or transitional care usually is not necessary for the patient with an arrhythmia unless the patient is hemodynamically unstable and has significant symptoms of decreased cardiac output. Home, community-based, or transitional care may be warranted if the patient has significant comorbidities, socioeconomic issues, or limited self-management skills that could increase the risk of nonadherence to the therapeutic regimen. A referral may also be indicated if the patient has had an electronic device implanted recently.

Evaluation

Expected patient outcomes may include:

1. Maintains cardiac output
   a. Demonstrates heart rate, blood pressure, respiratory rate, and level of consciousness within normal ranges
   b. Demonstrates no or decreased episodes of arrhythmia
2. Experiences reduced anxiety
   a. Expresses a positive attitude about living with the arrhythmia
   b. Expresses confidence in ability to take appropriate actions in an emergency
3. Expresses understanding of the arrhythmia and its treatment
   a. Explains the arrhythmia and its effects
   b. Describes the medication regimen and its rationale
   c. Explains the need to maintain a therapeutic serum level of the medication
   d. Describes a plan to eliminate or limit factors that contribute to the arrhythmia
   e. States actions to take in the event of an emergency

ADJUNCT MODALITIES AND MANAGEMENT

Arrhythmia treatments depend on whether the disorder is acute or chronic, as well as on the cause of the arrhythmia and its actual or potential hemodynamic effects.

Acute arrhythmias may be treated with medications or with external electrical therapy (emergency defibrillation, cardioversion, or pacing). Many antiarrhythmic medications are used to treat atrial and ventricular tachyarrhythmias (see Table 22-1). The choice of medication depends on the specific arrhythmia and its duration, the presence of structural heart disease (e.g., heart failure), and the patient's response to previous treatment. The nurse is responsible for monitoring and documenting the patient's responses to the medication and for ensuring that the patient has the knowledge and ability to manage the medication regimen.

If medications alone are ineffective in eliminating or decreasing the arrhythmia, certain adjunct mechanical therapies are available. The most common therapies are elective cardioversion and defibrillation for acute tachyarrhythmia, and implantable electronic devices for bradycardias (pacemakers) and chronic tachyarrhythmias (ICDs). Surgical treatments, although less common, are also available. The nurse is responsible for assessing the patient's understanding of and response to mechanical therapy, as well as the patient's self-management abilities. The nurse explains that the purpose of the device is to help the patient lead a life that is as active and productive as possible.

Cardioversion and Defibrillation

Cardioversion and defibrillation are used to treat tachyarrhythmias by delivering an electrical current that depolarizes a critical mass of myocardial cells. When the cells repolarize, the SA node is usually able to recapture its role as the heart's pacemaker.

Concept Mastery Alert

One major difference between cardioversion and defibrillation is the timing of the delivery of electrical current. In cardioversion, the delivery of the electrical current is synchronized with the patient's electrical events; in defibrillation, the delivery of the current is immediate and unsynchronized.

The same type of device, called a *defibrillator,* is used for both cardioversion and defibrillation. The electrical voltage required to defibrillate the heart is usually greater than that required for cardioversion and may cause more myocardial damage. Only biphasic types of defibrillators are now manufactured; these deliver an electrical charge from one paddle that then automatically redirects its charge back to the originating paddle. Because the delivery of the electrical charge varies among devices, the manufacturer's

recommended dose should be followed for the first and subsequent defibrillations (Link et al., 2015; Soar et al., 2018).

Figure 22-23 • Standard paddle placement for defibrillation.

The electrical current may be delivered externally through the skin with the use of paddles or with conductor pads. The paddles or pads may be placed on the front of the chest (standard placement) (see Fig. 22-23), or one pad may be placed on the front of the chest and the other pad placed under the patient's back just left of the spine (anteroposterior placement) (see Fig. 22-24).

Defibrillator multifunction conductor pads contain a conductive medium and are connected to the defibrillator to allow for hands-off defibrillation. This method reduces the risk of touching the patient during the procedure and increases electrical safety. Automated external defibrillators (AEDs), which are now found in many public areas, use this type of delivery for the electrical current.

Quality and Safety Nursing Alert

When using paddles, the appropriate conductant is applied between the paddles and the patient's skin. Any other type of conductant, such as ultrasound gel, should not be substituted.

Whether using pads or paddles, the nurse must observe two safety measures. First, good contact must be maintained between the pads or paddles and the patient's skin (with a conductive medium between them) to prevent electrical current from leaking through the air (arcing) when the defibrillator is

discharged. Second, no one is to be in contact with the patient or with anything that is touching the patient when the defibrillator is discharged, to minimize the chance that electrical current is conducted to anyone other than the patient. Chart 22-5 provides a review of nursing responsibility when a patient is cardioverted or defibrillated.

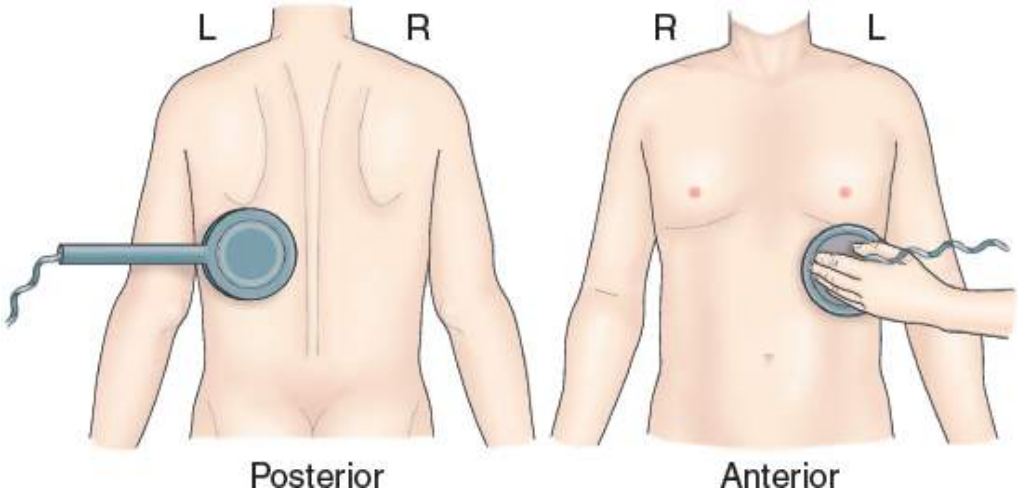

Figure 22-24 • Anteroposterior paddle placement for defibrillation.

Chart 22-5

Assisting with External Defibrillation or Cardioversion

When assisting with external defibrillation or cardioversion, the nurse should remember these key points:

- Multifunction conductor pads or paddles are used, with a conducting medium between the paddles and the skin in the proper locations. The conducting medium is available as a sheet, gel, or paste. Gels or pastes with poor electrical conductivity (e.g., ultrasound gel) should not be used.
- Paddles or pads should be placed so that they do not touch the patient's clothing or bed linen and are not near medication patches or in the direct flow of oxygen.
- Women with large breasts should have the left pad or paddle placed underneath or lateral to the left breast.
- During cardioversion, the monitor leads must be attached to the patient in order to set the defibrillator to the synchronized mode ("in sync"). If defibrillating, the defibrillator must *not* be in the synchronized mode (most machines default to the "not-sync" mode).
- When using paddles, 20–25 lb of pressure must be used in order to ensure good skin contact.
- When using a manual discharge device, it must not be charged until it is ready to shock; then thumbs and fingers must be kept off the discharge buttons until paddles or pads are on the chest and ready to deliver the electrical charge.
- When it is time to defibrillate, whomever is delivering the charge should announce, "charging to (number of joules)" prior to discharging.
- "Clear!" must be called three times before discharging: As "Clear" is called the first time, the discharger must visually check that they are not touching the patient, bed, or equipment; as "Clear" is called the second time, the discharger must visually check that no one else is touching the bed, the patient, or equipment, including the endotracheal tube or adjuncts; and as "Clear" is called the third time, the discharger must perform a final visual check to ensure that everyone is clear of the patient and anything touching the patient.
- The delivered energy and resulting rhythm are recorded.
- Cardiopulmonary resuscitation (CPR) is immediately resumed after the defibrillation charge is delivered, if appropriate, starting with chest compressions.
- If CPR is necessary, after five cycles (about 2 minutes) of CPR, the cardiac rhythm is checked again and another shock is delivered, if warranted. A vasoactive or antiarrhythmic medication is given as soon as possible after the rhythm check to facilitate a positive response to defibrillation.
- After the event is complete, the skin under the pads or paddles is inspected for burns; if any are detected, the primary provider or a wound care nurse is consulted about appropriate treatment.

- The defibrillator is plugged back into an outlet, and supplies are restocked as needed.

Adapted from Link, M. S., Berkow, L. C., Kudenchuk, P. J., et al. (2015). Part 7: Adult advanced cardiovascular life support: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation, 132*(18 supp 2), S444–S464; Soar, J., Donnino, M. W., Maconochie, I., et al. (2018). 2018 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations summary. *Resuscitation, 133*, 194–206.

Electrical Cardioversion

Electrical cardioversion involves the delivery of a "timed" electrical current to terminate a tachyarrhythmia. In cardioversion, the defibrillator is set to synchronize with the ECG on a cardiac monitor so that the electrical impulse discharges during ventricular depolarization (QRS complex). The synchronization prevents the discharge from occurring during the vulnerable period of repolarization (T wave), which could result in VT or ventricular fibrillation. The ECG monitor connected to the external defibrillator usually displays a mark or line that indicates sensing of a QRS complex. Sometimes the lead and the electrodes must be changed for the monitor to recognize the patient's QRS complex. When the synchronizer is on, no electrical current is delivered if the defibrillator does not discern a QRS complex. Therefore, it is important to ensure that the patient is connected to the monitor and to select a lead (not "paddles") that has the most appropriate sensing of the QRS. Because there may be a short delay until recognition of the QRS, the discharge buttons of an external manual defibrillator must be held down until the shock has been delivered. In most monitors, the synchronization mode must be reactivated if the initial cardioversion was ineffective and another cardioversion is needed (i.e., the device defaults to unsynchronized defibrillation mode).

If the cardioversion is elective and the arrhythmia has lasted longer than 48 hours, anticoagulation for a few weeks before cardioversion may be indicated (January et al., 2014, 2019). Digoxin is usually withheld for 48 hours before cardioversion to ensure the resumption of sinus rhythm with normal conduction. The patient is instructed not to eat or drink for at least 4 hours before the procedure. Gel-covered paddles or conductor pads are positioned anteroposteriorly (front and back) for cardioversion. Before cardioversion, the patient receives moderate sedation IV as well as an analgesic medication or anesthesia. Respiration is then supported with supplemental oxygen delivered by a bag-valve mask device with suction equipment readily available. Although patients rarely require intubation, equipment is nearby in case it is needed. The amount of voltage used varies from 50 to 360 joules, depending

on the defibrillator's technology, the type and duration of the arrhythmia, and the size and hemodynamic status of the patient (Link et al., 2015; Soar et al., 2018).

Indications of a successful response are conversion to sinus rhythm, adequate peripheral pulses, and adequate blood pressure. Because of the sedation, airway patency must be maintained and the patient's state of consciousness assessed. Vital signs and oxygen saturation are monitored and recorded until the patient is stable and recovered from sedation and analgesic medications or anesthesia. ECG monitoring is required during and after cardioversion (Link et al., 2015; Soar et al., 2018).

Defibrillation

Defibrillation is used in emergency situations as the treatment of choice for ventricular fibrillation and pulseless VT, the most common cause of abrupt loss of cardiac function and sudden cardiac death. Defibrillation is not used for patients who are conscious or have a pulse. The energy setting for the initial and subsequent shocks using a monophasic defibrillator should be set at 360 joules (Link et al., 2015; Soar et al., 2018). The energy setting for the initial shock using a biphasic defibrillator may be set at 150 to 200 joules, with the same or an increasing dose with subsequent shocks (Link et al., 2015; Soar et al., 2018). The sooner defibrillation is used, the better the survival rate (Hedge & Gnugnoli, 2019). Several studies have demonstrated that early defibrillation performed by lay people in a community setting can increase the survival rate (Hedge & Gnugnoli, 2019). If immediate CPR is provided and defibrillation is performed within 5 minutes, more adults in ventricular fibrillation may survive with intact neurologic function (Link et al., 2015; Soar et al., 2018). The availability and the use of AEDs in public places can shorten the interval from collapse to rhythm recognition and defibrillation, which can significantly improve survival out of the hospital (Hedge & Gnugnoli, 2019).

Epinephrine is given after initial unsuccessful defibrillation to make it easier to convert the arrhythmia to a normal rhythm with the next defibrillation. This medication may also increase cerebral and coronary artery blood flow. Antiarrhythmic medications such as amiodarone, lidocaine, or magnesium may be given if ventricular arrhythmia persists (see Table 22-1). This treatment with continuous CPR, medication administration, and defibrillation continues until a stable rhythm resumes or until it is determined that the patient cannot be revived.

Electrophysiology Studies

An EPS is an invasive procedure used to evaluate and treat various chronic arrhythmias that have caused cardiac arrest or significant symptoms. It also is indicated for patients with symptoms that suggest an arrhythmia that has gone undetected and undiagnosed by other methods. Because an EPS is invasive, it is performed in the hospital and may require that the patient be admitted. An EPS is used to do the following:

- Identify the impulse formation and propagation through the cardiac electrical conduction system
- Assess the function or dysfunction of the SA and AV nodal areas
- Identify the location (called *mapping*) and mechanism of the arrhythmogenic foci (the exact site where the arrhythmia originates)
- Assess the effectiveness of antiarrhythmic medications and devices for the patient with an arrhythmia
- Treat certain arrhythmias through the destruction of the causative cells (ablation)

An EPS procedure is a type of cardiac catheterization that is performed in a specially equipped cardiac catheterization laboratory by an electrophysiologist, assisted by other EPS laboratory personnel. The patient is conscious but lightly sedated. Usually, one or more catheters are inserted into the groin, neck, or antecubital fossa. The electrodes are positioned within the heart at specific locations—for instance, in the right atrium near the sinus node, in the coronary sinus, near the tricuspid valve, and at the apex of the right ventricle. The number and placement of electrodes depend on the type of study being conducted. These electrodes allow the electrical signal to be recorded from within the heart (intracardiogram).

The electrodes also allow the electrophysiologist to introduce a pacing stimulus to the intracardiac area at a precisely timed interval and rate, thereby stimulating the area (programmed stimulation). An area of the heart may be paced at a rate much faster than the normal rate of **automaticity**, the rate at which impulses are spontaneously formed (e.g., in the sinus node). This allows the pacemaker to become an artificial focus of automaticity and to assume control (overdrive suppression). Then, the pacemaker is stopped suddenly, and the time it takes for the sinus node to resume control is assessed. A prolonged time indicates dysfunction of the sinus node.

One of the main purposes of programmed stimulation is to assess the ability of the area surrounding the electrode to cause a reentry arrhythmia. One or a series of premature impulses is delivered to an area in an attempt to cause the tachyarrhythmia. Because the precise location of the suspected area and the specific timing of the pacing needed are unknown, the electrophysiologist uses many different techniques to cause the arrhythmia during the study. If the arrhythmia can be reproduced by programmed stimulation, it is called *inducible.* Once an arrhythmia is induced, a treatment plan is determined and

implemented. If, on the follow-up EPS, the tachyarrhythmia cannot be induced, then the treatment is determined to be effective. Different medications may be given and combined with cardiac implantable electronic devices to determine the most effective treatment to suppress the arrhythmia.

Patient care, patient education, and associated complications of an EPS are similar to those associated with cardiac catheterization (see Chapter 21). The study is usually about 2 hours in length; however, if the electrophysiologist conducts not only a diagnostic procedure but also treatment, the study can take up to 6 hours. During the procedure, patients benefit from a calm, reassuring approach.

Patients who are to undergo an EPS may be anxious about the procedure and its outcome. A detailed discussion involving the patient, the family, and the electrophysiologist usually occurs to ensure that the patient can give informed consent and to reduce the patient's anxiety about the procedure. Before the procedure, the nurse educates the patient about the EPS and its usual duration, the environment where the procedure is performed, and what to expect. Although an EPS is not painful, it does cause discomfort and can be tiring. It may also cause feelings that were experienced when the arrhythmia occurred in the past. In addition, patients are educated about what will be expected of them (e.g., lying very still during the procedure, reporting symptoms or concerns).

The patient should also know that the arrhythmia may occur during the procedure. It often stops on its own; if it does not, treatment is given to restore the patient's normal rhythm. The arrhythmia may have to be terminated using cardioversion or defibrillation, but this is performed under more controlled circumstances than if performed in an emergency.

Postprocedural care is similar to that for cardiac catheterization, including restriction of activity to promote hemostasis at the insertion site (see Chapter 21). To identify any complications and to ensure healing, the patient's vital signs and the appearance of the insertion site are assessed frequently. Because an artery is not always used, there is a lower incidence of vascular complications than with other catheterization procedures (Zipes, Libby, Bonow, et al., 2018).

Pacemaker Therapy

A pacemaker is an electronic device that provides electrical stimuli to the heart muscle. Pacemakers are usually used when a patient has a permanent or temporary slower-than-normal impulse formation, or a symptomatic AV or ventricular conduction disturbance. They may also be used to control some tachyarrhythmias that do not respond to medication. Biventricular (both ventricles) pacing, also called **cardiac resynchronization therapy (CRT)**,

may be used to treat advanced heart failure. Pacemaker technology also may be used in conjunction with an ICD.

Pacemakers can be permanent or temporary. Temporary pacemakers are used to support patients until they improve or receive a permanent pacemaker (e.g., after acute MI or during open heart surgery). Temporary pacemakers are used only in hospital settings.

Pacemaker Design and Types

Pacemakers consist of two components: an electronic pulse generator and pacemaker electrodes, which are located on leads or wires. The generator contains the circuitry and batteries that determine the rate (measured in beats per minute) and the strength or output (measured in milliamperes [mA]) of the electrical stimulus delivered to the heart. The generator also has circuitry that can detect the intracardiac electrical activity to cause an appropriate response; this component of pacing is called *sensitivity* and is measured in millivolts (mV). Sensitivity is set at the level that the intracardiac electrical activity must exceed to be sensed by the device. Leads, which carry the impulse created by the generator to the heart, can be threaded by fluoroscopy through a major vein into the heart, usually the right atrium and ventricle (endocardial leads), or they can be lightly sutured onto the outside of the heart and brought through the chest wall during open heart surgery (epicardial wires). These epicardial pacemakers are typically temporary and are removed by a gentle tug a few days after surgery. The endocardial leads may be temporarily placed with catheters through a vein (usually the femoral, subclavian, or internal jugular vein [transvenous wires]), usually guided by fluoroscopy. The leads may also be part of a specialized pulmonary artery catheter (see Chapter 21). However, obtaining a pulmonary artery wedge pressure may cause the leads to move out of pacing position. The endocardial and epicardial wires are connected to a temporary generator, which is about the size of a cellular phone. The energy source for a temporary generator is a common household battery. Monitoring for pacemaker malfunctioning and battery failure is a nursing responsibility.

The endocardial leads also may be placed permanently, passed into the heart through the subclavian, axillary, or cephalic vein, and connected to a permanent generator. These types of pacemakers are sometimes also called transvenous pacemakers. Most current leads have a fixation mechanism (e.g., a screw) at the end of the lead that allows precise positioning and avoidance of dislodgement. The permanent generator, which often weighs less than 1 ounce and is the size of a pack of chewing gum, is usually implanted in a subcutaneous pocket created in the pectoral region, below the clavicle in men, or behind the breast in women (see Fig. 22-25). This procedure usually takes about 1 hour, and it is performed in a cardiac catheterization laboratory using a

local anesthetic and moderate sedation. Close monitoring of the respiratory status is needed until the patient is fully awake.

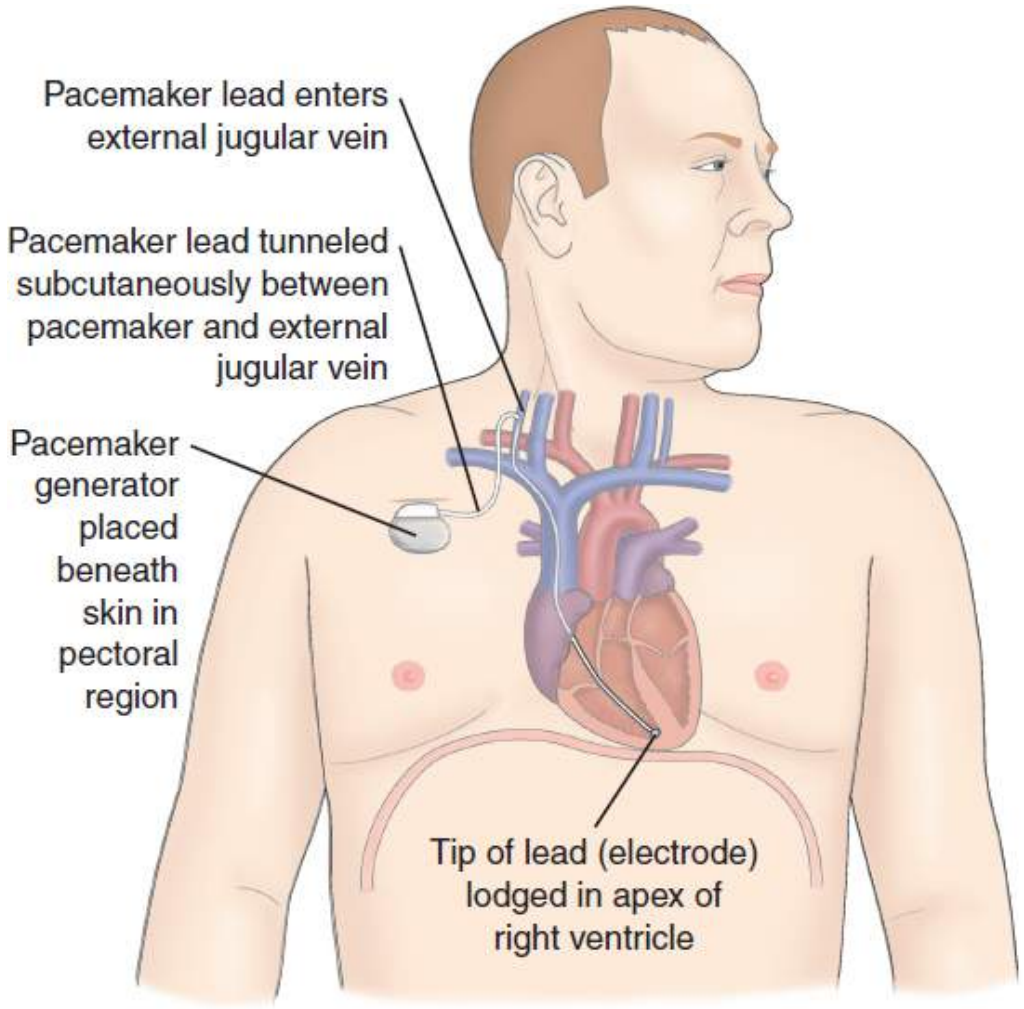

Figure 22-25 • Implanted transvenous pacing lead (with electrode) and pacemaker generator.

Leadless pacemakers, a newer type of permanent pacemaker, are 90% smaller than transvenous pacemakers. They feature a self-contained, single-unit pulse generator and electrode that is inserted transvenously directly into the right ventricle (Groner & Grippe, 2019; Hayes, 2018).

Permanent pacemaker generators are insulated to protect against body moisture and warmth and have filters that protect them from electrical interference from most household devices, motors, and appliances. Lithium cells are most commonly used; they last approximately 5 to 15 years, depending on the type of pacemaker, how it is programmed, and how often it is used. Most pacemakers have an elective replacement indicator (ERI), which is a signal that indicates when the battery is approaching depletion. The pacemaker continues to function for several months after the appearance of ERI to ensure that there is adequate time for a battery replacement. Although

some batteries are rechargeable, most are not. Because the battery is permanently sealed in the pacemaker, the entire generator must be replaced. To replace a failing generator of a transvenous pacemaker, the leads are disconnected, the old generator is removed, and a new generator is reconnected to the existing leads and reimplanted in the already existing subcutaneous pocket. Sometimes the leads are also replaced. When leadless pacemaker batteries signal that they must be replaced, a new system is simply implanted and the old battery is then disabled (Groner & Grippe, 2019). Battery replacement of both systems is usually performed using a local anesthetic. The patient usually can be discharged from the hospital the day of the procedure.

If a patient suddenly develops a bradycardia, is symptomatic but has a pulse, and is unresponsive to atropine, emergency pacing may be started with transcutaneous pacing, which most defibrillators are now equipped to perform. Some AEDs are able to do both defibrillation and transcutaneous pacing. Large pacing ECG electrodes (sometimes the same conductive pads used for cardioversion and defibrillation) are placed on the patient's chest and back. The electrodes are connected to the defibrillator, which is the temporary pacemaker generator (see Fig. 22-26). Because the impulse must travel through the patient's skin and tissue before reaching the heart, transcutaneous pacing can cause significant discomfort (burning sensation and involuntary muscle contraction) and is intended to be used only in emergencies for short periods of time. This type of pacing necessitates hospitalization. If the patient is alert, sedation and analgesia may be given. After transcutaneous pacing, the skin under the electrode should be inspected for erythema and burns. Transcutaneous pacing is not indicated for pulseless bradycardia (Link et al., 2015; Soar et al., 2018).

Pacemaker Generator Functions

Because of the sophistication and wide use of pacemakers, a universal code has been adopted to provide a means of safe communication about their function. The coding is referred to as the NASPE-BPEG code because it is sanctioned by the North American Society of Pacing and Electrophysiology and the British Pacing and Electrophysiology Group. The complete code consists of five letters; the fourth and fifth letters are used only with permanent pacemakers (Bernstein, Daubert, Fletcher, et al., 2002; Mulpuru, Madhavan, McLeod, et al., 2017; Tracy, Epstein, Darbar, et al., 2012; see Chart 22-6).

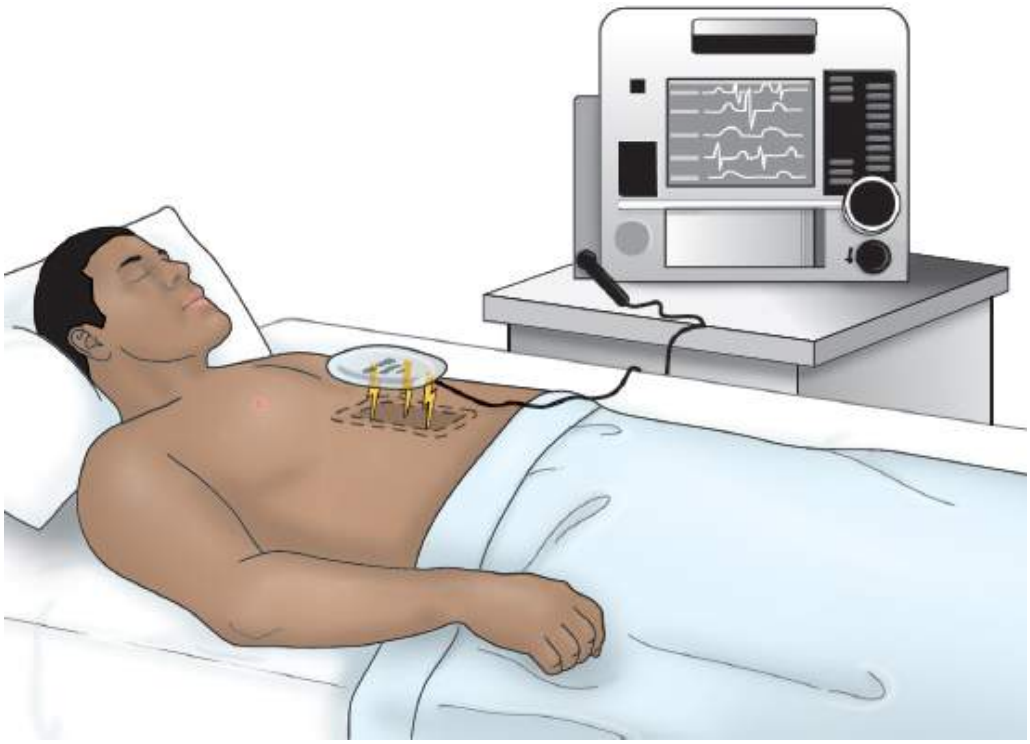

Figure 22-26 • Transcutaneous pacemaker with electrode pads connected to the anterior and posterior chest walls.

Chart 22-6

North American Society of Pacing and Electrophysiology and the British Pacing and Electrophysiology Group Code (NASPE-BPEG Code) for Pacemaker Generator Function

- The first letter of the code identifies the chamber or chambers being paced (i.e., the chamber containing a pacing electrode). The letter characters for this code are A (atrium), V (ventricle), or D (dual, meaning both A and V).
- The second letter identifies the chamber or chambers being sensed by the pacemaker generator. Information from the electrode within the chamber is sent to the generator for interpretation and action by the generator. The letter characters are A (atrium), V (ventricle), D (dual), and O (indicating that the sensing function is turned off).
- The third letter of the code describes the type of response that will be made by the pacemaker to what is sensed. The letter characters used to describe this response are I (inhibited), T (triggered), D (dual—inhibited and triggered), and O (none). Inhibited response means that the response of the pacemaker is controlled by the activity of the patient's heart—that is, when the patient's heart beats, the pacemaker does not function, but when the heart does not beat, the pacemaker does function. In contrast, a triggered response means that the pacemaker responds (paces the heart) when it senses intrinsic heart activity.
- The fourth letter of the code is related to a permanent generator's ability to vary the heart rate. This ability is available in most current pacemakers. The possible letters are O, indicating no rate responsiveness, or R, indicating that the generator has rate modulation (i.e., the pacemaker has the ability to automatically adjust the pacing rate from moment to moment based on parameters, such as QT interval, physical activity, acid–base changes, body temperature, rate and depth of respirations, or oxygen saturation). A pacemaker with rate-responsive ability is capable of improving cardiac output during times of increased cardiac demand, such as exercise and decreasing the incidence of atrial fibrillation. All contemporary pacemakers have some type of sensor system that enables them to provide rate-adaptive pacing.
- The fifth letter of the code has two different indications: (1) that the permanent generator has multisite pacing capability with the letters A (atrium), V (ventricle), D (dual), and O (none); or (2) that the pacemaker has an antitachycardia function.
- Commonly, only the first three letters are used for a pacing code. An example of an NASPE-BPEG code is DVI:
  D: Both the atrium and the ventricle have a pacing electrode in place.
  V: The pacemaker is sensing the activity of the ventricle only.
  I: The pacemaker's stimulating effect is inhibited by ventricular activity—in other words, it does not create an impulse when the pacemaker

senses that the patient's ventricle is active.

Adapted from Bernstein, A. D., Daubert, J-C., Fletcher, R. D., et al. (2002). The revised NASPE/BPEG generic code for antibradycardia, adaptive-rate, and multisite pacing. North American Society of Pacing and Electrophysiology/British Pacing and Electrophysiology Group. *Pacing and Clinical Electrophysiology, 25*(2), 260–264; Gillis, A. M., Russo, A. M., Ellenbogen, K. A., et al. (2012). HRS/ACCF expert consensus statement on pacemaker device and mode selection. *Journal of American College of Cardiology, 60*(7), 682–703; Mulpuru, S. K., Madhavan, M., McLeod, C. J., et al. (2017). Cardiac pacemakers: Function, troubleshooting, and management: Part 1 of a 2-Part Series. *Journal of the American College of Cardiology, 69*(2), 189–210.

Figure 22-27 • Pacemaker capture. **A.** Atrial pacemaker; note that each vertical pacemaker spike is followed by a P wave. **B.** Ventricular pacemaker; note that each vertical pacemaker spike is followed by a QRS complex. Reprinted with permission from Morton, G. M., & Fontaine, D. K. (2018). *Critical care nursing: A holistic approach* (11th ed., Fig. 18-34A and B). Philadelphia, PA: Wolters Kluwer.

The pacemaker paces the atrium and then the ventricle when no ventricular activity is sensed for a period of time (the time is individually programmed into the pacemaker for each patient). A straight vertical line usually can be seen on the ECG when pacing is initiated. The line that represents pacing is called a *pacemaker spike.* The appropriate ECG complex should immediately follow the pacing spike; therefore, a P wave should follow an atrial pacing spike (see Fig. 22-27A) and a QRS complex should follow a ventricular pacing spike (see Fig. 22-27B). Because the impulse starts in a different place than the patient's normal rhythm, the QRS complex or P wave that responds to pacing looks different from the patient's normal ECG complex. *Capture* is a term used to denote that the appropriate complex followed the pacing spike.

The type of pacemaker generator and the settings selected depend on the patient's arrhythmia, underlying cardiac function, and age. Pacemakers are

generally set to sense and respond to intrinsic activity, which is called *on-demand pacing*. If the pacemaker is set to pace but not to sense, it is called a *fixed* or *asynchronous pacemaker*; this is written in pacing code as AOO or VOO. The pacemaker paces at a constant rate, independent of the patient's intrinsic rhythm. VOO pacing may indicate battery failure.

VVI (V, paces the ventricle; V, senses ventricular activity; I, paces only if the ventricles do not depolarize) pacing causes loss of AV synchrony and atrial kick, which may cause a decrease in cardiac output and an increase in atrial distention and venous congestion. Pacemaker syndrome, causing symptoms such as chest discomfort, shortness of breath, fatigue, activity intolerance, and orthostatic hypotension, is most common with VVI pacing (Mulpuru et al., 2017; Tracy et al., 2012). Atrial pacing and dual-chamber (right atrial and RV) pacing have been found to reduce the incidence of atrial fibrillation, ventricular dysfunction, and heart failure (Mulpuru et al., 2017; Tracy et al., 2012).

Single-chamber atrial pacing (AAI) or dual-chamber pacing (DDD) is recommended over VVI in patients with sinus node dysfunction, the most common cause of bradycardias requiring a pacemaker, and a functioning AV node (Mulpuru et al., 2017; Tracy et al., 2012). AAI pacing ensures synchrony between atrial and ventricular stimulation (and therefore contraction), as long as the patient has no conduction disturbances in the AV node. Dual-chamber pacemakers are recommended as the treatment for patients with AV conduction disturbances (Mulpuru et al., 2017; Tracy et al., 2012).

Synchronized biventricular pacing, also called *cardiac resynchronization therapy (CRT),* is associated with improved mortality rates in patients with heart failure and in patients with left bundle branch block (Agrawal, 2018). Synchronized biventricular pacing features three leads: one for the right atrium; one for the right ventricle; and one for the left ventricle, usually placed in the left lateral wall. This therapy improves cardiac function, resulting in decreased heart failure symptoms and an improved quality of life. Biventricular pacing may be used with an ICD (Agrawal, 2018).

Complications of Pacemaker Use

Complications associated with pacemakers relate to their presence within the body and improper functioning (see Chart 22-7). In the initial hours after a temporary or permanent pacemaker is inserted, the most common complication is dislodgment of the pacing electrode. Minimizing patient activity can help prevent this complication. If a temporary electrode is in place, the extremity through which the catheter has been advanced is immobilized. With a permanent pacemaker, the patient is instructed initially to restrict activity on the side of the implantation.

Leadless pacemakers are associated with fewer complications than transvenous pacemakers, including fewer infections, hematomas, lead dislodgement, and lead fracture. However, they provide only single-chamber RV pacing and do not feature concomitant defibrillator capabilities, limiting their usefulness (Groner & Grippe, 2019; Hayes, 2018).

The ECG is monitored very carefully to detect pacemaker malfunction. Improper pacemaker function, which can arise from failure in one or more components of the pacing system, is outlined in Table 22-2. The following data should be noted on the patient's record: model of pacemaker, type of generator, date and time of insertion, location of pulse generator, stimulation threshold, and pacer settings (e.g., rate, energy output [mA], sensitivity [mV], and duration of interval between atrial and ventricular impulses [AV delay]). This information is important for identifying normal pacemaker function and diagnosing pacemaker malfunction.

Chart 22-7

Potential Complications from Insertion of a Pacemaker

- Local infection at the entry site of the leads for temporary pacing, or at the subcutaneous site for permanent generator placement. Prophylactic antibiotic and antibiotic irrigation of the subcutaneous pocket prior to generator placement has decreased the rate of infection to a minimal rate.
- Pneumothorax or hemothorax. The risk is reduced if cephalic vein cut down, contrast venography, or ultrasound guidance is utilized.
- Bleeding and hematoma at the lead entry sites for temporary pacing, or at the subcutaneous site for permanent generator placement. This usually can be managed with cold compresses and discontinuation of antiplatelet and antithrombotic medications.
- Ventricular ectopy and tachycardia from irritation of the ventricular wall by the endocardial electrode.
- Movement or dislocation of the lead placed transvenously (perforation of the myocardium).
- Phrenic nerve, diaphragmatic (hiccupping may be a sign), or skeletal muscle stimulation if the lead is dislocated or if the delivered energy (mA) is set high. The occurrence of this complication is avoided by testing during device implantation.
- Cardiac perforation resulting in pericardial effusion and, rarely, cardiac tamponade, which may occur at the time of implantation or months later. This condition can be recognized by the change in QRS complex morphology, diaphragmatic stimulation, or hemodynamic instability.
- Twiddler syndrome may occur when the patient manipulates the generator, causing lead dislodgement or fracture of the lead.
- Pacemaker syndrome (hemodynamic instability caused by ventricular pacing and the loss of AV synchrony).

Adapted from Link, M. S., Berkow, L. C., Kudenchuk, P. J., et al. (2015). Part 7: Adult advanced cardiovascular life support: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation, 132*(18 suppl 2), S444–S464; Mulpuru, S. K., Madhavan, M., McLeod, C. J., et al. (2017). Cardiac pacemakers: Function, troubleshooting, and management: Part 1 of a 2-Part Series. *Journal of the American College of Cardiology, 69*(2), 189–210; Soar, J., Donnino, M. W., Maconochie, I., et al. (2018). 2018 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations summary. *Resuscitation, 133*, 194–206; Tracy, C. M., Epstein, A. E., Darbar, D., et al. (2012). ACCF/AHA/HRS focused update of the 2008 guidelines for device-based therapy of cardiac rhythm abnormalities: A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Journal of the American College of Cardiology, 60*(14), 1297–1313.

A patient experiencing pacemaker malfunction may develop bradycardia as well as signs and symptoms of decreased cardiac output (e.g., diaphoresis, orthostatic hypotension, syncope). The degree to which these symptoms become apparent depends on the severity of the malfunction, the patient's level of dependency on the pacemaker, and the patient's underlying condition. Pacemaker malfunction is diagnosed by analyzing the ECG. Manipulating the electrodes, changing the generator's settings, or replacing the pacemaker generator or leads (or both) may be necessary.

TABLE 22-2 Assessing Pacemaker Malfunction

Problem	Possible Cause	Nursing Considerations
Loss of capture—complex does *not* follow pacing spike	Inadequate stimulus Lead dislodgement Lead wire fracture Catheter malposition Battery depletion Electronic insulation break Medication change Myocardial ischemia	Check security of all connections; increase milliamperage. Reposition extremity; turn patient to left side. Change battery. Change generator.
Undersensing—pacing spike occurs at preset interval despite the patient's intrinsic rhythm	Sensitivity too high Electrical interference (e.g., by a magnet) Faulty generator	Decrease sensitivity. Eliminate interference. Replace generator.
Oversensing—loss of pacing artifact; pacing does not occur at preset interval despite the lack of intrinsic rhythm	Sensitivity too low Electrical interference Battery depletion Change in medication	Increase sensitivity. Eliminate interference. Change battery.
Loss of pacing—total absence of pacing spikes	Oversensing Battery depletion Loose or disconnected wires Perforation	Change battery. Check security of all connections. Apply magnet over permanent generator. Obtain 12-lead ECG and portable chest x-ray. Assess for murmur. Contact physician.
Change in pacing QRS shape	Septal perforation	Obtain 12-lead ECG and portable chest x-ray. Assess for murmur. Contact physician.
Rhythmic diaphragmatic or chest wall twitching or hiccupping	Output too high Myocardial wall perforation	Decrease milliamperage. Turn pacer off. Contact physician at once. Monitor closely for decreased cardiac output.

ECG, electrocardiogram.

Adapted from Mulpuru, S. K., Madhavan, M., McLeod, C. J., et al. (2017). Cardiac pacemakers: Function, troubleshooting, and management: Part 1 of a 2-Part Series. *Journal of the American College of Cardiology*, *69*(2), 189–210.

Inhibition of permanent pacemakers or reversion to asynchronous fixed rate pacing can occur with exposure to strong electromagnetic fields (electromagnetic interference [EMI]). However, pacemaker technology allows patients to safely use most household electronic appliances and devices (e.g., microwave ovens, electric tools). Gas-powered engines should be turned off before working on them. Objects that contain magnets (e.g., the earpiece of a phone, large stereo speakers, jewelry) should not be near the generator for longer than a few seconds. Patients are advised to place digital cellular phones at least 6 to 12 inches away from (or on the side opposite of) the pacemaker generator and not to carry them in a shirt pocket. Large electromagnetic fields, such as those produced by magnetic resonance imaging (MRI), radio and television transmitter towers and lines, transmission power lines (not the distribution lines that bring electricity into a home), and electrical substations may cause EMI. Patients should be cautioned to avoid such situations or to simply move farther away from the area if they experience dizziness or a feeling of rapid or irregular heartbeats (palpitations). Welding and the use of a chain saw should be avoided. If such tools are used, precautionary steps such as limiting the welding current to a 60- to 130-ampere range or using electric rather than gasoline-powered chain saws are advised.

In addition, the metal of the pacemaker generator may trigger store and library antitheft devices as well as airport and building security alarms; however, these alarm systems generally do not interfere with the pacemaker function. Patients should walk through them quickly and avoid standing in or near these devices for prolonged periods of time. The handheld screening devices used in airports may interfere with the pacemaker. Patients should be advised to ask security personnel to perform a hand search instead of using the handheld screening device. Patients also should be educated to wear or carry medical identification to alert personnel to the presence of the pacemaker.

Pacemaker Surveillance

Remote monitoring technology is now routinely embedded in the pacemaker so that it replaces the need for frequent in-person follow-up cardiologist visits; this is also associated with improved survival (Costa, Yeung, Gilbert, et al., 2018). Remote monitoring systems in use include transtelephonic monitoring (use of an analog phone with transmission through a landline), inductive monitoring (use of a wand with transmission through a landline or a cellular connection), and remote wandless monitoring (use of wandless transmitter through radiofrequency) (Madhavan, Mulpuru, McLeod, et al., 2017). Remote monitoring allows pertinent information, such as ECG data, to be transmitted to the primary provider at the cardiology clinic. In addition, the pacemaker rate and other data concerning pacemaker function (e.g., generator setting, battery status, sensing function, lead integrity, pacing data, such as number of pacing

events) are obtained and evaluated by the cardiologist. This simplifies the diagnosis of a failing generator, reassures the patient, and improves management when the patient is physically remote from pacemaker testing facilities. A follow-up schedule is variable, and is dependent upon the patient's needs and the pacemaker in use; the system is setup for maintenance checks on an annual basis.

Implantable Cardioverter Defibrillator

The **implantable cardioverter defibrillator (ICD)** is an electronic device that detects and terminates life-threatening episodes of tachycardia or fibrillation, especially those that are ventricular in origin. Patients at high risk of VT or ventricular fibrillation and who would benefit from an ICD are those who have survived sudden cardiac death, which usually is caused by ventricular fibrillation, or have experienced spontaneous, symptomatic VT (syncope secondary to VT) not due to a reversible cause (called a *secondary prevention intervention*). Patients with coronary artery disease who are 40 days postacute MI with moderate to severe LV dysfunction (ejection fraction less than or equal to 35%) are at risk of sudden cardiac death and therefore an ICD is indicated (called a *primary prevention intervention*). An ICD implantation is also recommended in patients who have been diagnosed with nonischemic dilated cardiomyopathy for at least 9 months and have functional NYHA Class II or III heart failure (Wilkoff, Fauchier, Stiles, et al., 2015) (see Chapter 25, Table 25-1) (Al-khatib et al., 2018; Ganz, 2019).

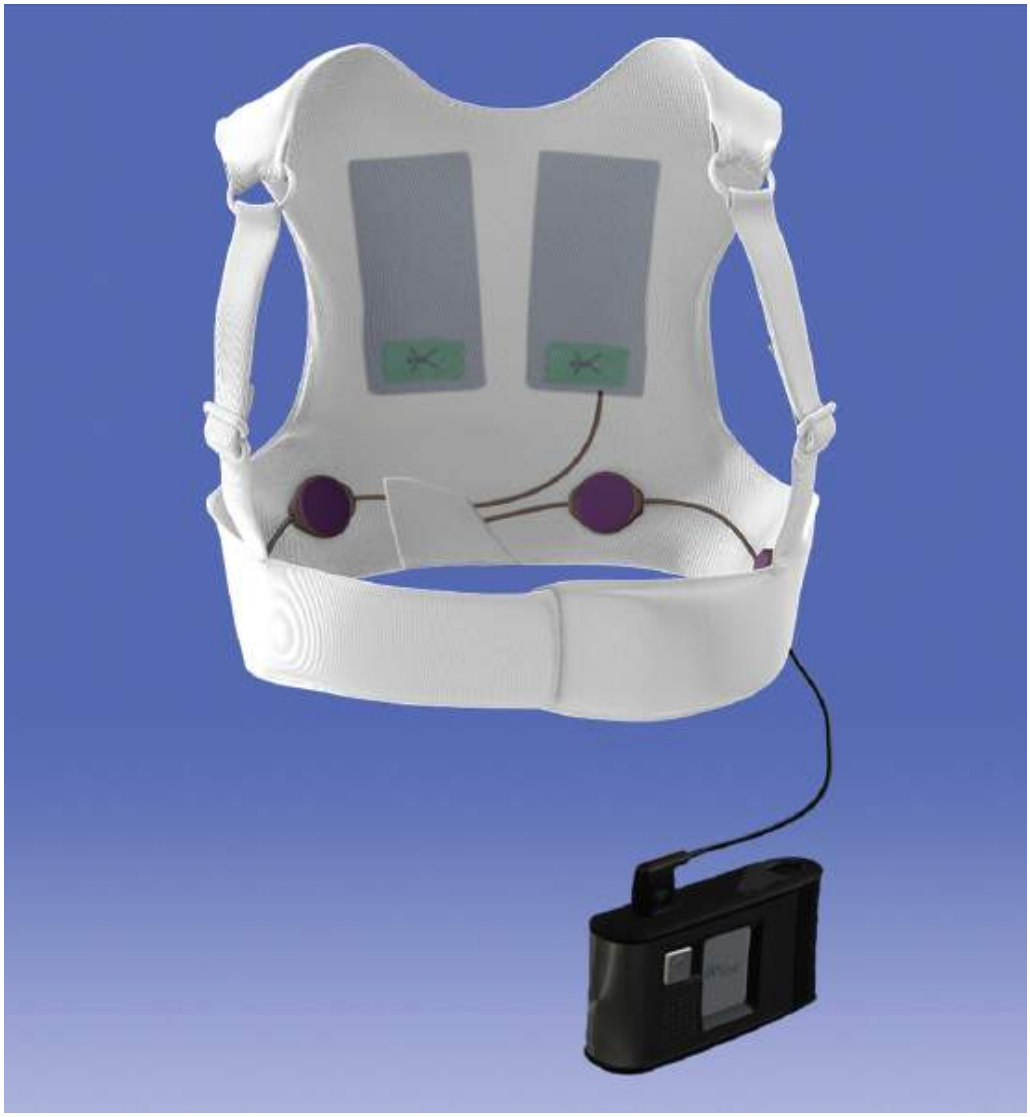

Figure 22-28 • The wearable cardioverter defibrillator vest. Courtesy of ZOLL LifeVest.

Because there may be a waiting period for ICD implantation, especially those postacute MI, patients who are at risk for sudden cardiac death may be prescribed a wearable vestlike automated defibrillator, which works just like an AED in that a shock is delivered less than a minute after a life-threatening rhythm is detected (National Heart, Lung, and Blood Institute [NHLBI], 2019; see Fig. 22-28). Prior to the delivery of the shock, the vest vibrates and issues an alarm to announce that a shock is imminent. The vest weighs about a pound, is worn under the patient's clothing, and is attached to a monitor with a battery that is worn in a holster or on a shoulder strap. The monitor automatically downloads information once a day, usually in the middle of the night. The vest must be worn at all times, even if the patient is admitted to the hospital and placed on an ECG monitor, and removed only when showering or bathing. The battery needs to be changed every day. Education is provided to

the patient by the device manufacturer. However, the nurse should assess the patient's understanding of the education provided and explore any issues that may prevent the patient from wearing it.

An ICD has a generator about the size of a pack of chewing gum that is implanted in a subcutaneous pocket, usually in the upper chest wall. An ICD also has at least an RV lead that is implanted transvenously and can sense intrinsic electrical activity and deliver an electrical impulse. The implantation procedure, postimplantation care, and length of hospital stay are much like those for insertion of a pacemaker (see Fig. 22-29).

ICDs are designed to respond to two criteria: a rate that exceeds a predetermined level and a change in the isoelectric line segments. When an arrhythmia occurs, rate sensors require a set duration of time to sense the arrhythmia. Then, the device automatically charges; after a second "look" confirms the arrhythmia, it delivers the programmed charge through the lead to the heart. The time from arrhythmia detection to electrical discharge depends on the charging time, which depends on the programmed energy level (Zipes et al., 2018). However, in an ICD that has the capability of providing atrial therapies, the device can be programmed to be activated by the patient, giving the patient time to activate the charge at a time and place of their choosing. The life of the lithium battery is about 9 years but varies depending on the use of the ICD. ICD surveillance is similar to that of the pacemaker; however, it includes stored endocardial ECGs as well as information about the number and frequency of shocks that have been delivered.

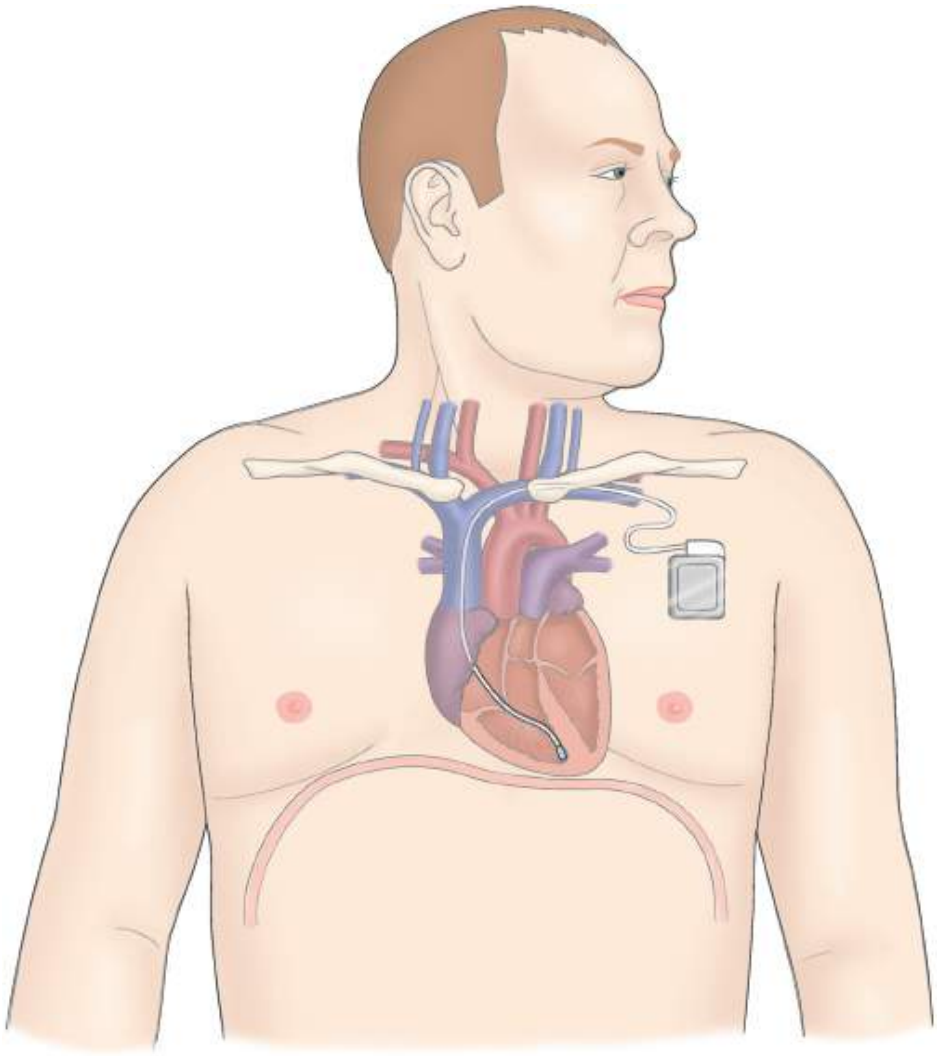

Figure 22-29 • The implantable cardioverter defibrillator consists of a generator and a sensing/pacing/defibrillating electrode.

Antiarrhythmic medication may be given with this technology to minimize the occurrence of a tachyarrhythmia and to reduce the frequency of ICD discharge.

Several types of devices are available. ICD, the generic name, is used as the abbreviation for these various devices. Each device offers a different delivery sequence, but all are capable of delivering high-energy (high-intensity) defibrillation to treat a tachycardia (atrial or ventricular).

Some ICDs can respond with (1) antitachycardia pacing, in which the device delivers electrical impulses at a fast rate in an attempt to disrupt the tachycardia, (2) low-energy (low-intensity) cardioversion, or (3) defibrillation; others may use all three techniques. Pacing is used to terminate tachycardias caused by a conduction disturbance called *reentry,* which is repetitive restimulation of the heart by the same impulse. An impulse or a series of impulses is delivered to the heart by the device at a fast rate to collide with and stop the heart's reentry conduction impulses, and therefore to stop the

tachycardia. Typically, ICDs also have pacemaker capability if the patient develops bradycardia, which sometimes occurs after treatment of the tachycardia. Usually, the mode is VVI.

The subcutaneous ICD is a more recently introduced therapeutic alternative to the conventional ICD. The main advantage to subcutaneous defibrillators is that the complications associated with vascular access are avoided. Patients without pacing indications, or antitachycardia pacing, or cardiac resynchronization are best candidates for this technology (Sideris, Archontakis, Gatzoulis, et al., 2017).

Which device is used and how it is programmed depend on the patient's arrhythmia(s). The device may be programmed differently for different arrhythmias (e.g., ventricular fibrillation, VT with a fast ventricular rate, and VT with a slow ventricular rate). As with pacemakers, there is an NASPE-BPEG code for communicating the functions of the ICDs (Bernstein et al., 2002; Wilkoff et al., 2015). The first letter represents the chamber or chambers shocked (O, none; A, atrium; V, ventricle; D, both atrium and ventricle). The second letter represents the chamber that can be antitachycardia paced (O, A, V, D, meaning the same as the first letter). The third letter indicates the method used by the generator to detect a tachycardia (E, electrogram; H, hemodynamics). The last letter represents the chambers that have antibradycardia pacing (O, A, V, D, meaning the same as the first and second letters of the ICD code).

Complications of ICD implantation are similar to those associated with pacemaker insertion. The primary potential complication is surgery-related infection; its risk increases with battery or lead replacement. A few complications are associated with the technical aspects of the equipment, like those of pacemakers, such as premature battery depletion and dislodged or fractured leads. Inappropriate delivery of ICD therapy, usually due to oversensing or atrial and sinus tachycardias with a rapid ventricular rate response, is the most frequent long-term complication. This requires reprogramming of the device.

Nursing Management

After a permanent electronic device (pacemaker or ICD) is inserted, the patient's heart rate and rhythm are monitored by ECG. The device's settings are noted and compared with the ECG recordings to assess the device's function. For example, pacemaker malfunction is detected by examining the pacemaker spike and its relationship to the surrounding ECG complexes. In addition, cardiac output and hemodynamic stability are assessed to identify the patient's response to pacing and the adequacy of pacing. The appearance or increasing frequency of arrhythmia is observed and reported to the primary provider. If the patient has an ICD implanted and develops VT or ventricular

fibrillation, the ECG should be recorded to note the time between the onset of the arrhythmia and the onset of the device's shock or antitachycardia pacing.

The incision site where the generator was implanted is observed for bleeding, hematoma formation, or infection, which may be evidenced by swelling, unusual tenderness, drainage, and increased warmth. The patient may complain of continuous throbbing or pain. These symptoms are reported to the primary provider.

A chest x-ray is usually taken after the procedure and prior to discharge to document the position of leads in addition to ensuring that the procedure did not cause a pneumothorax. It is necessary to assess the function of the device throughout its lifetime and especially after changes in the patient's medication regimen. For example, antiarrhythmic agents, beta-blockers, and diuretics may increase the pacing threshold, whereas corticosteroids and alpha-adrenergic agents may decrease the pacing threshold; the opposite effect occurs when the patient is taken off these medications.

The patient is also assessed for anxiety, depression, or anger, which may be symptoms of ineffective coping with the implantation. In addition, the level of knowledge and education needs of the patient and family and the history of adherence to the therapeutic regimen should be identified. It is especially important to include the family when providing education and support.

In the peri- and postoperative phases, the nurse carefully observes the patient's responses to the device and provides the patient and family with further education as needed. The nurse also assists the patient and family in addressing concerns and in making decisions about self-care and lifestyle changes necessitated by the arrhythmia and resulting device implantation.

Preventing Infection

The nurse changes the dressing as needed and inspects the insertion site for redness, swelling, soreness, or any unusual drainage. Any change in wound appearance, an increase in the patient's temperature, or an increase in the patient's white blood count should be reported to the primary provider.

Promoting Effective Coping

The patient treated with an electronic device experiences not only lifestyle and physical changes but also emotional changes (Palese, Cracina, Purino, et al., 2019; see Chart 22-8 Nursing Research Profile: Experiences of Patients Shocked by an Implantable Cardioverter Defibrillator). At different times during the healing process, the patient may feel angry, depressed, fearful, anxious, or a combination of these emotions. Although each patient uses individual coping strategies (e.g., humor, prayer, communication with a significant other) to manage emotional distress, some strategies may work better than others. Signs that may indicate ineffective coping include social

isolation, increased or prolonged irritability or depression, and difficulty in relationships.

To promote effective coping strategies, the nurse must recognize both the patient's and family's perceptions of the situation and their resulting emotional state and assist them to explore their reactions and feelings. Because of the unpredictable and possibly painful ICD discharge, patients with ICDs are most vulnerable to feelings of helplessness, leading to depression. The nurse can help the patient identify positive methods to deal with the actual or perceived limitations and manage any lifestyle changes needed. The nurse may help the patient identify changes (e.g., loss of ability to participate in contact sports), the emotional responses to the change (e.g., anger), and how the patient responds to that emotion (e.g., quickly becomes angry when talking with spouse). The nurse reassures the patient that these responses are normal and helps the patient identify realistic goals (e.g., develop interest in another activity) and develop a plan to attain these goals. The patient and family should be encouraged to talk about their experiences and emotions with each other and the health care team. The nurse may refer the patient and family to a hospital, community, or online support group. The nurse may also encourage the use of spiritual resources. Based on the patient's interest, the nurse also may educate the patient about easy-to-use stress reduction techniques (e.g., deep-breathing exercises, relaxation) to facilitate coping. Instructing the patient about the ICD may help the patient cope with changes that occur as a result of device implantation.

Chart 22-8 **NURSING RESEARCH PROFILE**

Experiences of Patients Shocked by an Implantable Cardioverter Defibrillator

Palese, A., Cracina, A., Purino, M., et al. (2019). The experiences of patients electrically shocked by an implantable cardioverter defibrillator: Findings from a descriptive qualitative study. *Nursing in Critical Care*. Retrieved on 7/9/2019 at: doi.org/10.1111/nicc.12424

Purpose

Insertion rates for implantable cardioverter defibrillators (ICDs) have steadily risen. ICDs may be surgically implanted as a secondary preventive measure for survivors of ventricular arrhythmias or sudden cardiac death and as primary prevention for patients with preexisting select cardiac conditions. The ICD is proven to be effective in lowering mortality rates in sudden cardiac death; however, little has been explored regarding the patients' experiences as lived before, during, and after shocks from an ICD.

Design

This study used a descriptive qualitative design. A convenience sample of adult patients with ICDs who reported at least one shock during their first follow-up visit post ICD implantation were eligible to participate. All patients were followed by a cardiology department in an academic hospital located in northern Italy. A total of 50 participants consented to enroll in this study. Each participant went through semi-structured face-to-face audiorecorded interviews. Content analysis methodology was used to analyze the data.

Findings

The content analysis revealed four themes*: feeling surprised versus feeling altered by the changes inside me; living an intense, monodimensional experience versus living a multidimensional storm experience*; *facing the event alone versus being supported*; and *living a drama versus being used to it*. Most participants reported that they received shocks in their homes or in other community-based settings, many with family members present, and that they then presented to their local emergency department. Most participants could not recall the moments preceding the shocks, but did report feeling vague physical symptoms.

Nursing Implications

Findings from this study suggest that ICD shocks can have a profound effect on patients' physical and emotional health. Nurses need to be vigilant to recognize patients' educational needs. Furthermore, nurses need to tailor appropriate, supportive interventions to improve patients' experiences living with an ICD. In particular, nurses can assist patients with ICDs in identifying pre-shock prodromal physical symptoms so that the ICD may be reprogrammed if indicated, or so that the doses of antiarrhythmic medications might be better titrated to prevent arrhythmias. Moreover, most

participants in this study received shocks outside the health care setting, and many of them were shocked in the presence of family members. Tailoring education programs to include significant others in identifying prodromal symptoms pre-shock and in seeking appropriate treatment post-shock may improve the quality of life of family members and patients with ICDs.

Promoting Home, Community-Based, and Transitional Care

After device insertion, the patient's hospital stay is typically short (e.g., may be 1 day or less), and follow-up in an outpatient clinic, office, or device clinic is common. The patient's anxiety and feelings of vulnerability may interfere with the ability to learn information provided. The nurse needs to include caregivers in the education and provide printed materials for use by the patient and caregiver. The nurse establishes priorities for learning with the patient and caregiver. Education includes the importance of periodic device monitoring, promoting safety, surgical site care, and avoiding EMI (see Chart 22-9). In addition, the educational plan should include information about activities that are safe and those that may be dangerous. The nurse discusses with the patient and family what they have to do when a shock is delivered. The nurse may facilitate CPR training for the family.

Chart 22-9 **HOME CARE CHECKLIST**

Educating the Patient with an Implantable Cardiac Device

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of device implantation on physiologic functioning, ADLs, IADLs, self-image and roles, relationships (including sexuality), and spirituality.
- State changes in lifestyle (e.g., diet, activity, mobility/driving restrictions) necessary to maintain health.
- State the name, dose, side effects, frequency, and schedule for all medications.
- For patients with pacemakers, check pulse daily. Report *immediately* any sudden slowing or increasing of the pulse rate. This may indicate pacemaker malfunction.
- Avoid infection at the insertion site of the device:
- Leave the incision uncovered and observe it daily for redness, increased swelling, and heat.
- Take temperature at same time each day; report any increase.
- Avoid wearing tight, restrictive clothing that may cause friction over the insertion site.
- Initially avoid soaking in the tub and lotion, creams, or powders in the area of the device.
- Adhere to activity restrictions:
- Restrict movement of arm until incision heals; do not raise arm above head for 2 wks.
- Avoid heavy lifting for a few weeks.
- Discuss safety of activities (e.g., driving) with a primary provider.
- Recognize that although it may take up to 2–3 wks to resume normal activities, physical activity does not usually have to be curtailed, with the exception of contact sports.
- Electromagnetic interference: Understand the importance of the following:
- Avoid large magnetic fields, such as those created by MRI, large motors, arc welding, and electrical substations. Magnetic fields may deactivate the device, negating its effect on an arrhythmia.
- At security gates at airports, government buildings, or other secured areas, show identification card and request a hand (not handheld device) search. Obtain and carry a letter from the primary provider about this requirement.
- Some electrical and small motor devices, as well as products that contain magnets (e.g., cellular phones), may interfere with the functioning of the cardiac device if the electrical device is placed very close to it. Avoid leaning directly over large electrical devices or motors, or ensure that contact is of brief duration; place cellular phone on opposite side of cardiac device.

- Household appliances (e.g., microwave ovens) should not cause any concern.
- Describe precautions and safety measures to be used:
- Describe what to do if symptoms occur, and notify the primary provider if any discharges seem unusual.
- Maintain a log that records discharges of an ICD. Record events that precipitate the sensation of shock. This provides important data for the primary provider to use in readjusting the medical regimen.
- Encourage family members to attend a cardiopulmonary resuscitation class.
- Call 911 for emergency assistance if feeling of dizziness occurs.
- Wear medical identification (e.g., MedicAlert) that includes primary provider information.
- Avoid frightening family or friends with unexpected shocks from an ICD, which will not harm them. Inform family and friends that in the event they are in contact with the patient when a shock is delivered, they may also feel the shock. It is especially important to warn sexual partners that this may occur.
- Carry medical identification with the primary provider's name, type and model number of the device, manufacturer's name, and hospital where device was inserted.
- Identify community resources for peer and caregiver/family support.
- Adhere to appointments for follow-up care that are scheduled to monitor the electronic performance of the cardiac device. This is especially important during the first month after implantation and near the end of the battery life. Remember to take the log of ICD discharges to review with the primary provider.
- Identify the need for health promotion, disease prevention, and screening activities.

ADL, activities of daily living; IADL, instrumental activities of daily living; ICD, implantable cardioverter defibrillator.

CRITICAL THINKING EXERCISES

1 ebp Your uncle, who has a history of alcohol abuse, calls to tell you that his primary provider told him that he has atrial fibrillation. He says that he has been prescribed warfarin and that he really doesn't want to take it because he heard that it is an ingredient in "rat poison." What is the strength of the evidence that supports your uncle's continued adherence to warfarin therapy? What are the risks involved should he decide that he will not take this drug as prescribed?

2 pq You work as a staff nurse on a surgical gynecology unit. A 55-year-old woman assigned to your care is one day post total abdominal hysterectomy. On your initial rounds, the patient is resting comfortably in bed with moderate pain, heart rate of 65 bpm, blood pressure of 120/70 mm Hg, and respiratory rate of 20 breaths per minute. Four hours later, you enter the patient's room and she is sleeping with a heart rate of 98 bpm, blood pressure of 110/60 mm Hg, and respiratory rate of 16 breaths per minute. What are the possible causes of this increase in heart rate? What are your assessment priorities?

3 ipc It is the start of the 12-hour day shift on the cardiovascular unit where you work. A 45-year-old patient who was admitted last evening with a MI is now suddenly experiencing frequent PVCs and a four-beat run of ventricular tachycardia. The patient has remained hemodynamically stable during these episodes. You are preparing for the morning huddle with team members that include unlicensed assistive personnel and attending health care providers. How will you facilitate this interprofessional discussion concerning your patient's PVCs and ventricular tachycardia?

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference, consensus statement, or guideline.

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Resources

American Association of Critical-Care Nurses, www.aacn.org
American Association of Heart Failure Nurses (AAHFN), www.aahfn.org
American College of Cardiology (ACC), www.acc.org
American Heart Association, National Center, www.heart.org
Heart Rhythm Society, www.hrsonline.org
National Institutes of Health, National Heart, Lung, Blood Institute, Health Information Center, www.nhlbi.nih.gov

23 Management of Patients with Coronary Vascular Disorders

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the pathophysiology, clinical manifestations, and treatment of coronary vascular disorders including coronary atherosclerosis, angina pectoris, and myocardial infarction.
2. Use the nursing process as a framework for care of the patient with angina pectoris, with acute coronary syndrome, or who has undergone cardiac surgery.
3. Describe percutaneous coronary interventional and coronary artery revascularization procedures.
4. Identify the nursing care of a patient who has had a percutaneous coronary interventional procedure for treatment of coronary artery disease.

NURSING CONCEPT

Perfusion

GLOSSARY

acute coronary syndrome (ACS): signs and symptoms that indicate unstable angina or acute myocardial infarction

angina pectoris: chest pain brought about by myocardial ischemia

atheroma: fibrous cap composed of smooth muscle cells that forms over lipid deposits within arterial vessels and protrudes into the lumen of the vessel, narrowing the lumen and obstructing blood flow; also called *plaque*

atherosclerosis: abnormal accumulation of lipid deposits and fibrous tissue within arterial walls and the lumen

contractility: ability of the cardiac muscle to shorten in response to an electrical impulse

coronary artery bypass graft (CABG): a surgical procedure in which a blood vessel from another part of the body is grafted onto the occluded coronary artery below the occlusion in such a way that blood flow bypasses the blockage

high-density lipoprotein (HDL): a protein-bound lipid that transports cholesterol to the liver for excretion in the bile; composed of a higher proportion of protein to lipid than low-density lipoprotein; exerts a beneficial effect on the arterial wall

ischemia: insufficient tissue oxygenation

low-density lipoprotein (LDL): a protein-bound lipid that transports cholesterol to tissues in the body; composed of a lower proportion of protein to lipid than high-density lipoprotein; exerts a harmful effect on the arterial wall

metabolic syndrome: a cluster of metabolic abnormalities including insulin resistance, obesity, dyslipidemia, and hypertension that increase the risk of cardiovascular disease

myocardial infarction (MI): death of heart tissue caused by lack of oxygenated blood flow

percutaneous coronary intervention (PCI): a procedure in which a catheter is placed in a coronary artery, and one of several methods is employed to reduce blockage within the artery

percutaneous transluminal coronary angioplasty (PTCA): a type of percutaneous coronary intervention in which a balloon is inflated within a coronary artery to break an atheroma and open the vessel lumen, improving coronary artery blood flow

stent: a metal mesh that provides structural support to a coronary vessel, preventing its closure

sudden cardiac death: abrupt cessation of effective heart activity

thrombolytic: a pharmacologic agent that breaks down blood clots; alternatively referred to as a fibrinolytic

troponin: a cardiac muscle biomarker; measurement is used as an indicator of heart muscle injury

Cardiovascular disease is the leading cause of death in the United States for men and women of all racial and ethnic groups (Arnett, Blumenthal, Albert, et al., 2019).

Research related to the identification of and treatment for cardiovascular disease includes all segments of the population affected by cardiac conditions, including women, children, and people of diverse racial and ethnic backgrounds. The results of ongoing research are used by nurses to identify specific prevention and treatment strategies in these populations.

Coronary Artery Disease

Coronary artery disease (CAD) is the most prevalent type of cardiovascular disease in adults. For this reason, nurses must recognize various manifestations of coronary artery conditions and evidence-based methods for assessing, preventing, and treating these disorders.

Coronary Atherosclerosis

The most common cause of cardiovascular disease in the United States is **atherosclerosis**, an abnormal accumulation of lipid, or fatty substances, and fibrous tissue in the lining of arterial blood vessel walls. These substances block and narrow the coronary vessels in a way that reduces blood flow to the myocardium. Atherosclerosis involves a repetitious inflammatory response to injury of the artery wall and subsequent alteration in the structural and biochemical properties of the arterial walls. New information that relates to the development of atherosclerosis has increased the understanding of treatment and prevention of this progressive and potentially life-threatening process.

Pathophysiology

The inflammatory response involved with the development of atherosclerosis begins with injury to the vascular endothelium and progresses over many years (Norris, 2019). The injury may be initiated by smoking or tobacco use, hypertension, hyperlipidemia, and other factors. The endothelium undergoes changes and stops producing the normal antithrombotic and vasodilating agents. The presence of inflammation attracts inflammatory cells, such as macrophages. The macrophages ingest lipids, becoming "foam cells" that transport the lipids into the arterial wall. Some of the lipid is deposited on the arterial wall, forming fatty streaks. Activated macrophages also release biochemical substances that can further damage the endothelium by contributing to the oxidation of low-density lipoprotein (LDL). The oxidized LDL is toxic to the endothelial cells and fuels progression of the atherosclerotic process (Norris, 2019).

Following the transport of lipid into the arterial wall, smooth muscle cells proliferate and form a fibrous cap over a core filled with lipid and inflammatory infiltrate. These deposits, called **atheromas**, or plaques, protrude into the lumen of the vessel, narrowing it and obstructing blood flow (see Fig. 23-1). Plaque may be stable or unstable, depending on the degree of inflammation and thickness of the fibrous cap. If the fibrous cap over the plaque is thick and the lipid pool remains

relatively stable, it can resist the stress of blood flow and vessel movement. If the cap is thin and inflammation is ongoing, the lesion becomes what is called *vulnerable plaque.* At this point, the lipid core may grow, causing the fibrous plaque to rupture. A ruptured plaque attracts platelets and causes thrombus formation. A thrombus may then obstruct blood flow, leading to acute coronary syndrome (ACS), which may result in an acute **myocardial infarction (MI)**. When an MI occurs, a portion of the heart muscle no longer receives blood flow and becomes necrotic.

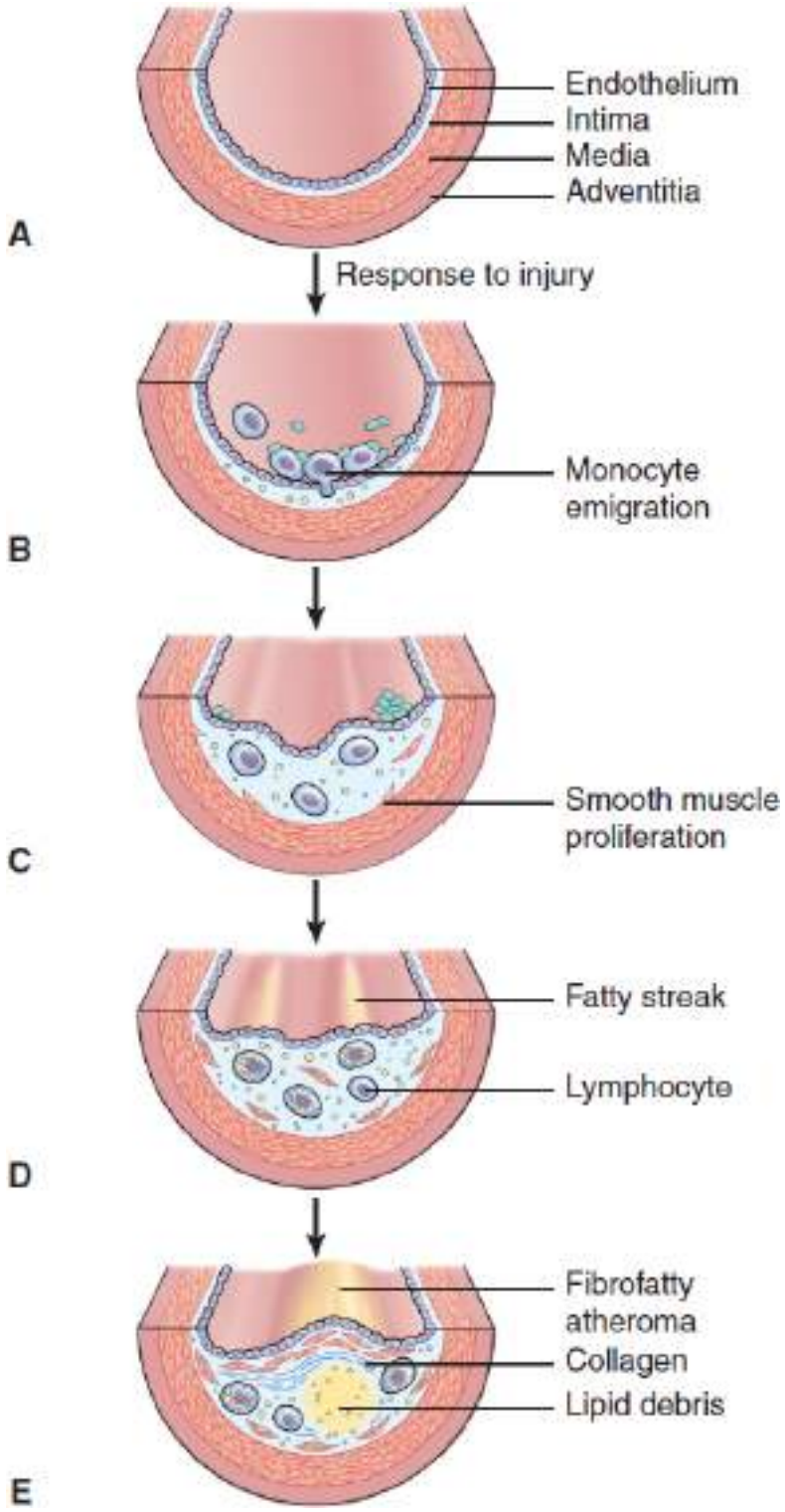

Figure 23-1 • **A, B.** Atherosclerosis begins as monocytes and lipids enter the intima of an injured vessel. Smooth muscle cells proliferate within the vessel wall (**C**), contributing to the development of fatty accumulations and atheroma (**D**). As the plaque enlarges, the vessel narrows and blood flow decreases (**E**). The plaque may rupture and a thrombus might form, obstructing blood flow.

The anatomic structure of the coronary arteries makes them particularly susceptible to atherosclerosis. As Figure 23-2 shows, the three major coronary arteries have multiple branches. Atherosclerotic lesions most often form where the vessels branch and with turbulent blood flow, suggesting a hemodynamic component is involved in their formation (Norris, 2019). Although heart disease is most often caused by atherosclerosis of the coronary arteries, other phenomena may also decrease blood flow to the heart. Examples include vasospasm (sudden constriction or narrowing) of a coronary artery and profound hypotension.

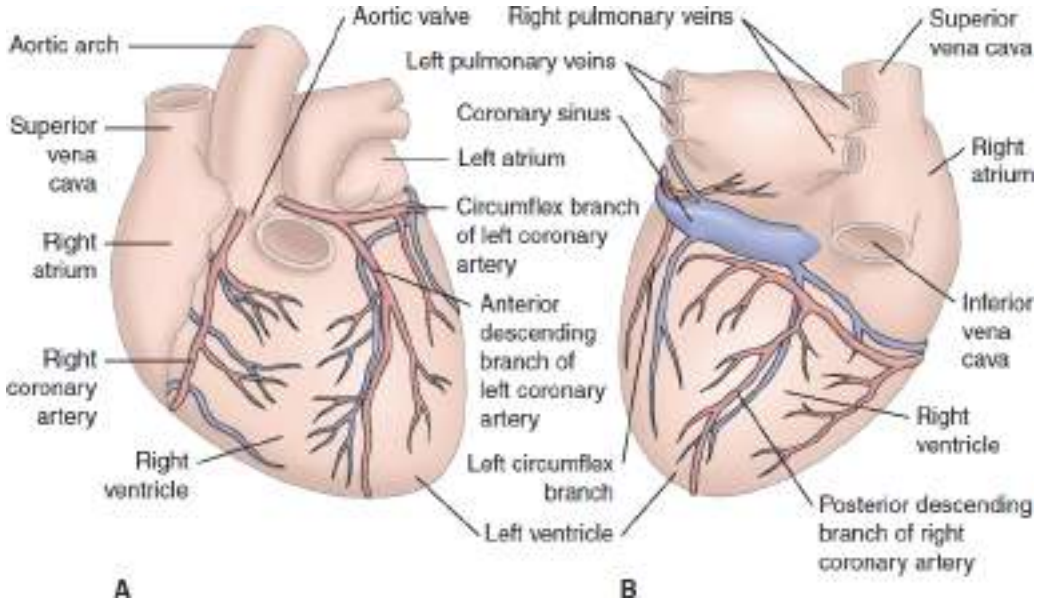

Figure 23-2 • The coronary arteries supply the heart muscle with oxygenated blood, adjusting the flow according to metabolic needs. **A.** Anterior view of the heart. **B.** Posterior view of heart.

Clinical Manifestations

CAD produces symptoms and complications according to the location and degree of narrowing of the arterial lumen, thrombus formation, and obstruction of blood flow to the myocardium. This impediment to blood flow is usually progressive, causing an inadequate blood supply that deprives the cardiac muscle cells of oxygen needed for their survival. The condition is known as **ischemia**. **Angina pectoris** refers to chest pain that is brought about by myocardial ischemia. Angina pectoris usually is caused by significant coronary atherosclerosis. If the decrease in blood supply is great enough, of long enough duration, or both, irreversible damage and death of myocardial cells may result. Over time, irreversibly damaged myocardium undergoes degeneration and is replaced by scar tissue, causing various degrees of myocardial dysfunction. Significant myocardial damage may result in persistently low cardiac output and heart failure where the heart cannot support the body's needs for blood. A decrease in blood supply from CAD may cause the heart to abruptly stop beating; this is known as **sudden cardiac death** (see Chapter 25 for further discussion on CPR).

The most common manifestation of myocardial ischemia is the onset of chest pain. However, the classic epidemiologic study of the people in Framingham,

Massachusetts, showed that nearly 15% of men and women who had coronary events, which included unstable angina, MIs, or sudden cardiac death events, were totally asymptomatic prior to the coronary event (Kannel, 1986). Patients with myocardial ischemia may present to an emergency department (ED) or clinic with a variety of symptoms other than chest pain. Some complain of epigastric distress and pain that radiates to the jaw or left arm. Patients who are older or have a history of diabetes or heart failure may report shortness of breath. Many women have been found to have atypical symptoms, including indigestion, nausea, palpitations, and numbness (Davis, 2017). Prodromal symptoms may occur (e.g., angina a few hours to days before the acute episode), or a major cardiac event may be the first indication of coronary atherosclerosis.

Risk Factors

Epidemiologic studies point to several factors that increase the probability that a person will develop heart disease. Major risk factors are listed in Chart 23-1. Although many people with CAD have one or more risk factors, some do not have classic risk factors. Elevated **low-density lipoprotein (LDL)**, also known as bad cholesterol, is a well-known risk factor and the primary target of cholesterol-lowering therapy. People at the highest risk for having a cardiac event are those with known CAD or those with diabetes, peripheral arterial disease, abdominal aortic aneurysm, or carotid artery disease. The latter diseases are referred to as CAD risk equivalents, because patients with these diseases have the same risk for a cardiac event as patients with CAD. The likelihood of having a cardiac event is also affected by factors, such as age, gender, systolic blood pressure, smoking history, level of total cholesterol, and level of **high-density lipoprotein (HDL)**, also known as good cholesterol. The Framingham Risk Calculator is a tool commonly used to estimate the risk for having a cardiac event within the next 10 years (Grundy, Stone, Bailey, et al., 2018). This tool is designed for adults 20 years and older. The calculation is performed using the individual's risk factor data, including age, gender, total cholesterol, HDL, smoking status, systolic blood pressure, and need for antihypertensive medication.

In addition, a cluster of metabolic abnormalities known as **metabolic syndrome** has emerged as a major risk factor for cardiovascular disease (Grundy et al., 2018). A diagnosis of this syndrome is made when a patient has three of the following five risk factors:

- Enlarged waist circumference (greater than 35.4 inches in males, greater than 31.4 inches in females)
- Elevated triglycerides (greater than or equal to 175 mg/dL, or currently on drug treatment for elevated triglycerides)
- Reduced HDL (less than 40 mg/dL in males, less than 50 mg/dL in females, or currently on drug treatment for reduced HDL)
- Hypertension (systolic blood pressure greater than or equal to 130 mm Hg and/or diastolic blood pressure greater than or equal to 80 mm Hg on an average of two to three measurements obtained on two to three separate occasions, or currently on antihypertensive drug treatment for a history of hypertension)

Chart 23-1 RISK FACTORS

Coronary Artery Disease

A nonmodifiable risk factor is a circumstance over which a person has no control. A modifiable risk factor is one over which a person may exercise control, such as by changing a lifestyle or personal habit or by using medication. A risk factor may operate independently or in tandem with other risk factors. The more risk factors a person has, the greater the likelihood of coronary artery disease (CAD). Those at risk are advised to seek regular medical examinations and to engage in heart-healthy behavior (a deliberate effort to reduce the number and extent of risks).

Nonmodifiable Risk Factors

Family history of CAD (first-degree relative with cardiovascular disease at 55 years of age or younger for men and at 65 years of age or younger for women)
Increasing age (more than 45 years for men; more than 55 years for women)
Gender (men develop CAD at an earlier age than women)
Race (higher incidence of heart disease in African Americans than in Caucasians)
History of premature menopause (before age 40) and history of pregnancy-associated disorders such as preeclampsia
Primary hypercholesterolemia (a genetic condition resulting in elevated LDL)

Modifiable Risk Factors

Hyperlipidemia
Tobacco use
Hypertension
Diabetes
Metabolic syndrome
Obesity
Physical inactivity
Chronic inflammatory conditions (e.g., rheumatoid arthritis, lupus, HIV/AIDS)
Chronic kidney disease

Adapted from Arnett, D. K., Blumenthal, R. S., Albert, M. A., et al. (2019). ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease. *Journal of the American College of Cardiology, 74*(10), e177–e232.

- Elevated fasting glucose (greater than or equal to 100 mg/dL on two separate occasions, or current drug treatment for elevated glucose)

Many people with type 2 diabetes fit this clinical picture. Theories suggest that in patients with obesity, excessive adipose tissue may secrete mediators that lead to metabolic changes. Adipokines (adipose tissue cytokines), free fatty acids, and other substances are known to modify insulin action and contribute to atherogenic changes in the cardiovascular system (see Fig. 23-3).

C-reactive protein (CRP) is known to be an inflammatory marker for cardiovascular risk, including acute coronary events and stroke. The liver produces CRP in response to a stimulus such as tissue injury, and high levels of this protein may occur in people with diabetes and those who are likely to have an acute coronary event (Norris, 2019). To determine overall cardiovascular risk, clinicians may view high sensitivity C-reactive protein (hs-CRP) test results together with other screening tools such as measurements of lipid levels.

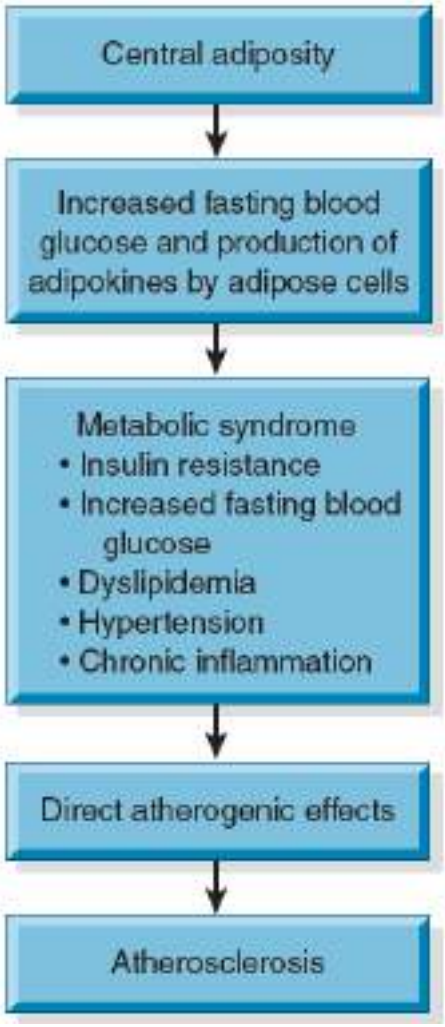

Figure 23-3 • Pathophysiology of cardiovascular disease in metabolic syndrome. Central adiposity plays a major role in the development of metabolic syndrome. Adipokines released from fat cells along with other hormones and metabolites are thought to contribute to the development of metabolic abnormalities. The eventual effect of these processes is the promotion of atherosclerosis.

Prevention

Four modifiable risk factors—cholesterol abnormalities, tobacco use, hypertension, and diabetes—are established risk factors for CAD and its complications. As a result, they receive much attention in health promotion programs.

Controlling Cholesterol Abnormalities

The association of a high blood cholesterol level with heart disease is well established, and the metabolism of fats is known to be an important contributor to the development of heart disease. Fats, which are insoluble in water, are encased in

water-soluble lipoproteins that allow them to be transported within the circulatory system. The various lipoproteins are categorized by their protein content, which is measured in density. The density increases when more protein is present. Four elements of fat metabolism—total cholesterol, LDL, HDL, and triglycerides—are known to affect the development of heart disease. Cholesterol is processed by the gastrointestinal (GI) tract into lipoprotein globules called *chylomicrons*. These are reprocessed by the liver as lipoproteins (see Fig. 23-4). This is a physiologic process necessary for the formation of lipoprotein-based cell membranes and other important metabolic processes. When an excess of LDL is produced, LDL particles adhere to receptors in the arterial endothelium. Here, macrophages ingest them, contributing to plaque formation.

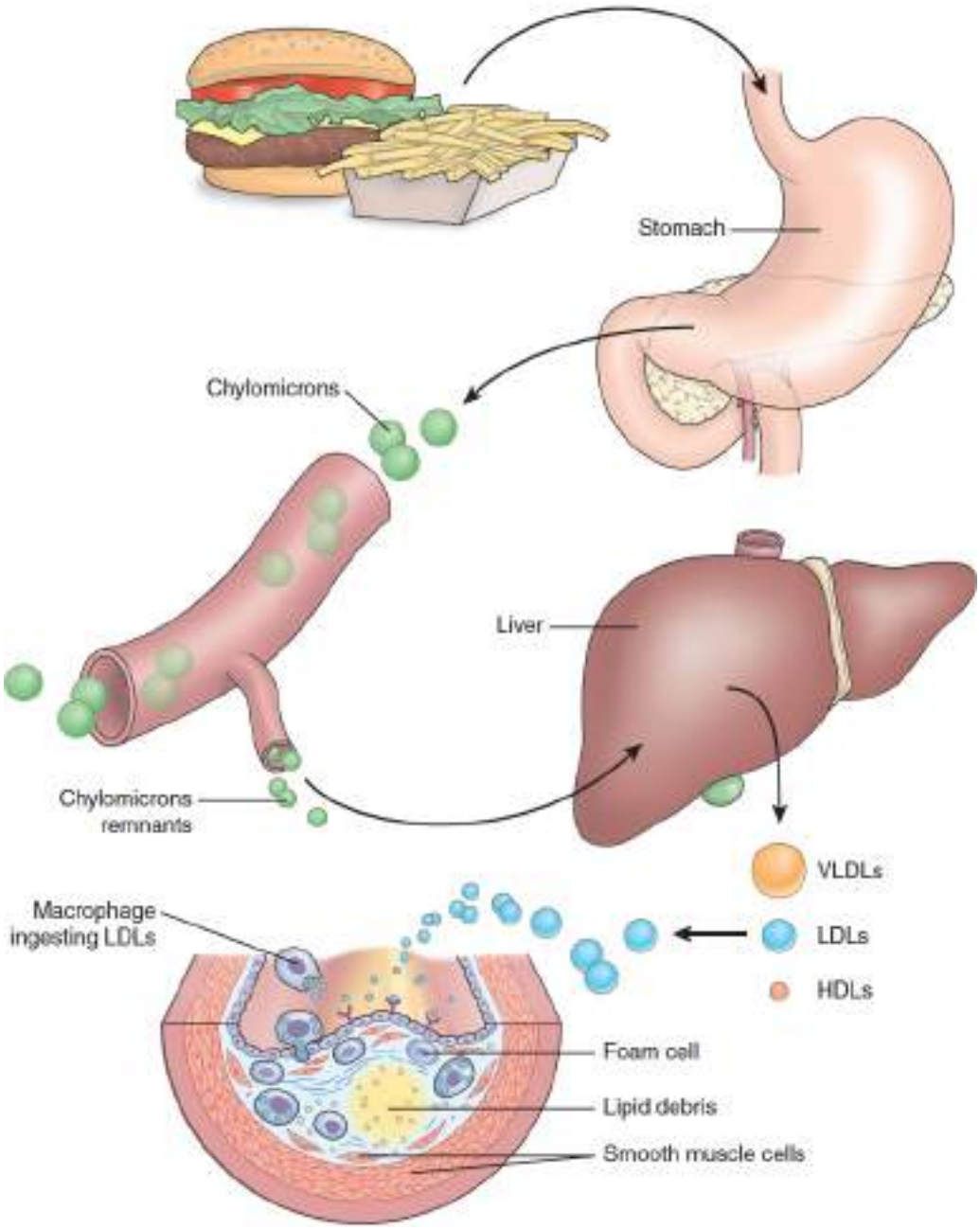

Figure 23-4 • Lipoproteins and the development of atherosclerosis. As dietary cholesterol and saturated fat are processed by the gastrointestinal tract, chylomicrons enter the blood. They are broken down into chylomicron remnants in the capillaries. The liver processes them into lipoproteins. When these are released into the circulation, excess low-density lipoproteins (LDLs) adhere to receptors on the intimal wall. Macrophages also ingest LDLs and transport them into the vessel wall, beginning the process of plaque formation. HDLs, high-density lipoproteins; VLDLs, very–low-density lipoproteins.

The American College of Cardiology and the American Heart Association (ACC/AHA) have developed clinical practice guidelines on the treatment of blood cholesterol to reduce cardiovascular risk in adults (Grundy et al., 2018). These guidelines address primary prevention (preventing the occurrence of CAD) and secondary prevention (preventing the progression of CAD). All adults 20 years and older should have a fasting lipid profile (total cholesterol, LDL, HDL, and triglycerides) performed at least once every 5 years, and more often if the profile is abnormal. Patients who have had an acute event (e.g., MI), a percutaneous coronary intervention (PCI), or a coronary artery bypass graft (CABG) require assessment of their LDL cholesterol level within a few months of the event or procedure, because LDL levels may be low immediately after the acute event or procedure. Subsequently, lipids should be monitored every 4 to 12 weeks until the desired level is achieved and then every 3 to 12 months as needed (Grundy et al., 2018). A fasting lipid profile should demonstrate the following values (Stone, Robinson, Lichtenstein, et al., 2014):

- LDL cholesterol less than 100 mg/dL (less than 70 mg/dL for very high risk patients)
- Total cholesterol less than 200 mg/dL
- HDL cholesterol greater than 40 mg/dL for males and greater than 50 mg/dL for females
- Triglyceride less than 150 mg/dL

LDL is the target of current therapy because of its strong association with advancing CAD. The total cholesterol level is also a clear predictor of coronary events. HDL is known as good cholesterol because it transports other lipoproteins such as LDL to the liver, where they can be degraded and excreted. Because of this, a high HDL level is a strong negative risk factor for heart disease (i.e., it protects against heart disease).

Triglyceride is made up of fatty acids and is transported through the blood by a lipoprotein. Although an elevated triglyceride level (more than 200 mg/dL) may be genetic in origin, it also can be caused by obesity, physical inactivity, excessive alcohol intake, high-carbohydrate diets, diabetes, kidney disease, and certain medications, such as oral contraceptives and corticosteroids.

Concept Mastery Alert

It is important to remember the different types of cholesterol and the role of each as a risk factor for heart disease. HDL is the “good cholesterol,” and higher levels are better; LDL is the “bad cholesterol,” and lower levels are better.

Dietary Measures

Adults who need to lower LDL (and blood pressure) should consider the AHA’s diet recommendations or the Mediterranean diet, which are reported to reduce mortality from cardiovascular disease (Franquesa, Pujol-Busquets, García-Fernández, et al., 2019). Both eating plans provide similar key elements: an emphasis on plant foods (fruits, vegetables, whole-grain breads or other forms of cereals, beans, nuts, and seeds), minimally processed foods, seasonally fresh foods, inclusion of fish, and minimal intake of red meat. Individuals needing to lower LDL and blood pressure

should also limit the intake of sweets and sugar sweetened beverages (Arnett et al., 2019). Adopting a strict vegetarian diet can significantly reduce blood lipids, blood glucose, body mass index, and blood pressure; however, this type of intensive dietary program may not be acceptable to all patients who need to modify risk factors. Referral to a dietitian can help patients in following a diet that is appropriate.

Many resources are available to assist people in controlling their cholesterol levels. The National Heart, Lung, and Blood Institute (NHLBI) and its National Cholesterol Education Program (NCEP), the AHA, and the American Diabetes Association (ADA), as well as CAD support groups and reliable Internet sources, are a few examples of the available resources (see Resources section at the end of this chapter). Cookbooks and recipes that include the nutritional contents of foods can be included as resources for patients. Dietary control has been made easier because food manufacturers are required to provide nutritional data on product labels. The label information of interest to a person attempting to eat a heart-healthy diet is as follows: serving size (expressed in household measures), amount of total fat per serving, amount of saturated fat and trans fat per serving, amount of cholesterol per serving, and amount of fiber per serving.

Physical Activity

Management of an elevated triglyceride level focuses on weight reduction and increased physical activity. Regular, moderate physical activity increases HDL levels and reduces triglyceride levels, decreasing the incidence of coronary events and reducing overall mortality risk. The goal for most adults is to engage in moderate-intensity aerobic activity of at least 150 minutes per week or vigorous-intensity aerobic activity of at least 75 minutes per week, or an equivalent combination (Arnett et al., 2019). In addition, adults should engage in muscle-strengthening activities on 2 or more days each week that work all major muscle groups. The nurse helps the patient to set realistic goals for physical activity. For example, inactive patients can start with activity that lasts 3 minutes, such as parking farther from a building to increase daily walking time. Patients should be instructed to engage in an activity or variety of activities that interest them to maintain motivation. They should also be taught to exercise to an intensity that does not preclude their ability to talk; if they cannot have a conversation while exercising, they should slow down or switch to a less intensive activity. When the weather is hot and humid, patients should exercise during the early morning, or indoors, and wear loose-fitting clothing. When the weather is cold, they should layer clothing and wear a hat. Patients should stop any activity if chest pain, unexpected shortness of breath, dizziness, lightheadedness, or nausea occurs.

Medications

If diet alone cannot normalize serum cholesterol levels, medications can have a synergistic effect with the prescribed diet and control cholesterol levels (see Table 23-1). Lipid-lowering medications can reduce CAD mortality in patients with elevated lipid levels and in at-risk patients with normal lipid levels (Grundy et al., 2018). The various types of lipid-lowering agents affect the lipid components somewhat differently; these types include 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) (or statins), fibric acids (or fibrates), bile acid sequestrants (or resins),

cholesterol absorption inhibitors, and proprotein convertase subtilisin-kexin type 9 (PCSK9) agents. Because of their high cost, PCSK9 agents are prescribed on a limited basis, but may be considered for those at high cardiovascular risk or who have familial hypercholesterolemia (Grundy et al., 2018).

Before starting statin therapy, the provider and patient should discuss risk factors, adherence to a healthy lifestyle, benefits of risk-reduction, the potential of adverse effects and drug–drug interactions, as well as patient preferences for an individualized treatment plan (Grundy et al., 2018).

Promoting Cessation of Tobacco Use

Tobacco use contributes to the development and severity of CAD in at least three ways:

- Nicotinic acid in tobacco triggers the release of catecholamines, which raise the heart rate and blood pressure (Frandsen & Pennington, 2021). Nicotinic acid can also cause the coronary arteries to constrict. These effects lead to an increased risk of CAD and sudden cardiac death.
- Tobacco use can increase the oxidation of LDL, damaging the vascular endothelium (Lee, Ong, Zhou, et al., 2019). This increases platelet adhesion and leads to a higher probability of thrombus formation.
- Inhalation of smoke increases the blood carbon monoxide level and decreases the supply of oxygen to the myocardium (Frandsen & Pennington, 2021). Hemoglobin, the oxygen-carrying component of blood, combines more readily with carbon monoxide than with oxygen. Myocardial ischemia and reduced contractility can result.

TABLE 23-1 Select Medications that Affect Lipoprotein Metabolism

Medications	Therapeutic Effects	Considerations
HMG-CoA Reductase Inhibitors (Statins)		
Atorvastatin Simvastatin Rosuvastatin	↓ Total cholesterol ↓ LDL ↑ HDL ↓ TGs Inhibit enzyme involved in lipid synthesis (HMG-CoA) Favorable effects on vascular endothelium, including anti-inflammatory and antithrombotic effects	Frequently given as initial therapy for significantly elevated cholesterol and LDL levels Myalgia and arthralgia are common adverse effects Myopathy and possible rhabdomyolysis are potential serious effects Monitor liver function tests Contraindicated in liver disease Check for drug interactions Indication for use now includes ACS and stroke Administer in evening
Fibric Acids (Fibrates)		
Fenofibrate Gemfibrozil	↑ HDL ↓ TGs ↓ Synthesis of TGs and other lipids	Adverse effects include diarrhea, flatulence, rash, myalgia Serious adverse effects include pancreatitis, hepatotoxicity, and rhabdomyolysis Contraindicated in severe kidney and liver disease Use with caution in patients who are also taking statins
Bile Acid Sequestrants		
Cholestyramine Colestipol Colesevelam	↓ LDL Slight ↑ HDL Oxidize cholesterol into bile acids, which ↓ fat absorption	Most often used as adjunct therapy when statins alone have not been effective in controlling lipid levels Side effects include constipation, abdominal pain, GI bleeding May decrease absorption of other drugs Taken before meals
Cholesterol Absorption Inhibitor		
Ezetimibe	↓ LDL Inhibits absorption of cholesterol in small intestine	Better tolerated than bile acid sequestrants Used in combination with other agents, such as statins Side effects include abdominal pain, arthralgia, myalgia Contraindicated in liver disease
Proprotein Convertase Subtilisin-Kexin Type 9 (PCSK9) Agents		
Alirocumab Evolocumab	Prolongs receptor activity to promote clearance of cholesterol ↓ LDL ↓ risk of MI and stroke ↓ need for stent or CABG	Only administered by subcutaneous injection via a pen device, one or two times per month as prescribed Side effects include rhinitis, sore throat, flulike symptoms, muscle pain, diarrhea, and redness, pain, or bruising at injection site

↓ decrease, ↑ increase; ACS, acute coronary syndrome; CABG, coronary artery bypass graft; GI, gastrointestinal; HDL, high-density lipoprotein; HMG-CoA, 3-hydroxy-3-methylglutaryl coenzyme A; LDL, low-density lipoprotein; MI, myocardial infarction; TGs, triglycerides.

Adapted from Frandsen, G., & Pennington, S. S. (2021). *Abrams' clinical drug therapy: Rationales for nursing practice* (12th ed.). Philadelphia, PA: Wolters Kluwer Health.

A person at increased risk for heart disease is encouraged to stop tobacco use through any means possible: educational programs, counseling, consistent motivation and reinforcement messages, support groups, and medications. Some people have found complementary therapies (e.g., acupuncture, guided imagery, hypnosis) to be helpful. People who stop smoking reduce their risk of heart disease within the first year, and the risk continues to decline as long as they refrain from smoking (Benjamin, Muntner, Alonso, et al., 2019).

The use of medications such as the nicotine patch, nicotine lozenges, nicotine gum, varenicline, or bupropion may assist with stopping the use of tobacco (Barua, Rigotti, Benowitz, et al., 2018). Products containing nicotine have some of the same effects as smoking: catecholamine release (increasing heart rate and blood pressure) and increased platelet adhesion. These medications should be used for a short time and at the lowest effective doses.

Exposure to others' smoke (passive or secondhand smoke) increases the risk for CAD by 25% to 30% and for stroke by 20% to 30% (Benjamin et al., 2019). Other forms of tobacco use are becoming increasingly common today. Use of electronic nicotine delivery systems (ENDS) including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars has increased, particularly among adolescents and young adults. Specifically, e-cigarette use, which entails inhalation of a vaporized liquid that includes nicotine, solvents, and flavoring ("vaping"), has risen significantly in these groups. Use of cigarillos and other mass market cigars, hookahs, and water pipes are also on the rise. Short-term exposure to water pipe smoking is associated with an increase in systolic blood pressure and heart rate, but long-term effects remain unclear. The cardiovascular risks associated with e-cigarette use are not yet known (Benjamin et al., 2019).

Managing Hypertension

Hypertension is defined as systolic blood pressure measurements of greater than 130 mm Hg and/or diastolic blood pressure levels greater than 80 mm Hg. A single reading is not adequate to make a diagnosis. Averaging two or three measurements obtained on two to three different occasions will provide a more accurate measurement (Whelton, Carey, Aronow, et al., 2018). The risk of cardiovascular disease increases as blood pressure increases, and current guidelines support treating hypertension with a goal of keeping the blood pressure under 130/80 for all adults (Whelton et al., 2018). Long-standing elevated blood pressure may result in increased stiffness of the vessel walls, leading to vessel injury and a resulting inflammatory response within the intima. Inflammatory mediators then lead to the release of growth-promoting factors that cause vessel hypertrophy and hyperresponsiveness. These changes result in acceleration and aggravation of atherosclerosis. Hypertension also increases the work of the left ventricle, which must pump harder to eject blood

into the arteries. Over time, the increased workload causes the heart to enlarge and thicken (i.e., hypertrophy) and may eventually lead to heart failure.

Early detection of high blood pressure and adherence to a therapeutic regimen can prevent the serious consequences associated with untreated elevated blood pressure, including CAD. Intensive management of hypertension lowers the risk of cardiovascular events, including heart attack and stroke, and lowers the risk of death (Whelton et al., 2018; see Chapter 27 for a detailed discussion of hypertension).

Controlling Diabetes

Diabetes is known to accelerate the development of heart disease. Hyperglycemia fosters dyslipidemia, increased platelet aggregation, and altered red blood cell function, which can lead to thrombus formation. These metabolic alterations may impair endothelial cell–dependent vasodilation and smooth muscle function, promoting the development of atherosclerosis. Treatment with insulin, metformin, and other therapeutic interventions that lower plasma glucose levels can lead to improved endothelial function and patient outcomes. See Chapter 46 for a detailed discussion of diabetes.

Gender

Heart disease has long been recognized as a cause of morbidity and mortality in men, but it has not always been as readily recognized in women. Cardiovascular events in women occur an average of 10 years later in life than they do in men (Wada, Miyauchi, & Daida, 2019). Women tend to have a higher incidence of complications from cardiovascular disease and a higher mortality. In addition, women tend to not recognize the symptoms of CAD as early as men, and they wait longer to report their symptoms and seek medical assistance (Wada et al., 2019).

The age difference between women and men who were newly diagnosed with CAD was traditionally thought to be related to estrogen. Menopause is now recognized as a milestone in the aging process, during which risk factors tend to accumulate. Cardiovascular disease may be well developed by the time of menopause, and although hormone therapy (HT) (formerly referred to as hormone replacement therapy) for menopausal women was once promoted as preventive therapy for CAD, research does not support HT as an effective means of prevention. HT decreases menopausal symptoms and the risk of osteoporosis-related bone fractures; however, it also has been associated with an increased incidence of CAD, breast cancer, deep vein thrombosis, stroke, and pulmonary embolism. Current guidelines do not recommend HT for primary or secondary prevention of CAD (Wada et al., 2019; see Chapter 21 for further discussion).

In the past, women who possibly had coronary vascular events were less likely than men to be referred for coronary artery diagnostic procedures such as heart catheterization or treatment with invasive interventions (e.g., PCI). However, as a result of better education of health care professionals and the general public, gender differences now have less influence on diagnosis and treatment (Wada et al., 2019).

Unfolding Patient Stories: Carl Shapiro • Part 1

Carl Shapiro, who has a family history of atherosclerotic cardiovascular disease, is diagnosed with hypertension and hyperlipidemia during a routine visit to his primary provider. He is overweight, smokes a half pack of cigarettes per day, and describes his job as stressful. What questions can the nurse ask Carl Shapiro to help develop a plan for patient education? What topics are important for the nurse to address, and how can the information be presented? (Carl Shapiro's story continues in Chapter 67.)

Care for Carl and other patients in a realistic virtual environment: vSim (**thepoint.lww.com/vSimMedicalSurgical**). Practice documenting these patients' care in DocuCare (**thepoint.lww.com/DocuCareEHR**).

Angina Pectoris

Angina pectoris is a clinical syndrome usually characterized by episodes or paroxysms of pain or pressure in the anterior chest. The cause is insufficient coronary blood flow, resulting in a decreased oxygen supply when there is increased myocardial demand for oxygen in response to physical exertion or emotional stress. In other words, the need for oxygen exceeds the supply.

Pathophysiology

Angina is usually caused by atherosclerotic disease and most often is associated with a significant obstruction of at least one major coronary artery. Normally, the myocardium extracts a large amount of oxygen from the coronary circulation to meet its continuous demands. When demand increases, flow through the coronary arteries needs to be increased. When there is a blockage in a coronary artery, flow cannot be increased and ischemia results. The types of angina are listed in Chart 23-2. Several factors are associated with typical anginal pain:

- Physical exertion, which precipitates an attack by increasing myocardial oxygen demand
- Exposure to cold, which causes vasoconstriction and elevated blood pressure, with increased oxygen demand
- Eating a heavy meal, which increases the blood flow to the mesenteric area for digestion, thereby reducing the blood supply available to the heart muscle; in a severely compromised heart, shunting of blood for digestion can be sufficient to induce anginal pain

Chart 23-2

Types of Angina

- **Stable angina:** predictable and consistent pain that occurs on exertion and is relieved by rest and/or nitroglycerin
- **Unstable angina** (also called *preinfarction angina* or *crescendo angina*): symptoms increase in frequency and severity; may not be relieved with rest or nitroglycerin
- **Intractable or refractory angina:** severe incapacitating chest pain
- **Variant angina** (also called *Prinzmetal's angina*): pain at rest with reversible ST-segment elevation; thought to be caused by coronary artery vasospasm
- **Silent ischemia:** objective evidence of ischemia (such as electrocardiographic changes with a stress test), but patient reports no pain

- Stress or any emotion-provoking situation, causing the release of catecholamines, which increases blood pressure, heart rate, and myocardial workload

Unstable angina is not closely associated with these listed factors. It may occur at rest (see later discussion).

Clinical Manifestations

Ischemia of the heart muscle may produce pain or other symptoms, varying from mild indigestion to a choking or heavy sensation in the upper chest. The severity ranges from discomfort to agonizing pain. The pain may be accompanied by severe apprehension and a feeling of impending death. It is often felt deep in the chest behind the sternum (retrosternal area). Typically, the pain or discomfort is poorly localized and may radiate to the neck, jaw, shoulders, and inner aspects of the upper arms, usually the left arm. The patient often feels tightness or a heavy choking or strangling sensation that has a viselike, insistent quality. The patient with diabetes may not have severe pain with angina because autonomic neuropathy can blunt nociceptor transmission, dulling the perception of pain (Norris, 2019).

A feeling of weakness or numbness in the arms, wrists, and hands, as well as shortness of breath, pallor, diaphoresis, dizziness or lightheadedness, and nausea and vomiting, may accompany the pain. An important characteristic of angina is that it subsides with rest or administration of nitroglycerin. In many patients, anginal symptoms follow a stable, predictable pattern.

Unstable angina is characterized by attacks that increase in frequency and severity and are not relieved by rest and administration of nitroglycerin. Patients with unstable angina require medical intervention.

Gerontologic Considerations

The older adult with angina may not exhibit a typical pain profile because of the diminished pain transmission that can occur with aging. Often the presenting

symptom in older adults is dyspnea. Sometimes there are no symptoms ("silent" CAD), making recognition and diagnosis a clinical challenge. Older patients should be encouraged to recognize their chest pain–like symptom (e.g., weakness) as an indication that they should rest or take prescribed medications. Pharmacologic stress testing and cardiac catheterization may be used to diagnose CAD in older patients. Medications used to manage angina are given cautiously in older adults because they are associated with an increased risk of adverse reactions (Frandsen & Pennington, 2021). Invasive procedures (e.g., PCI) that were once considered too risky in older adults are now being performed successfully, and many older adults benefit from symptom relief and longer survival (Lattuca, Kerneis, & Zeitouni, 2019).

Assessment and Diagnostic Findings

The diagnosis of angina begins with the patient's history related to the clinical manifestations of ischemia. A 12-lead electrocardiogram (ECG) may show changes indicative of ischemia, such as T-wave inversion, ST-segment elevation, or the development of an abnormal Q wave (Norris, 2019). Laboratory studies are performed; these generally include cardiac biomarker testing to rule out ACS (see later discussion). The patient may undergo an exercise or pharmacologic stress test in which the heart is monitored continuously by an ECG, echocardiogram, or both. The patient may also be referred for a nuclear scan or invasive procedure (e.g., cardiac catheterization, coronary angiography).

Medical Management

The objectives of the medical management of angina are to decrease the oxygen demand of the myocardium and to increase the oxygen supply. Medically, these objectives are met through pharmacologic therapy and control of risk factors. Alternatively, reperfusion procedures may be used to restore the blood supply to the myocardium. These include PCI procedures (e.g., percutaneous transluminal coronary angioplasty [PTCA] and intracoronary stents) and CABG (see later discussion).

Pharmacologic Therapy

Table 23-2 summarizes drug therapy.

Nitroglycerin

Nitrates are a standard treatment for angina pectoris. Nitroglycerin is a potent vasodilator that improves blood flow to the heart muscle and relieves pain. Nitroglycerin dilates primarily the veins and, to a lesser extent, the arteries. Dilation of the veins causes venous pooling of blood throughout the body. As a result, less blood returns to the heart, and filling pressure (preload) is reduced. If the patient is hypovolemic (does not have adequate circulating blood volume), the decrease in filling pressure can cause a significant decrease in cardiac output and blood pressure (Frandsen & Pennington, 2021).

Nitrates also relax the systemic arteriolar bed, lowering blood pressure and decreasing afterload. These effects decrease myocardial oxygen requirements,

bringing about a more favorable balance between supply and demand.

Nitroglycerin may be given by several routes: sublingual tablet or spray, oral capsule, topical agent, and intravenous (IV) administration. Sublingual nitroglycerin is generally placed under the tongue or in the cheek (buccal pouch) and ideally alleviates the pain of ischemia within 3 minutes. Chart 23-3 provides more information on self-administration of sublingual nitroglycerin. Oral preparations and topical patches are used to provide sustained effects. A regimen in which the patches are applied in the morning and removed at bedtime allows for a nitrate-free period to prevent the development of tolerance.

TABLE 23-2 Select Medications Used to Treat Stable Angina

Medications	Major Indications
Nitrates	
Nitroglycerin	Short- and long-term reduction of myocardial oxygen consumption through selective vasodilation
Beta-Adrenergic Blocking Agents (Beta-Blockers)	
Metoprolol Atenolol	Reduction of myocardial oxygen consumption by blocking beta-adrenergic stimulation of the heart
Calcium Ion Antagonists (Calcium Channel Blockers)	
Amlodipine Diltiazem	Negative inotropic effects; indicated in patients not responsive to beta-blockers; used as primary treatment for vasospasm
Antiplatelet Medications	
Aspirin	Prevention of platelet aggregation
Clopidogrel Prasugrel Ticagrelor	
Anticoagulants	
Heparin (unfractionated) Low-molecular-weight heparins: Enoxaparin Dalteparin	Prevention of thrombus formation

Adapted from Rousan, T. A., Mathew, S. T., & Thadani, U. (2017). Drug therapy for stable angina pectoris. *Drugs*, *77*(3), 265–284.

A continuous or intermittent IV infusion of nitroglycerin may be given to the hospitalized patient with recurring signs and symptoms of ischemia or after a revascularization procedure. The rate of infusion is titrated to the patient's pain level and blood pressure. It usually is not given if the systolic blood pressure is less than 90 mm Hg. Generally, after the patient is symptom-free, the nitroglycerin may be switched to an oral or topical preparation within 24 hours. A common adverse effect of nitroglycerin is headache, which may limit the use of this drug in some patients.

Beta-Adrenergic Blocking Agents

Beta-blockers such as metoprolol reduce myocardial oxygen consumption by blocking beta-adrenergic sympathetic stimulation to the heart. The result is a reduction in heart rate, slowed conduction of impulses through the conduction system, decreased blood pressure, and reduced myocardial **contractility** (force of contraction). Because of these effects, beta-blockers balance the myocardial oxygen needs (demands) and the amount of oxygen available (supply). This helps control chest pain and delays the onset of ischemia during work or exercise. Beta-blockers reduce the incidence of recurrent angina, infarction, and cardiac mortality. The dose can be titrated to achieve a resting heart rate of 50 to 60 bpm (Frandsen & Pennington, 2021).

Cardiac side effects and possible contraindications include hypotension, bradycardia, advanced atrioventricular block, and acute heart failure. If a beta-blocker is given IV for an acute cardiac event, the ECG, blood pressure, and heart rate are monitored closely after the medication has been given. Side effects include depressed mood, fatigue, decreased libido, and dizziness. Patients taking beta-blockers are cautioned not to stop taking them abruptly, because angina may worsen, and MI may develop. Beta-blocker therapy should be decreased gradually over several days before being discontinued. Patients with diabetes who take beta-blockers are instructed to monitor their blood glucose levels as prescribed because beta-blockers can mask signs of hypoglycemia. Beta-blockers that are not cardioselective also affect the beta-adrenergic receptors in the bronchioles, causing bronchoconstriction, and therefore are contraindicated in patients with significant chronic pulmonary disorders, such as asthma.

Chart 23-3 **PHARMACOLOGY**

Self-Administration of Nitroglycerin

Most patients with angina pectoris self-administer nitroglycerin on an as-needed basis. A key nursing role in such cases is educating patients about the medication and how to take it. Sublingual nitroglycerin comes in tablet and spray forms.

- Instruct the patient to make sure that the mouth is moist, the tongue is still, and saliva is not swallowed until the nitroglycerin tablet dissolves. If the pain is severe, the patient can crush the tablet between the teeth to hasten sublingual absorption.
- Advise the patient to carry the medication at all times as a precaution. However, because nitroglycerin is very unstable, it should be carried securely in its original container (e.g., capped dark glass bottle); tablets should never be removed and stored in metal or plastic pillboxes.
- Explain that nitroglycerin is volatile and is inactivated by heat, moisture, air, light, and time. Instruct the patient to renew the nitroglycerin supply every 6 months.
- Inform the patient that the medication should be taken in anticipation of any activity that may produce pain. Because nitroglycerin increases tolerance for exercise and stress when taken prophylactically (i.e., before angina-producing activity, such as exercise, stair-climbing, or sexual intercourse), it is best taken before pain develops.
- Recommend that the patient note how long it takes for the nitroglycerin to relieve the discomfort. Advise the patient that if pain persists after taking three sublingual tablets at 5-minute intervals, emergency medical services should be called.
- Discuss possible side effects of nitroglycerin, including flushing, throbbing headache, hypotension, and tachycardia.
- Advise the patient to sit down for a few minutes when taking nitroglycerin to avoid hypotension and syncope.

Adapted from Comerford, K. C., & Durkin, M. T. (Eds.) (2020). *Nursing2020 Drug Handbook*. Philadelphia, PA: Wolters Kluwer.

Calcium Channel Blocking Agents

Calcium channel blockers have a variety of effects on the ischemic myocardium. These agents decrease sinoatrial node automaticity and atrioventricular node conduction, resulting in a slower heart rate and a decrease in the strength of myocardial contraction (negative inotropic effect). These effects decrease the workload of the heart. Calcium channel blockers also increase myocardial oxygen supply by dilating the smooth muscle wall of the coronary arterioles; they decrease myocardial oxygen demand by reducing systemic arterial pressure and the workload of the left ventricle (Frandsen & Pennington, 2021). The calcium channel blockers most commonly used are amlodipine and diltiazem. In addition to their use to treat angina, they are commonly prescribed for hypertension. Hypotension may occur after the administration of any of the calcium channel blockers, particularly when administered IV. Other side effects may include atrioventricular block, bradycardia, and constipation.

Antiplatelet and Anticoagulant Medications

Antiplatelet medications are given to prevent platelet aggregation and subsequent thrombosis, which impedes blood flow through the coronary arteries.

Aspirin

Aspirin prevents platelet aggregation and reduces the incidence of MI and death in patients with CAD (Frandsen & Pennington, 2021). A 162- to 325-mg dose of aspirin should be given to the patient with a new diagnosis of angina and then continued with 81 to 325 mg daily. Patients should be advised to continue aspirin even if they concurrently take other analgesics such as acetaminophen. Because aspirin may cause GI upset and bleeding, the use of histamine-2 (H_2) blockers (e.g., famotidine) or proton pump inhibitors (e.g., omeprazole) should be considered concomitant with continued aspirin therapy (Ibanez, James, Agewall, et al., 2018).

Adenosine Diphosphate Receptor Antagonists ($P2Y_{12}$)

These medications act on different pathways than aspirin to block platelet activation. However, unlike aspirin, these agents may take a few days to achieve antiplatelet effects. Clopidogrel is commonly prescribed in addition to aspirin in patients at high risk for MI. Newer oral agents such as prasugrel and ticagrelor may be used in place of clopidogrel during coronary events and interventions (Frandsen & Pennington, 2021). Both carry the risk of bleeding from the GI tract or other sites.

Heparin

Unfractionated IV heparin prevents the formation of new blood clots (i.e., it is an anticoagulant). Treating patients with unstable angina with heparin reduces the occurrence of MI. If the patient's signs and symptoms indicate a significant risk for a cardiac event, the patient is hospitalized and may be given an IV bolus of heparin and started on a continuous infusion. The dose of heparin given is based on the results of the activated partial thromboplastin time (aPTT). Heparin therapy is usually considered therapeutic when the aPTT is 2 to 2.5 times the normal aPTT value.

A subcutaneous injection of low-molecular-weight heparin (LMWH; enoxaparin or dalteparin) may be used instead of IV unfractionated heparin to treat patients with unstable angina or non–ST-segment elevation myocardial infarction (NSTEMI) (Frandsen & Pennington, 2021). LMWH provides effective and stable anticoagulation, potentially reducing the risk of rebound ischemic events, and eliminating the need to monitor aPTT results. LMWHs may be beneficial before and during PCIs as well as for ACS.

Because unfractionated heparin and LMWH increase the risk of bleeding, the patient is monitored for signs and symptoms of external and internal bleeding, such as low blood pressure, increased heart rate, and decreased serum hemoglobin and hematocrit. The patient receiving heparin is placed on bleeding precautions, which include:

- Applying pressure to the site of any needle puncture for a longer time than usual
- Avoiding intramuscular (IM) injections
- Avoiding tissue injury and bruising from trauma or use of constrictive devices (e.g., continuous use of an automatic blood pressure cuff)

A decrease in platelet count or evidence of thrombosis may indicate heparin-induced thrombocytopenia (HIT), an antibody-mediated reaction to heparin that may result in thrombosis. Patients who have received heparin within the past 3 months and those who have been receiving unfractionated heparin for 4 to 14 days are at high risk for HIT (Frandsen & Pennington, 2021). As an alternative to LMWH and unfractionated heparin, argatroban, a direct antithrombotic agent might be prescribed (Frandsen & Pennington, 2021; see Chapter 29 for further discussion of HIT).

Glycoprotein IIb/IIIa Agents

IV administration of glycoprotein (GP) IIb/IIIa agents, such as abciximab or eptifibatide, is indicated for hospitalized patients with unstable angina and as adjunct therapy for PCI. These agents prevent platelet aggregation by blocking the GP IIb/IIIa receptors on the platelets, preventing adhesion of fibrinogen and other factors that crosslink platelets to each other and thus form intracoronary clots (Urden, Stacy, & Lough, 2019). As with heparin, bleeding is the major side effect, and bleeding precautions should be initiated.

Oxygen Administration

Oxygen therapy is usually initiated at the onset of chest pain in an attempt to increase the amount of oxygen delivered to the myocardium and to decrease pain. The therapeutic effectiveness of oxygen is determined by observing the rate and rhythm of respirations and the color of skin and mucous membranes. Blood oxygen saturation is monitored by pulse oximetry; the normal oxygen saturation (SpO_2) level is >95% on room air (Urden et al., 2019).

NURSING PROCESS

The Patient with Angina Pectoris

Assessment

The nurse gathers information about the patient's symptoms and activities, especially those that precede and precipitate attacks of angina pectoris. Appropriate questions are listed in Chart 23-4. The answers to these questions form the basis for designing an effective program of treatment and prevention. In addition to assessing angina pectoris or its equivalent, the nurse also assesses the patient's risk factors for CAD, the patient's response to angina, the patient's and family's understanding of the diagnosis, and adherence to the current treatment plan.

Diagnosis

NURSING DIAGNOSES

Based on the assessment data, major nursing diagnoses may include:

- Risk for impaired cardiac function
- Anxiety associated with cardiac symptoms and possible death
- Lack of knowledge about the underlying disease and methods for avoiding complications
- Able to perform self care

Chart 23-4 ASSESSMENT

Assessing Angina

Ask the following:

- "Where is the pain (or prodromal symptoms)? Can you point to it?"
- "Can you feel the pain anywhere else?"
- "How would you describe the pain?"
- "Is it like the pain you had before?"
- "Can you rate the pain on a 0–10 scale, with 10 being the most pain?"
- "When did the pain begin?"
- "How long does it last?"
- "What brings on the pain?"
- "What helps the pain go away?"
- "Do you have any other symptoms with the pain?"

COLLABORATIVE PROBLEMS/POTENTIAL COMPLICATIONS

Potential complications may include the following:

- ACS and/or MI (described later in this chapter)
- Arrhythmias and cardiac arrest (see Chapters 22 and 25)
- Heart failure (see Chapter 25)

- Cardiogenic shock (see Chapter 11)

Planning and Goals

Major patient goals include immediate and appropriate treatment when angina occurs, prevention of angina, reduction of anxiety, awareness of the disease process and understanding of the prescribed care, adherence to the self-care program, and absence of complications.

Nursing Interventions

Treating Angina

If the patient reports pain (or cardiac ischemia is suggested by prodromal symptoms, which may include sensations of indigestion or nausea, choking, heaviness, weakness or numbness in the upper extremities, dyspnea, or dizziness), the nurse takes immediate action. The patient experiencing angina is directed to stop all activities and sit or rest in bed in a semi-Fowler position to reduce the oxygen requirements of the ischemic myocardium. The nurse assesses the patient's angina, asking questions to determine whether the angina is the same as the patient typically experiences. A change may indicate a worsening of the disease or a different cause. The nurse then continues to assess the patient, measuring vital signs and observing for signs of respiratory distress. If the patient is in the hospital, a 12-lead ECG is usually obtained and assessed for ST-segment and T-wave changes. If the patient has been placed on cardiac monitoring with continuous ST-segment monitoring, the ST segment is assessed for changes.

Nitroglycerin is given sublingually, and the patient's response is assessed (relief of chest pain and effect on blood pressure and heart rate). If the chest pain is unchanged or is lessened but still present, nitroglycerin administration is repeated up to three doses. Each time blood pressure, heart rate, and the ST segment (if the patient is on a monitor with ST-segment monitoring capability) are assessed. The nurse administers oxygen therapy if the patient's respiratory rate is increased or if the oxygen saturation level is decreased. Oxygen is usually given at 2 L/min by nasal cannula, even without evidence of desaturation, although there is no current evidence of a positive effect on patient outcome. If the pain is significant and continues after these interventions, the patient is further evaluated for acute MI and may be transferred to a higher-acuity nursing unit (Ibanez et al., 2018).

Reducing Anxiety

Patients with angina often fear loss of their roles within society and the family. They may also fear that the pain (or the prodromal symptoms) may lead to an MI or death. Exploring the implications that the diagnosis has for the patient and providing information about the illness, its treatment, and methods of preventing its progression are important nursing interventions. Various stress reduction methods, such as guided imagery or music therapy, should be explored with the patient (Meghani, 2017). Addressing the spiritual needs of the patient and family may also assist in allaying anxieties and fears.

Preventing Pain

The nurse reviews the assessment findings, identifies the level of activity that causes the patient's pain or prodromal symptoms, and plans the patient's activities

accordingly. If the patient has pain frequently or with minimal activity, the nurse alternates the patient's activities with rest periods. Balancing activity and rest is an important aspect of the educational plan for the patient and family.

PROMOTING HOME, COMMUNITY-BASED, AND TRANSITIONAL CARE

Educating Patients About Self-Care. The program for educating the patient with angina is designed so that the patient and family understand the illness, identify the symptoms of myocardial ischemia, state the actions to take when symptoms develop, and discuss methods to prevent chest pain and the advancement of CAD. The goals of education are to reduce the frequency and severity of anginal attacks, to delay the progress of the underlying disease if possible, and to prevent complications. The factors outlined in Chart 23-5 are important in educating the patient with angina pectoris.

The self-care program is prepared in collaboration with the patient and family or friends. Activities should be planned to minimize the occurrence of anginal episodes. The patient needs to understand that any pain unrelieved within 15 minutes by the usual methods, including nitroglycerin (see Chart 23-3), should be treated at the closest ED; the patient should call 911 for assistance.

Continuing and Transitional Care. For patient with disability or special needs, arrangements are made for transitional, home, or community care when appropriate. A home health or transitional care nurse can assist the patient with scheduling and keeping follow-up appointments. The patient may need reminders about follow-up monitoring, including periodic laboratory testing. In addition, the home health nurse may monitor the patient's adherence to dietary restrictions and to prescribed antianginal medications, including nitroglycerin. If the patient has severe anginal symptoms, the nurse may assess the home environment and recommend modifications that diminish the occurrence of anginal episodes. For instance, if a patient cannot climb stairs without experiencing ischemia, the home health nurse may help the patient plan daily activities that minimize stair-climbing.

Chart 23-5 **HOME CARE CHECKLIST**

Managing Angina Pectoris

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of angina pectoris on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- State changes in lifestyle (e.g., diet, activity) or home environment necessary to maintain health.
- Follow a diet low in saturated fat, high in fiber, and, if indicated, lower in calories.
- Reduce the probability of an episode of anginal pain by balancing rest with regular daily activities that do not produce chest discomfort, shortness of breath, or undue fatigue.
- Follow the prescribed exercise regimen.
  - Recognize that temperature extremes (particularly cold) may induce anginal pain; therefore, avoid exercise in temperature extremes.
- State the name, dose, side effects, frequency, and schedule for all medications.
- Take medications, especially aspirin and beta-blockers, as prescribed.
- Carry nitroglycerin at all times; state when and how to use it; identify its side effects.
- Avoid using medications or any over-the-counter substances (e.g., diet pills, nasal decongestants) that can increase the heart rate and blood pressure without first discussing with the primary provider.
- Use appropriate resources for support during emotionally stressful times (e.g., counselor, nurse, clergy, primary provider).
- Stop smoking and the use of other forms of tobacco and avoid secondhand smoke (because smoking increases the heart rate, blood pressure, and blood carbon monoxide levels).
- Achieve and maintain normal blood pressure.
- Achieve and maintain normal blood glucose levels.
- State how to reach primary provider with questions or complications.
  - Report increase in symptoms to the primary provider.
  - State time and date of follow-up appointments and testing.
- Identify the need for health promotion (e.g., weight reduction, cessation of tobacco use, stress management), disease prevention, and screening activities.

ADLs, activities of daily living; IADLs, independent activities of daily living.

Evaluation

Expected patient outcomes may include:

1. Reports that pain is relieved promptly
   a. Recognizes symptoms
   b. Takes immediate action
   c. Seeks medical assistance if pain persists or changes in quality

2. Reports decreased anxiety
    a. Expresses acceptance of diagnosis
    b. Expresses control over choices within medical regimen
    c. Does not exhibit signs and symptoms that indicate a high level of anxiety
3. Understands ways to avoid complications and is free of complications
    a. Describes the process of angina
    b. Explains reasons for measures to prevent complications
    c. Exhibits stable ECG
    d. Experiences no signs and symptoms of acute MI
4. Adheres to self-care program
    a. Takes medications as prescribed
    b. Keeps health care appointments
    c. Implements plan to reduce risk factors

Acute Coronary Syndrome and Myocardial Infarction

Acute coronary syndrome (ACS) is an emergent situation characterized by an acute onset of myocardial ischemia that results in myocardial death (i.e., MI) if definitive interventions do not occur promptly. (Although the terms *coronary occlusion, heart attack,* and *myocardial infarction* are used synonymously, the preferred term is *myocardial infarction.*) The spectrum of ACS includes unstable angina, NSTEMI, and ST-segment elevation myocardial infarction (STEMI).

Pathophysiology

In unstable angina, there is reduced blood flow in a coronary artery, often due to rupture of an atherosclerotic plaque. A clot begins to form on top of the coronary lesion, but the artery is not completely occluded. This is an acute situation that can result in chest pain and other symptoms that may be referred to as preinfarction angina because the patient will likely have an MI if prompt interventions do not occur.

In an MI, plaque rupture and subsequent thrombus formation result in complete occlusion of the artery, leading to ischemia and necrosis of the myocardium supplied by that artery. Vasospasm (sudden constriction or narrowing) of a coronary artery, decreased oxygen supply (e.g., from acute blood loss, anemia, or low blood pressure), and increased demand for oxygen (e.g., from a rapid heart rate, thyrotoxicosis, or ingestion of cocaine) are other causes of MI. In each case, a profound imbalance exists between myocardial oxygen supply and demand.

The area of infarction develops over minutes to hours. As the cells are deprived of oxygen, ischemia develops, cellular injury occurs, and the lack of oxygen results in infarction, or the death of cells. The expression “time is muscle” reflects the urgency of appropriate treatment to improve patient outcomes. Approximately every 40 seconds, an American will have an MI (Benjamin et al., 2019), and many of these

people will die as a result. Early recognition and treatment of patients presenting with an MI will improve their chances of survival.

Various descriptions are used to further identify an MI: the type (NSTEMI, STEMI), the location of the injury to the ventricular wall (anterior, inferior, posterior, or lateral wall), and the point in time within the process of infarction (acute, evolving, or old). The differentiation between NSTEMI and STEMI is determined by diagnostic tests and is explained later in this chapter.

The 12-lead ECG identifies the type and location of the MI, and other ECG indicators, such as a Q wave, and patient history, identify the timing. Regardless of the location, the goals of medical therapy are to relieve symptoms, prevent or minimize myocardial tissue death, and prevent complications. The pathophysiology of CAD and the risk factors involved were discussed earlier in this chapter.

Clinical Manifestations

Chest pain that occurs suddenly and continues despite rest and medication is the presenting symptom in most patients with ACS. Some of these patients have prodromal symptoms or a previous diagnosis of CAD, but others report no previous symptoms. Patients may present with a combination of symptoms, including chest pain, shortness of breath, indigestion, nausea, and anxiety. They may have cool, pale, and moist skin. Their heart rate and respiratory rate may be faster than normal. These signs and symptoms, which are caused by stimulation of the sympathetic nervous system, may be present for only a short time or may persist. In many cases, the signs and symptoms of MI cannot be distinguished from those of unstable angina; hence, the evolution of the term *acute coronary syndrome.*

Assessment and Diagnostic Findings

The diagnosis of ACS is generally based on the presenting symptoms (see Chart 23-6); the 12-lead ECG and laboratory tests (e.g., serial cardiac biomarkers) are performed to clarify whether the patient has unstable angina, NSTEMI, or STEMI (Ibanez et al., 2018). The prognosis depends on the severity of coronary artery obstruction and the presence and extent of myocardial damage. Physical examination is always conducted, but the examination alone does not confirm the diagnosis.

Patient History

The patient history includes the description of the presenting symptom (e.g., pain), the history of previous cardiac and other illnesses, and the family history of heart disease. The history should also include information about the patient's risk factors for heart disease.

Electrocardiogram

The 12-lead ECG provides information that assists in ruling out or diagnosing an acute MI. It should be obtained within 10 minutes from the time a patient reports pain or arrives in the ED. By monitoring serial ECG changes over time, the location, evolution, and resolution of an MI can be identified and monitored.

The ECG changes that occur with an MI are seen in the leads that view the involved surface of the heart. The expected ECG changes are T-wave inversion, ST-segment elevation, and development of an abnormal Q wave (see Fig. 23-5). Because infarction evolves over time, the ECG also changes over time. The first ECG signs of an acute MI are usually seen in the T wave and ST segment (Urden et al., 2019). As the area of injury becomes ischemic, myocardial repolarization is altered and delayed, causing the T wave to invert. Myocardial injury also causes ST-segment changes. The ST segment is normally flat on the ECG tracing. The injured myocardial cells depolarize normally but repolarize more rapidly than normal cells, causing the ST segment to rise at least 1 mm above the isoelectric line (the area between the T wave and the next P wave is used as the reference for the isoelectric line). This change is measured 0.06 to 0.08 seconds after the end of the QRS—a point called the *J point* (Urden et al., 2019) (see Fig. 23-6). An elevation in the ST segment in two contiguous leads is a key diagnostic indicator for MI (i.e., STEMI).

Chart 23-6 **ASSESSMENT**

Assessing for Acute Coronary Syndrome or Acute Myocardial Infarction

Be alert for the following signs and symptoms:

Cardiovascular

- Chest pain or discomfort not relieved by rest or nitroglycerin; palpitations. Heart sounds may include S_3, S_4, and new onset of a murmur.
- Increased jugular venous distention may be seen if the myocardial infarction (MI) has caused heart failure.
- Blood pressure may be elevated because of sympathetic stimulation or decreased because of decreased contractility, impending cardiogenic shock, or medications.
- Irregular pulse may indicate atrial fibrillation.
- In addition to ST-segment and T-wave changes, the electrocardiogram may show tachycardia, bradycardia, or other arrhythmias.

Respiratory

Shortness of breath, dyspnea, tachypnea, and crackles if MI has caused pulmonary congestion. Pulmonary edema may be present.

Gastrointestinal

Nausea, indigestion, and vomiting.

Genitourinary

Decreased urinary output may indicate cardiogenic shock.

Skin

Cool, clammy, diaphoretic, and pale appearance due to sympathetic stimulation may indicate cardiogenic shock.

Neurologic

Anxiety, restlessness, and lightheadedness may indicate increased sympathetic stimulation or a decrease in contractility and cerebral oxygenation. The same symptoms may also herald cardiogenic shock.

Psychological

Fear with feeling of impending doom, or denial that anything is wrong.

The appearance of abnormal Q waves is another indication of MI. Q waves develop within 1 to 3 days because there is no depolarization current conducted from necrotic tissue (Urden et al., 2019). A new and significant Q wave is 0.04 seconds or longer and 25% of the R wave depth. An acute MI may also cause a significant decrease in the height of the R wave. During an acute MI, injury and ischemic changes are usually present. An abnormal Q wave may be present without ST-segment and T-wave changes, which indicates an old, not acute, MI. For some patients, there is no persistent ST elevation or other ECG changes; therefore, an NSTEMI is diagnosed by blood levels of cardiac biomarkers.

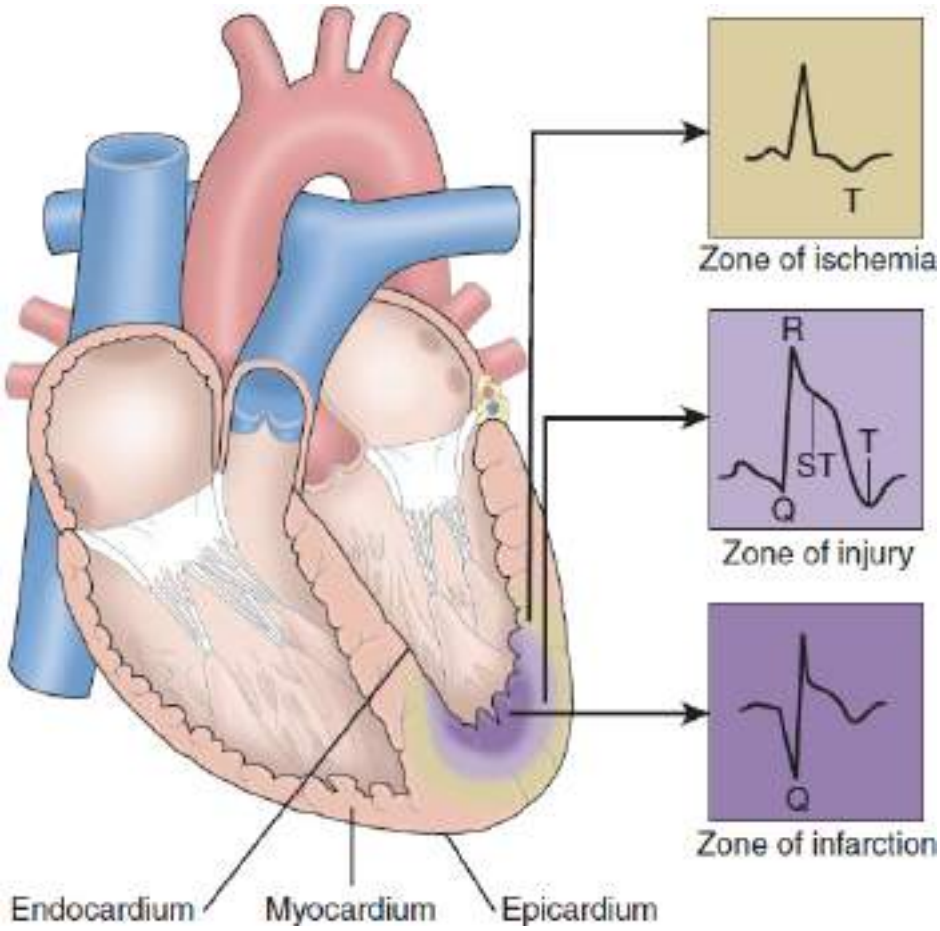

Figure 23-5 • Effects of ischemia, injury, and infarction on an electrocardiogram recording. Ischemia causes inversion of the T wave because of altered repolarization. Cardiac muscle injury causes elevation of the ST segment. Later, Q waves develop because of the absence of depolarization current from the necrotic tissue and opposing currents from other parts of the heart.

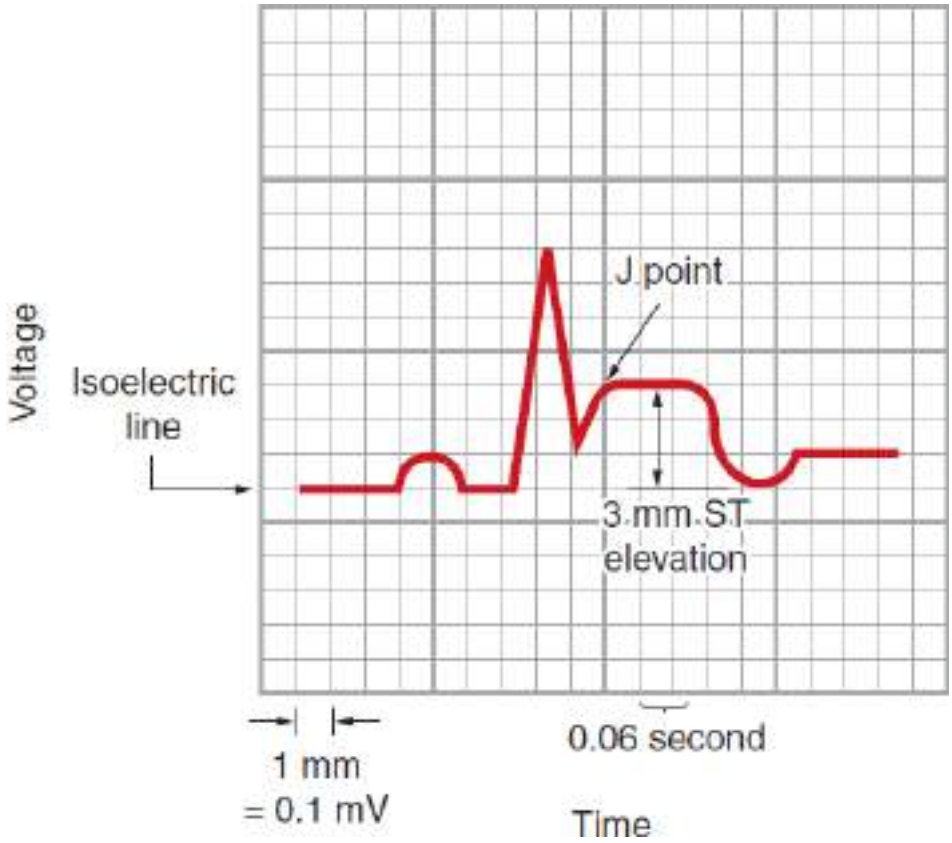

Figure 23-6 • Using the electrocardiogram to diagnose acute myocardial infarction (MI). (ST-segment elevation is measured 0.06 to 0.08 seconds after the J point. An elevation of more than 1 mm in contiguous leads is indicative of acute MI.)

Using the information presented, patients are diagnosed with one of the following forms of ACS:

- *Unstable angina:* The patient has clinical manifestations of coronary ischemia, but ECG and cardiac biomarkers show no evidence of acute MI.
- *STEMI:* The patient has ECG evidence of acute MI with characteristic changes in two contiguous leads on a 12-lead ECG. In this type of MI, there is a significant damage to the myocardium.
- *NSTEMI:* The patient has elevated cardiac biomarkers (e.g., troponin) but no definite ECG evidence of acute MI. In this type of MI, there may be less damage to the myocardium.

During recovery from an MI, the ST segment often is the first ECG indicator to return to normal. Q-wave alterations are usually permanent. An old STEMI is usually indicated by an abnormal Q wave or decreased height of the R wave without ST-segment and T-wave changes.

Echocardiogram

The echocardiogram is used to evaluate ventricular function. It may be used to assist in diagnosing an MI, especially when the ECG is nondiagnostic. The echocardiogram

can detect hypokinetic and akinetic wall motion and can determine the ejection fraction (see Chapter 21).

Laboratory Tests

Cardiac enzymes and biomarkers, which include troponin, creatine kinase (CK), and myoglobin, are used to diagnose an acute MI. Cardiac biomarkers can be analyzed rapidly, expediting an accurate diagnosis. These tests are based on the release of cellular contents into the circulation when myocardial cells die.

Troponin

Troponin, a protein found in myocardial cells, regulates the myocardial contractile process. There are three isomers of troponin: C, I, and T. Troponins I and T are specific for cardiac muscle, and these biomarkers are currently recognized as reliable and critical markers of myocardial injury (Norris, 2019). An increase in the level of troponin in the serum can be detected within a few hours during acute MI. It remains elevated for a long period, often as long as 2 weeks, and it therefore can be used to detect recent myocardial damage. It should be noted that cardiac troponin levels may rise during inflammation and other forms of mechanical stress on the myocardium. These include sepsis, heart failure, and respiratory failure (Felker & Fudim, 2018).

Creatine Kinase and Its Isoenzymes

There are three CK isoenzymes: CK-MM (skeletal muscle), CK-MB (heart muscle), and CK-BB (brain tissue). CK-MB is the cardiac-specific isoenzyme; it is found mainly in cardiac cells and therefore increases when there has been damage to these cells. Elevated CK-MB is an indicator of acute MI; the level begins to increase within a few hours and peaks within 24 hours of an infarct.

Myoglobin

Myoglobin is a heme protein that helps transport oxygen. Like the CK-MB enzyme, myoglobin is found in cardiac and skeletal muscle. The myoglobin level starts to increase within 1 to 3 hours and peaks within 12 hours after the onset of symptoms. An increase in myoglobin is not very specific in indicating an acute cardiac event; however, negative results can be used to rule out an acute MI.

Chart 23-7

Treatment Guidelines for Acute Myocardial Infarction

- Use rapid transit to the hospital.
- Obtain 12-lead electrocardiogram to be read within 10 minutes.
- Obtain laboratory blood specimens of cardiac biomarkers, including troponin.
- Obtain other diagnostics to clarify the diagnosis.
- Begin routine medical interventions:
  - Supplemental oxygen
  - Nitroglycerin
  - Morphine
  - Aspirin
  - Beta-blocker
  - Angiotensin-converting enzyme inhibitor within 24 hours
  - Anticoagulation with heparin and platelet inhibitors
  - Statin
- Evaluate for indications for reperfusion therapy:
  - Percutaneous coronary intervention
  - Thrombolytic therapy
- Continue therapy as indicated:
  - IV heparin, low-molecular-weight heparin, bivalirudin, or fondaparinux
  - Clopidogrel
  - Glycoprotein IIb/IIIa inhibitor
  - Bed rest for a minimum of 12–24 hours
  - Statin prescribed at discharge.

Adapted from Ibanez, B., James, S., Agewall, S., et al. (2018). 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. *European Heart Journal, 39*(2), 119–177.

Medical Management

The goals of medical management are to minimize myocardial damage, preserve myocardial function, and prevent complications. These goals are facilitated by the use of guidelines developed by the ACC and the AHA (see Chart 23-7).

The goal for treating patients with acute MI is to minimize myocardial damage by reducing myocardial oxygen demand and increasing oxygen supply with medications, oxygen administration, and bed rest. The resolution of pain and ECG changes indicate that demand and supply are in equilibrium; they may also indicate reperfusion. Visualization of blood flow through an open vessel in the catheterization laboratory is evidence of reperfusion.

Initial Management

The patient with suspected MI should immediately receive supplemental oxygen, aspirin, nitroglycerin, and morphine. Morphine is the drug of choice to reduce pain and anxiety. It also reduces preload and afterload, decreasing the work of the heart. The response to morphine is monitored carefully to assess for hypotension or decreased respiratory rate. Nurses should be aware that evolving research has

suggested an association between morphine and potential adverse outcomes, including larger infarct size, increased length of hospital stay, and mortality, and should stay abreast of changes to clinical guidelines impacting its use (McCarthy, Bhambhani, Pomerantsev, et al., 2018; Neto, 2018). A beta-blocker may also be used if arrhythmias occur. If a beta-blocker is not needed in the initial management period, it should be introduced within 24 hours of admission, once hemodynamics have stabilized and it is confirmed that the patient has no contraindications (Ibanez et al., 2018). Unfractionated heparin or LMWH may also be prescribed along with platelet-inhibiting agents to prevent further clot formation.

Emergent Percutaneous Coronary Intervention

The patient with STEMI is taken directly to the cardiac catheterization laboratory for an immediate PCI (if a cardiac catheterization laboratory is on site). The procedure is used to open the occluded coronary artery and promote reperfusion to the area that has been deprived of oxygen. Superior outcomes have been reported with the use of PCI when compared to thrombolytic agents (Urden et al., 2019) (also called *fibrinolytic* agents; see the Thrombolytics section). Thus, PCI is preferred as the initial treatment method for acute MI in all age groups (Urden et al., 2019). The procedure treats the underlying atherosclerotic lesion. Because the duration of oxygen deprivation determines the number of myocardial cells that die, the time from the patient's arrival in the ED to the time PCI is performed should be less than 60 minutes. This is frequently referred to as door-to-balloon time. A cardiac catheterization laboratory and staff must be available if an emergent PCI is to be performed within this short time. The nursing care related to PCI is presented later in this chapter.

Thrombolytics

Thrombolytic therapy is initiated when primary PCI is not available or the transport time to a PCI-capable hospital is too long. These agents are administered IV according to a specific protocol (see Chart 23-8). The thrombolytic agents used most often are alteplase, reteplase, and tenecteplase. The purpose of **thrombolytics** is to dissolve (i.e., lyse) the thrombus in a coronary artery (thrombolysis), allowing blood to flow through the coronary artery again (reperfusion), minimizing the size of the infarction and preserving ventricular function. However, although thrombolytics may dissolve the thrombus, they do not affect the underlying atherosclerotic lesion. The patient may be referred for a cardiac catheterization and other invasive procedures following the use of thrombolytic therapy. Thrombolytics should not be used if the patient is bleeding or has a bleeding disorder. They should be given within 30 minutes of symptom onset for best results (Norris, 2019). This is frequently referred to as door-to-needle time.

Inpatient Management

Following PCI or thrombolytic therapy, continuous cardiac monitoring is indicated, preferably in a cardiac intensive care unit (ICU). Continuing pharmacologic management includes aspirin, a beta-blocker, and an angiotensin-converting enzyme (ACE) inhibitor. ACE inhibitors prevent the conversion of angiotensin I to

angiotensin II. In the absence of angiotensin II, the blood pressure decreases and the kidneys excrete sodium and fluid (diuresis), decreasing the oxygen demand of the heart. The use of ACE inhibitors in patients after MI decreases mortality rates and prevents remodeling of myocardial cells that is associated with the onset of heart failure. Blood pressure, urine output, and serum sodium, potassium, and creatinine levels need to be monitored closely. If an ACE inhibitor is not suitable, an angiotensin receptor blocker (ARB) should be prescribed (Ibanez et al., 2018). Nicotine replacement therapy and tobacco cessation counseling should also be initiated for all tobacco users.

Chart 23-8 **PHARMACOLOGY**

Administration of Thrombolytic Therapy

Indications

- Chest pain lasting more than 20 minutes, unrelieved by nitroglycerin
- ST-segment elevation in at least two leads that face the same area of the heart
- Less than 12 hours from onset of pain

Absolute Contraindications

- Active bleeding
- Known bleeding disorder
- History of hemorrhagic stroke
- History of intracranial vessel malformation
- Recent major surgery or trauma
- Uncontrolled hypertension
- Pregnancy

Nursing Considerations

- Minimize the number of times the patient's skin is punctured.
- Avoid intramuscular injections.
- Draw blood for laboratory tests when starting the IV line.
- Start IV lines before thrombolytic therapy; designate one line to use for blood draws.
- Avoid continual use of noninvasive blood pressure cuff.
- Monitor for acute arrhythmias and hypotension.
- Monitor for reperfusion: resolution of angina or acute ST-segment changes.
- Check for signs and symptoms of bleeding: decrease in hematocrit and hemoglobin values, decrease in blood pressure, increase in heart rate, oozing or bulging at invasive procedure sites, back pain, muscle weakness, changes in level of consciousness, complaints of headache.
- Treat major bleeding by discontinuing thrombolytic therapy and any anticoagulants; apply direct pressure and notify the primary provider immediately.
- Treat minor bleeding by applying direct pressure if accessible and appropriate; continue to monitor.

Adapted from Urden, L. D., Stacy, K. M., & Lough, M. E. (2019). *Priorities in critical care nursing* (8th ed.). St. Louis, MO: Elsevier.

Cardiac Rehabilitation

After the patient with an MI is in a stable condition, an active rehabilitation program is initiated. Cardiac rehabilitation is an important continuing care program for patients with CAD that targets risk reduction by providing patient and family education, offering individual and group support, and encouraging physical activity and physical conditioning. The goals of rehabilitation for the patient who has had an MI are to extend life and improve the quality of life. The immediate objectives are to limit the

effects and progression of atherosclerosis, return the patient to work and a pre-illness lifestyle, enhance the patient's psychosocial and vocational status, and prevent another cardiac event. Cardiac rehabilitation programs increase survival, reduce recurrent events and the need for interventional procedures, and improve quality of life (Dickins & Braun, 2017).

Physical conditioning is achieved gradually over time. Many times, patients will "overdo it" in an attempt to achieve their goals too rapidly. Patients are observed for chest pain, dyspnea, weakness, fatigue, and palpitations and are instructed to stop exercise if any of these occur. Patients may also be monitored for an increase in heart rate above the target heart rate, an increase in systolic or diastolic blood pressure of more than 20 mm Hg, a decrease in systolic blood pressure, onset or worsening of arrhythmias, or ST-segment changes on the ECG.

Cardiac rehabilitation programs are categorized into three phases (Dickins & Braun, 2017). Phase I begins with the diagnosis of atherosclerosis, which may occur when the patient is admitted to the hospital for ACS. Because of brief hospital lengths of stay, mobilization occurs early and patient education focuses on the essentials of self-care rather than instituting behavioral changes for risk reduction. Priorities for in-hospital education include the signs and symptoms that indicate the need to call 911 (seek emergency assistance), the medication regimen, rest–activity balance, and follow-up appointments with the primary provider. The patient is reassured that although CAD is a lifelong disease and must be treated as such, they can likely resume a normal life after an MI. The amount and type of activity recommended at discharge depend on the patient's age, his or her condition before the cardiac event, the extent of the disease, the course of the hospital stay, and the development of any complications.

Phase II occurs after the patient has been discharged. The patient attends sessions three times a week for 4 to 6 weeks but may continue for as long as 6 months. The outpatient program consists of supervised, often ECG-monitored, exercise training that is individualized. At each session, the patient is assessed for the effectiveness of and adherence to the treatment. To prevent complications and another hospitalization, the cardiac rehabilitation staff alerts the referring primary provider to any problems. Phase II cardiac rehabilitation also includes educational sessions for patients and families that are given by cardiologists, exercise physiologists, dietitians, nurses, and other health care professionals. These sessions may take place outside a traditional classroom setting. For instance, a dietitian may take a group of patients to a grocery store to examine labels and meat selections or to a restaurant to discuss menu offerings for a heart-healthy diet.

Phase III is a long-term outpatient program that focuses on maintaining cardiovascular stability and long-term conditioning. The patient is usually self-directed during this phase and does not require a supervised program, although it may be offered. The goals of each phase build on the accomplishments of the previous phase.

NURSING PROCESS

The Patient with Acute Coronary Syndrome

Assessment

One of the most important aspects of care of the patient with ACS is the assessment. It establishes the patient's baseline, identifies the patient's needs, and helps determine the priority of those needs. Systematic assessment includes a careful history, particularly as it relates to symptoms: chest pain or discomfort, dyspnea (difficulty breathing), palpitations, unusual fatigue, syncope (faintness), or other possible indicators of myocardial ischemia. Each symptom must be evaluated with regard to time, duration, and the factors that precipitate the symptom and relieve it, and in comparison with previous symptoms. A focused physical assessment is critical to detect complications and any change in patient status. Chart 23-6 identifies important assessments and possible findings.

Two IV lines are typically placed for any patient with ACS to ensure that access is available for administering emergency medications. Medications are administered IV to achieve rapid onset and to allow for timely adjustment. After the patient's condition stabilizes, IV lines may be changed to a saline lock to maintain IV access.

Diagnosis

NURSING DIAGNOSES

Based on the clinical manifestations, history, and diagnostic assessment data, major nursing diagnoses may include:

- Acute pain associated with increased myocardial oxygen demand and decreased myocardial oxygen supply
- Risk for impaired cardiac function associated with reduced coronary blood flow
- Risk for hypovolaemia
- Impaired peripheral tissue perfusion associated with impaired cardiac output from left ventricular dysfunction
- Anxiety associated with cardiac event and possible death
- Lack of knowledge about post-ACS self-care

COLLABORATIVE PROBLEMS/POTENTIAL COMPLICATIONS

Potential complications may include the following:

- Acute pulmonary edema (see Chapter 25)
- Heart failure (see Chapter 25)
- Cardiogenic shock (see Chapter 11)
- Arrhythmias and cardiac arrest (see Chapters 22 and 25)
- Pericardial effusion and cardiac tamponade (see Chapter 25)

Planning and Goals

The major goals for the patient include relief of pain or ischemic signs (e.g., ST-segment changes) and symptoms, prevention of myocardial damage, maintenance

of effective respiratory function, maintenance or attainment of adequate tissue perfusion, reduced anxiety, adherence to the self-care program, and early recognition of complications. Care of the patient with ACS who has an uncomplicated MI is summarized in the Plan of Nursing Care (see Chart 23-9).

Nursing Interventions

Relieving Pain and Other Signs and Symptoms of Ischemia

Balancing myocardial oxygen supply with demand (e.g., as evidenced by the relief of chest pain) is the top priority in the care of the patient with an ACS. Although administering medications as described previously is required to accomplish this goal, nursing interventions are also important. Collaboration among the patient, nurse, and primary provider is critical in evaluating the patient's response to therapy and in altering the interventions accordingly.

Oxygen should be given along with medication therapy to assist with relief of symptoms. Administration of oxygen raises the circulating level of oxygen to reduce pain associated with low levels of myocardial oxygen. The route of administration (usually by nasal cannula) and the oxygen flow rate are documented. A flow rate of 2 to 4 L/min is usually adequate to maintain oxygen saturation levels of at least 95% unless chronic pulmonary disease is present.

Vital signs are assessed frequently as long as the patient is experiencing pain and other signs or symptoms of acute ischemia. Physical rest in bed with the head of the bed elevated or in a supportive chair helps decrease chest discomfort and dyspnea. Elevation of the head and torso is beneficial for the following reasons:

- Tidal volume improves because of reduced pressure from abdominal contents on the diaphragm and better lung expansion.
- Drainage of the upper lung lobes improves.
- Venous return to the heart (preload) decreases, reducing the work of the heart.

The pain associated with an acute MI reflects an imbalance in myocardial oxygen supply and demand or ineffective myocardial tissue perfusion. The pain also results in increases in heart rate, respiratory rate, and blood pressure. Promptly relieving the pain helps to reestablish this balance, thus decreasing the workload of the heart and minimizing damage to the myocardium. Relief of pain also helps to reduce the patient's anxiety level, which in turn reduces the sympathetic stress response, leading to a decrease in workload of the already stressed heart.

Improving Respiratory Function

Regular and careful assessment of respiratory function detects early signs of pulmonary complications. The nurse monitors fluid volume status to prevent fluid overload and encourages the patient to breathe deeply and change position frequently to maintain effective ventilation throughout the lungs. Pulse oximetry guides the use of oxygen therapy.

Promoting Adequate Tissue Perfusion

Bed or chair rest during the initial phase of treatment helps reduce myocardial oxygen consumption. This limitation on mobility should remain until the patient is

pain free and hemodynamically stable. Skin temperature and peripheral pulses must be checked frequently to monitor tissue perfusion.

Reducing Anxiety

Alleviating anxiety and decreasing fear are important nursing functions that reduce the sympathetic stress response. Less sympathetic stimulation decreases the workload of the heart, which may relieve pain and other signs and symptoms of ischemia.

Chart 23-9 PLAN OF NURSING CARE

Care of the Patient with an Uncomplicated Myocardial Infarction

NURSING DIAGNOSIS: Risk for impaired cardiac function associated with reduced coronary blood flow
GOAL: Relief of chest pain/discomfort

Nursing Interventions	Rationale	Expected Outcomes

1. Initially assess, document, and report to the primary provider the following:
a. The patient's description of chest discomfort, including location, intensity, radiation, duration, and factors that affect it; other symptoms such as nausea, diaphoresis, or complaints of unusual fatigue
b. The effect of coronary ischemia on perfusion to the heart (e.g., change in blood pressure, heart rhythm), to the brain (e.g., changes in level of consciousness), to the kidneys (e.g., decrease in urine output), and to the skin (e.g., color, temperature)
2. Obtain a 12-lead ECG recording
	1. These data assist in determining the cause and effect of the chest discomfort and provide a baseline with which post-therapy symptoms can be compared.
	a. There are many conditions associated with chest discomfort. There are characteristic clinical findings of ischemic pain and symptoms.
	b. Myocardial infarction (MI) decreases myocardial contractility and ventricular compliance and may produce arrhythmias. Cardiac output is reduced, resulting in reduced blood pressure and decreased organ perfusion.
		• Reports beginning relief of chest discomfort and symptoms
		• Appears comfortable and is free of pain and other signs or symptoms
		• Respiratory rate, cardiac rate, and blood pressure return to prediscomfort level
		• Skin warm and dry
		• Adequate cardiac output as evidenced by:
		  • Stable/improving electrocardiogram (ECG)
		  • Heart rate and rhythm
		  • Blood pressure
		  • Mentation
		  • Urine output
		  • Serum blood urea nitrogen (BUN) and creatinine
		  • Skin color and temperature
		• No adverse effects from medications

during symptomatic events, as prescribed, to assess for ongoing ischemia.	2. An ECG during symptoms may be useful in the diagnosis of ongoing ischemia.	
3. Administer oxygen as prescribed.	3. Oxygen therapy increases the oxygen supply to the myocardium.	
4. Administer medication therapy as prescribed and evaluate the patient's response continuously.	4. Medication therapy (nitroglycerin, morphine, beta-blocker, aspirin) is the first line of defense in preserving myocardial tissue.	
5. Ensure physical rest: head of bed elevated to promote comfort; diet as tolerated; the use of bedside commode; the use of stool softener to prevent straining at stool. Provide a restful environment and allay fears and anxiety by being calm and supportive. Individualize visitation, based on patient response.	5. Physical rest reduces myocardial oxygen consumption. Fear and anxiety precipitate the stress response; this results in increased levels of endogenous catecholamines, which increase myocardial oxygen consumption.	

NURSING DIAGNOSIS: Risk for impaired cardiac function associated with left ventricular failure

GOAL: Absence of respiratory distress

Nursing Interventions	Rationale	Expected Outcomes
1. Initially, every 4 hours, and with chest discomfort or symptoms, assess, document, and report to the primary provider	1. These data are useful in diagnosing left ventricular failure. Diastolic filling sounds (S_3 and S_4) result from	• No shortness of breath, dyspnea on exertion, orthopnea, or paroxysmal nocturnal dyspnea • Respiratory rate <20 breaths/min with

abnormal heart sounds (S_3 and S_4 gallop or new murmur), abnormal breath sounds (particularly crackles), decreased oxygenation, and activity intolerance.	decreased left ventricular compliance associated with MI. Papillary muscle dysfunction (from infarction of the papillary muscle) can result in mitral regurgitation and a reduction in stroke volume. The presence of crackles (usually at the lung bases) may indicate pulmonary congestion from increased left heart pressures. The association of symptoms and activity can be used as a guide for activity prescription and a basis for patient education.	physical activity and 16 breaths/min with rest • Skin color and temperature normal • SpO_2, PaO_2, and $PaCO_2$ within normal limits • Heart rate <100 bpm and >60 bpm, with blood pressure within patient's normal limits • Chest x-ray unchanged • Appears comfortable and rested

NURSING DIAGNOSIS: Impaired peripheral tissue perfusion associated with impaired cardiac output
GOAL: Maintenance/attainment of adequate tissue perfusion

Nursing Interventions	Rationale	Expected Outcomes
1. Initially, every 4 hours, and with chest discomfort, assess, document, and report to the primary provider the following: a. Hypotension b. Tachycardia and other arrhythmia c. Activity intolerance d. Mentation changes (use	1. These data are useful in determining a low cardiac output state.	• Blood pressure within the patient's normal range • Ideally, normal sinus rhythm without arrhythmia is maintained, or patient's baseline rhythm is maintained between 60 and 100 bpm without further arrhythmia. • Prescribed activity is well tolerated.

family input) e. Reduced urine output (<0.5 mL/kg/h) f. Cool, moist, cyanotic extremities, decreased peripheral pulses, prolonged capillary refill		• Remains alert and oriented and without cognitive or behavioral change • Appears comfortable • Urine output >0.5 mL/kg/h • Extremities warm and dry with normal color
NURSING DIAGNOSIS: Anxiety associated with cardiac event **GOAL:** Reduction of anxiety		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Assess, document, and report to the primary provider the patient's and family's level of anxiety and coping mechanisms.	1. These data provide information about psychological well-being. Causes of anxiety are variable and individual, and may include acute illness, hospitalization, pain, disruption of activities of daily living at home and at work, changes in role and self-image due to illness, and financial concerns. Because anxious family members can transmit anxiety to the patient, the nurse must also identify strategies to reduce the family's fear and anxiety.	• Reports less anxiety • The patient and family discuss their anxieties and fears about illness and death. • The patient and family appear less anxious. • Appears restful, respiratory rate <16 breaths/min, heart rate <100 bpm without ectopic beats, blood pressure within patient's normal limits, skin warm and dry • Participates actively in a progressive rehabilitation program • Practices stress reduction techniques
2. Assess the need for spiritual counseling and refer as appropriate.	2. If a patient finds support in a religion, spiritual	
3. Assess the need for social service		

referral.	counseling may assist in reducing anxiety and fear. 3. Social services can assist with posthospital care and financial concerns.	

NURSING DIAGNOSIS: Lack of knowledge about post-MI self-care
GOAL: Adheres to the home health care program; chooses lifestyle consistent with heart-healthy recommendations (see Chart 23-10).

The development of a trusting and caring relationship with the patient is critical in reducing anxiety. Providing information to the patient and family in an honest and supportive manner encourages the patient to be a partner in care and greatly assists in developing a positive relationship. Other interventions that can be used to reduce anxiety include ensuring a quiet environment, preventing interruptions that disturb sleep, and providing spiritual support consistent with the patient's beliefs. The nurse provides frequent opportunities for the patient to privately share concerns and fears. An atmosphere of acceptance helps the patient know that these concerns and fears are both realistic and normal. Alternative therapies such as pet therapy can help certain patients relax and reduce anxiety (Waite, Hamilton, & O'Brien, 2018). Many hospitals have developed infection control and safety procedures pertaining to the animals, their handlers, and the patients eligible for pet therapy.

Monitoring and Managing Potential Complications

Complications that can occur after acute MI are caused by the damage that occurs to the myocardium and to the conduction system from reduced coronary blood flow. Because these complications can be life-threatening, close monitoring for and early identification of their signs and symptoms are critical (see Chart 23-9).

The nurse monitors the patient closely for changes in cardiac rate and rhythm, heart sounds, blood pressure, chest pain, respiratory status, urinary output, skin color and temperature, mental status, ECG changes, and laboratory values. Any changes in the patient's condition must be reported promptly to the primary provider and emergency measures instituted when necessary.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care. The most effective way to increase the probability that the patient will implement a self-care regimen after discharge is to identify the patient's priorities, provide adequate education about heart-healthy living, and facilitate the patient's involvement in a cardiac rehabilitation program (Ibanez et al., 2018). Patient participation in the development of an individualized program enhances the potential for an effective treatment plan (see Chart 23-10).

Continuing and Transitional Care. Depending on the patient's condition and the availability of family assistance, home, community-based, or transitional, care may be indicated. The nurse making a home visit can assist the patient with scheduling and keeping follow-up appointments and with adhering to the prescribed cardiac rehabilitation regimen. The patient may need reminders about follow-up monitoring, including periodic laboratory testing, as well as ongoing assessment of cardiac status. In addition, the home health nurse monitors the patient's adherence to dietary restrictions and to prescribed medications. If the patient is receiving home oxygen, the nurse ensures that the patient is using the oxygen as prescribed and that appropriate home safety measures are maintained. If the patient has evidence of heart failure secondary to an MI, appropriate home care guidelines for the patient with heart failure are followed (see Chapter 25).

Evaluation

Expected patient outcomes may include:

1. Experiences relief of angina
2. Has stable cardiac and respiratory status
3. Maintains adequate tissue perfusion
4. Exhibits decreased anxiety
5. Adheres to a self-care program
6. Has no complications

INVASIVE CORONARY ARTERY PROCEDURES

Methods to reperfuse ischemic myocardial tissue when patients are refractory to more conservative management methods include PCIs and CABG surgery, as noted previously. The following sections discuss specific indications for each of these and the nursing management of patients who are having either PCIs or CABGs.

Percutaneous Coronary Interventions

Invasive interventional procedures to treat CAD include PTCA and intracoronary stent implantation. These procedures are classified as **percutaneous coronary interventions (PCIs),** as they are performed through a skin puncture rather than a surgical incision.

Percutaneous Transluminal Coronary Angioplasty

In **percutaneous transluminal coronary angioplasty (PTCA)**, a balloon-tipped catheter is used to open blocked coronary vessels and resolve ischemia. It is used in patients with angina and as an intervention for ACS. Catheter-based interventions can also be used to open blocked CABGs (see later discussion). The purpose of PTCA is to improve blood flow within a coronary artery by compressing the atheroma. The

procedure is attempted when the interventional cardiologist determines that PTCA can improve blood flow to the myocardium.

Chart 23-10 **HEALTH PROMOTION**

Promoting Health After Myocardial Infarction and Other Acute Coronary Syndromes

To extend and improve the quality of life, a patient who has had a myocardial infarction (MI) must make lifestyle adjustments to promote heart-healthy living. With this in mind, the nurse and patient develop a program to help achieve desired outcomes.

Making Lifestyle Modifications during Convalescence and Healing

Adaptation to an MI is an ongoing process and usually requires some modification of lifestyle. Educate patients to make the following specific modifications:

- Avoid any activity that produces chest pain, extreme dyspnea, or undue fatigue.
- Avoid extremes of heat and cold and walking against the wind.
- Lose weight, if indicated.
- Stop smoking and the use of tobacco; avoid secondhand smoke.
- Develop heart-healthy eating patterns and avoid large meals and hurrying while eating.
- Modify meals to align with the AHA dietary recommendations, the Mediterranean diet, or other recommended diets.
- Adhere to medical regimen, especially in taking medications.
- Follow recommendations that ensure that blood pressure and blood glucose are in control.
- Pursue activities that relieve and reduce stress.

Adopting an Activity Program

In addition, the patient needs to undertake a structured program of activity and exercise for long-term rehabilitation. Advise patients to:

- Engage in a regimen of physical conditioning with a gradual increase in activity duration and then a gradual increase in activity intensity.
- Enroll in a cardiac rehabilitation program.
- Walk daily, increasing distance and time as prescribed.
- Monitor pulse rate during physical activity.
- Avoid physical exercise immediately after a meal.
- Alternate activity with rest periods (some fatigue is normal and expected during convalescence).
- Participate in a daily program of exercise that develops into a program of regular exercise for a lifetime.

Managing Symptoms

The patient must learn to recognize and take appropriate action for recurrent symptoms. Make sure that patients know to do the following:

- Call 911 if chest pressure or pain (or prodromal symptoms) is not relieved in 15 minutes by taking 3 nitroglycerin tablets at 5-minute intervals.
- Contact the primary provider if any of the following occur: shortness of breath, fainting, slow or rapid heartbeat, swelling of feet and ankles.

PTCA is carried out in the cardiac catheterization laboratory. Hollow catheters called *sheaths* are inserted, usually in the femoral artery (and sometimes the radial artery), providing a conduit for other catheters. Catheters are then threaded through the femoral or radial artery, up through the aorta, and into the coronary arteries. Angiography is performed using injected radiopaque contrast agents (commonly called *dye*) to identify the location and extent of the blockage. A balloon-tipped dilation catheter is passed through the sheath and positioned over the lesion. The physician determines the catheter position by examining markers on the balloon that can be seen with fluoroscopy. When the catheter is properly positioned, the balloon is inflated with high pressure for several seconds and then deflated. The pressure compresses and often "cracks" the atheroma (see Fig. 23-7). The media and adventitia of the coronary artery are also stretched.

Several inflations with different balloon sizes may be required to achieve the goal, usually defined as an improvement in blood flow and a residual stenosis of less than 10% (Urden et al., 2019). Other measures of the success of PTCA are an increase in the artery's lumen and no clinically obvious arterial trauma. Because the blood supply to the coronary artery decreases while the balloon is inflated, the patient may complain of chest pain and the ECG may display ST-segment changes. Intracoronary stents are usually positioned in the intima of the vessel to maintain patency of the artery after the balloon is withdrawn.

If thick, deep, or concentric calcification is present, the lesion may require the use of devices such as cutting, scoring, or high pressure balloons, rotational atherectomy, orbital atherectomy and excimer lasers to prepare the lesion for stenting (Shlofmitz, Shlofmitz, & Lee, 2019).

In addition to these approaches, intravascular lithotripsy (IVL) is currently being investigated to treat calcified artery blockages with sonic pressure waves in a similar way that is used to treat kidney stones. Pulsatile sonic pressure waves are used during balloon inflation to fracture both intimal and medial calcium in the artery wall but pass through the surrounding soft vascular tissue in a safe manner. This technology is approved for use in peripheral arteries at this time. Further studies are being done to assess their efficacy in coronary arteries (Riley, Corl, & Kereiakes, 2019).

Coronary Artery Stent

After PTCA, the area that has been treated may close off partially or completely—a process called *restenosis*. The intima of the coronary artery has been injured and responds by initiating an acute inflammatory process. This process may include release of mediators that leads to vasoconstriction, clotting, and scar tissue formation. A coronary artery stent may be placed to overcome these risks. A **stent** is a metal

mesh that provides structural support to a vessel at risk of acute closure. The stent is initially positioned over the angioplasty balloon. When the balloon is inflated, the mesh expands and presses against the vessel wall, holding the artery open. The balloon is withdrawn, but the stent is left permanently in place within the artery (see Fig. 23-7). Eventually, endothelium covers the stent and it is incorporated into the vessel wall. The original stents do not contain medications and are known as bare metal stents. Some stents are coated with medications, such as sirolimus or paclitaxel, which may minimize the formation of thrombi or scar tissue within the coronary artery lesion. These drug-eluting stents (DES) have increased the success of PCI (Mishra, Edla, Tripathi, et al., 2019). Because of the risk of thrombus formation within the stent, the patient receives antiplatelet medications, usually aspirin and clopidogrel. Aspirin should be continued indefinitely and clopidogrel is continued for 1 year following stent placement (Urden et al., 2019).

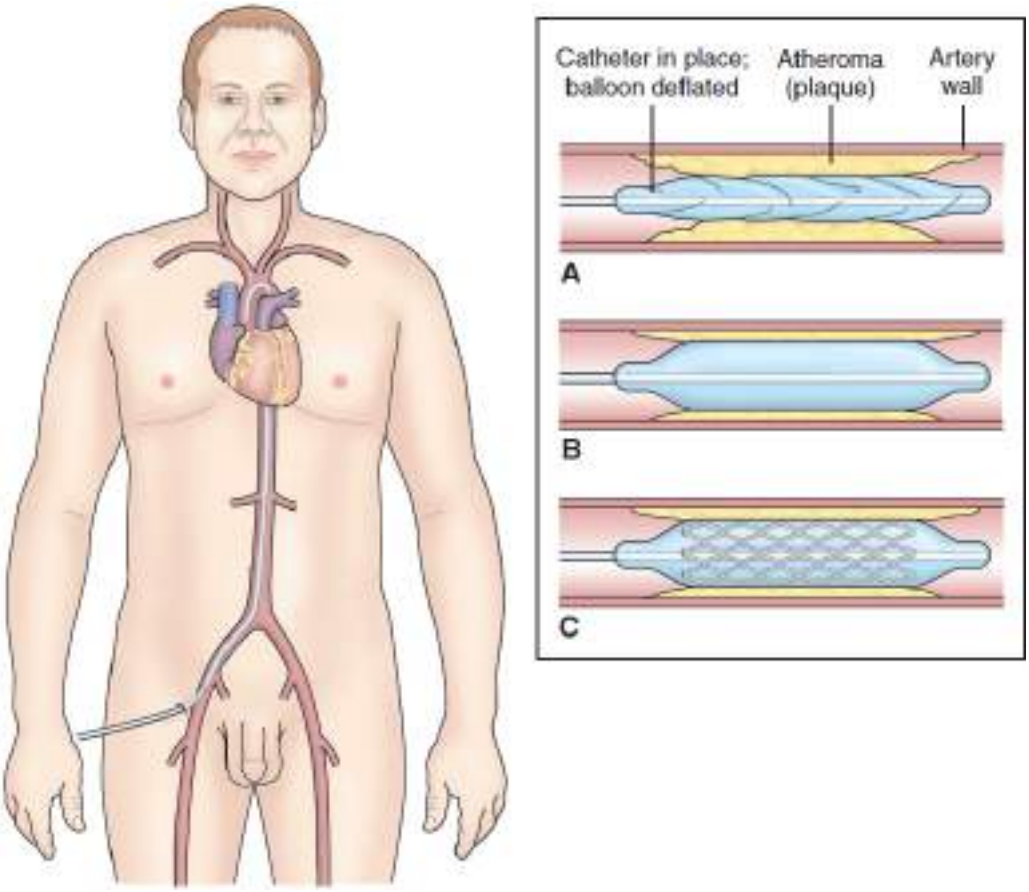

Figure 23-7 • Percutaneous transluminal coronary angioplasty. **A.** A balloon-tipped catheter is passed into the affected coronary artery and placed across the area of the atheroma (plaque). **B.** The balloon is then rapidly inflated and deflated with controlled pressure. **C.** A stent is placed to maintain patency of the artery, and the balloon is removed.

Complications

Complications that can occur during a PCI procedure include coronary artery dissection, perforation, abrupt closure, or vasospasm. Additional complications

include acute MI, serious arrhythmias (e.g., ventricular tachycardia), and cardiac arrest. Some of these complications may require emergency surgical treatment. Complications after the procedure may include abrupt closure of the coronary artery and a variety of vascular complications, such as bleeding at the insertion site, retroperitoneal bleeding, hematoma, and arterial occlusion (Urden et al., 2019). In addition, there is a risk of acute kidney injury from the contrast agent used during the procedure (see Table 23-3).

Postprocedure Care

Patient care is similar to that for a diagnostic cardiac catheterization (see Chapter 21). Patients who are not already hospitalized are admitted the day of the PCI. Those with no complications go home the same day. When the PCI is performed emergently to treat ACS, patients typically go to a critical care unit and stay in the hospital for a few days. During the PCI, patients receive IV heparin or a thrombin inhibitor (e.g., bivalirudin) and are monitored closely for signs of bleeding. Patients may also receive a GP IIb/IIIa agent (e.g., eptifibatide) for several hours following the PCI to prevent platelet aggregation and thrombus formation in the coronary artery (Urden et al., 2019). Hemostasis is achieved, and femoral sheaths may be removed at the end of the procedure by using a vascular closure device (e.g., Angio-Seal, VasoSeal) or a device that sutures the vessels. Hemostasis after sheath removal may also be achieved by direct manual pressure, a mechanical compression device (e.g., C-shaped clamp), or a pneumatic compression device (e.g., FemoStop).

Patients may return to the nursing unit with the large peripheral vascular access sheaths in place. The sheaths are then removed after blood studies (e.g., activated clotting time) indicate that the heparin is no longer active and the clotting time is within an acceptable range. This usually takes a few hours, depending on the amount of heparin given during the procedure. The patient must remain flat in bed and keep the affected leg straight until the sheaths are removed and then for a few hours afterward to maintain hemostasis. Because immobility and bed rest may cause discomfort, treatment may include analgesics and sedation. Nonpharmacologic interventions include repositioning and heat application for back pain. Sheath removal and the application of pressure on the vessel insertion site may cause the heart rate to slow and the blood pressure to decrease (vasovagal response). A dose of IV atropine is usually given to treat this response.

TABLE 23-3 Complications After Percutaneous Coronary Interventions

Complication	Clinical Manifestations	Possible Causes	Nursing Actions
Myocardial ischemia	Chest pain Ischemic changes on ECG Arrhythmias	Thrombosis Restenosis of coronary artery	Administer oxygen and nitroglycerin. Obtain 12-lead ECG. Notify cardiologist.
Bleeding and hematoma formation	Continuation of bleeding from vascular access site Swelling at site Formation of hard lump Pain with leg movement Possible hypotension and tachycardia	Anticoagulant therapy Vascular trauma Inadequate hemostasis Leg movement	Keep patient on bed rest. Apply manual pressure over sheath insertion site. Outline hematoma with marking pen. Notify primary provider if bleeding continues.
Retroperitoneal hematoma	Back, flank, or abdominal pain Hypotension Tachycardia Restlessness, agitation	Arterial leak of blood into the retroperitoneal space	Notify primary provider. Stop anticoagulants. Administer IV fluids. Anticipate diagnostic testing (e.g., computed tomography scan). Prepare patient for intervention.
Arterial occlusion	Lost/weakened pulse distal to sheath insertion site Extremity cool, cyanotic, painful	Arterial thrombus or embolus	Notify primary provider. Anticipate intervention.
Pseudoaneurysm formation	Swelling at vascular access site Pulsatile mass, bruit	Vessel trauma during the procedure	Notify primary provider. Anticipate intervention.
Arteriovenous fistula formation	Swelling at vascular access site Pulsatile mass, bruit	Vessel trauma during the procedure	Notify primary provider. Anticipate intervention.
Acute kidney injury	Decreased urine output Elevated BUN, serum creatinine	Nephrotoxic contrast agent	Monitor urine output, BUN, creatinine, electrolytes. Provide adequate hydration. Administer renal protective agents (acetylcysteine) before and after procedure as prescribed.

BUN, blood urea nitrogen; ECG, electrocardiogram; IV, intravenous.

Adapted from Urden, L. D., Stacy, K. M., & Lough, M. E. (2019). *Priorities in critical care nursing* (8th ed.). St. Louis, MO: Elsevier.

Some patients with unstable lesions and at high risk for abrupt vessel closure are restarted on heparin after sheath removal, or they receive an IV infusion of a GP IIb/IIIa inhibitor. These patients are monitored closely and may have a delayed recovery period.

After hemostasis is achieved, a pressure dressing is applied to the site. Patients resume self-care and ambulate unassisted within a few hours of the procedure. The duration of immobilization depends on the size of the sheath inserted, the type of anticoagulant given, the method of hemostasis, the patient's condition, and the physician's preference. On the day after the procedure, the site is inspected and the dressing removed. The patient is instructed to monitor the site for bleeding or development of a hard mass indicative of hematoma.

Surgical Procedures: Coronary Artery Revascularization

Advances in diagnostics, medical management, and surgical and anesthesia techniques, as well as the care provided in critical care and surgical units, home care, and rehabilitation programs, have continued to make surgery an effective treatment option for patients with CAD. CAD has been treated by myocardial revascularization since the 1960s, and the most common CABG techniques have been performed for more than 40 years. **Coronary artery bypass graft (CABG)** is a surgical procedure in which a blood vessel is grafted to an occluded coronary artery so that blood can flow beyond the occlusion; it is also called a *bypass graft.*

The major indications for CABG are:

- Alleviation of angina that cannot be controlled with medication or PCI
- Treatment for left main coronary artery stenosis or multivessel CAD
- Prevention of and treatment for MI, arrhythmias, or heart failure
- Treatment for complications from an unsuccessful PCI

The recommendation for CABG is determined by a number of factors, including the number of diseased coronary vessels, the degree of left ventricular dysfunction, the presence of other health problems, the patient's symptoms, and any previous treatment. CABG and PCI have shown similar results in outcomes, such as MI rate, mortality, and improvement of angina post-intervention. However, the requirement of a second reperfusion intervention has been shown to be lower with CABG compared to PCI therapy (Gaudino, Spadaccio, & Taggart, 2019).

CABG is performed less frequently in women (Angraal, Khera, Wang, et al., 2018). Compared with men, women referred for this surgery tend to be older and have more comorbidities such as diabetes. In addition, they have a higher risk of surgical complications and increased mortality (Angraal et al., 2018). Although some women have good outcomes following CABG, men generally have a better rate of graft patency and symptom relief.

For a patient to be considered for CABG, the coronary arteries to be bypassed must have at least a 70% occlusion, or at least a 50% occlusion in the left main coronary artery (Urden et al., 2019). If significant blockage is not present, flow

through the artery will compete with flow through the bypass, and circulation to the ischemic area of myocardium may not improve. The artery also must be patent beyond the area of blockage or the flow through the bypass will be impeded.

Current guidelines recommend use of the internal thoracic arteries (formerly called the internal mammary arteries) for CABG, because of their histologic characteristics and increased production of vasoactive molecules and anti-inflammatory cytokines which improve arterial patency. Recent studies demonstrate increased survival when using internal thoracic artery grafting. The left internal thoracic artery graft has been shown to have greater than 90% patency after 20 years and is the recommended conduit to use first (Gaudino et al., 2019). Arterial grafts are preferred to venous grafts because they do not develop atherosclerotic changes as quickly and remain patent longer. The surgeon leaves the proximal end of the thoracic artery intact and detaches the distal end of the artery from the chest wall. This end of the artery is then grafted to the coronary artery distal to the occlusion. The internal thoracic arteries may not be long enough to use for multiple bypasses. Because of this, many CABG procedures are performed with a combination of venous and arterial grafts.

A vein commonly used for CABG is the greater saphenous vein, followed by the lesser saphenous vein (see Fig. 23-8). The vein is removed from the leg and grafted to the ascending aorta and to the coronary artery distal to the lesion. Traditionally, a skin incision was made over the length of vein segment, but new techniques allow small leg incisions. Endovascular methods of vein harvesting have reduced complications such as infection and wound dehiscence, which are associated with longer leg incisions (Gaudino et al., 2019). Lower extremity edema continues to be a common adverse effect of vein removal. The degree of edema varies and usually diminishes over time. The patency of vein grafts can be limited. Within 5 to 10 years, atherosclerotic changes often develop in saphenous vein grafts.

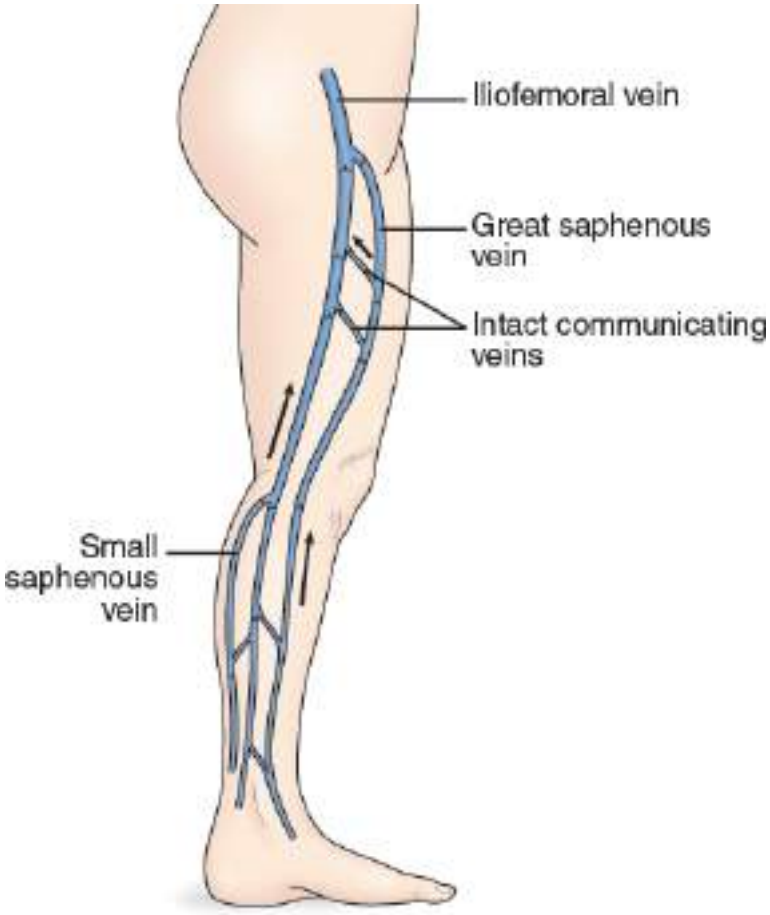

Figure 23-8 • The greater and lesser saphenous veins are commonly used in bypass graft procedures.

Traditional Coronary Artery Bypass Graft

CABG procedures are performed with the patient under general anesthesia. In the traditional CABG procedure, the surgeon performs a median sternotomy and connects the patient to the cardiopulmonary bypass (CPB) machine. Next, a blood vessel from another part of the patient's body (e.g., saphenous vein, left internal thoracic artery) is grafted distal to the coronary artery lesion, bypassing the obstruction (see Fig. 23-9). CPB is then discontinued, chest tubes and epicardial pacing wires are placed, and the incision is closed. The patient is then admitted to a critical care unit.

Cardiopulmonary Bypass

Many cardiac surgical procedures are possible because of CPB (i.e., extracorporeal circulation). The procedure mechanically circulates and oxygenates blood for the body while bypassing the heart and lungs. CPB maintains perfusion to body organs and tissues and allows the surgeon to complete the anastomoses in a motionless, bloodless surgical field.

CPB is accomplished by placing a cannula in the right atrium, vena cava, or femoral vein to withdraw blood from the body. The cannula is connected to tubing filled with an isotonic crystalloid solution. Venous blood removed from the body by the cannula is filtered, oxygenated, cooled or warmed by the machine, and then

returned to the body. The cannula used to return the oxygenated blood is usually inserted in the ascending aorta, or it may be inserted in the femoral artery (see Fig. 23-10). The heart is stopped by the injection of a potassium-rich cardioplegia solution into the coronary arteries. The patient receives heparin to prevent clotting and thrombus formation in the bypass circuit when blood comes in contact with the surfaces of the tubing. At the end of the procedure when the patient is disconnected from the bypass machine, protamine sulfate is given to reverse the effects of heparin.

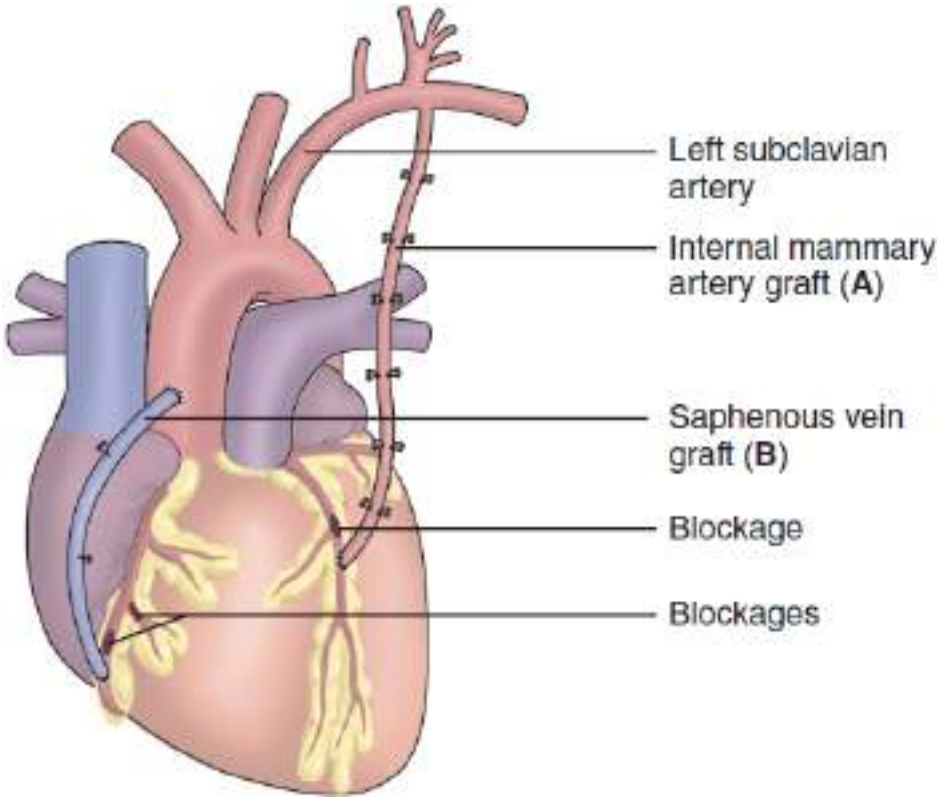

Figure 23-9 • Coronary artery bypass grafts. One or more procedures may be performed using various veins and arteries. **A.** Left internal thoracic artery (formerly called the left internal mammary artery), used frequently because of its functional longevity. **B.** Saphenous vein, also used as bypass graft.

During the procedure, hypothermia is maintained at a temperature of about 28°C (82.4°F) (Urden et al., 2019). The blood is cooled during CPB and returned to the body. The cooled blood slows the body's basal metabolic rate, thereby decreasing the demand for oxygen. Cooled blood usually has a higher viscosity, but the crystalloid solution used to prime the bypass tubing dilutes the blood. When the surgical procedure is completed, the blood is rewarmed as it passes through the CPB circuit. Urine output, arterial blood gases, electrolytes, and coagulation studies are monitored to assess the patient's status during CPB.

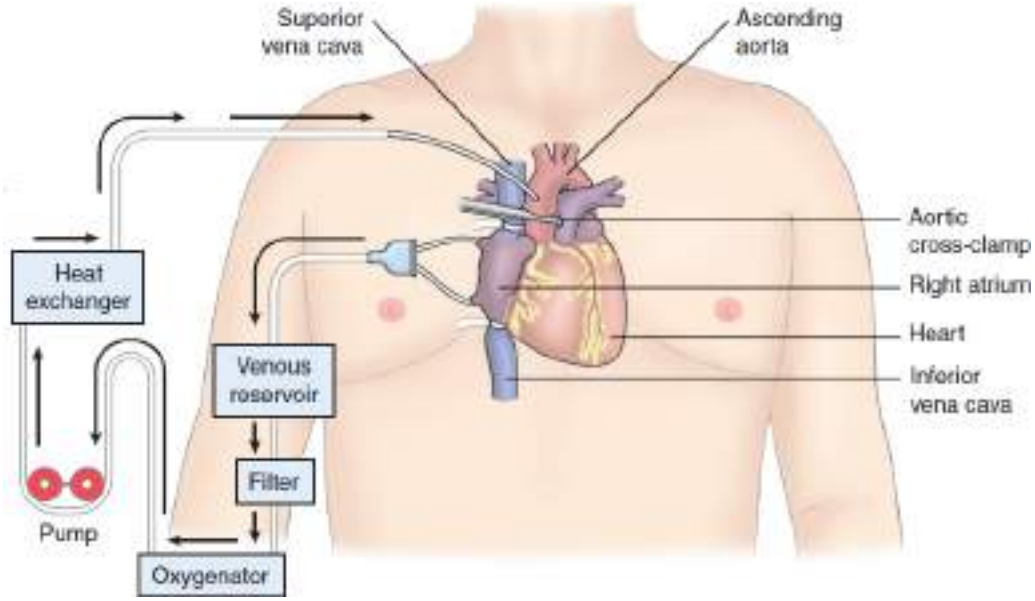

Figure 23-10 • The cardiopulmonary bypass system, in which cannulas are placed through the right atrium into the superior and inferior vena cavae to divert blood from the body and into the bypass system. The pump system creates a vacuum, pulling blood into the venous reservoir. The blood is cleared of air bubbles, clots, and particulates by the filter and then is passed through the oxygenator, releasing carbon dioxide and obtaining oxygen. Next, the blood is pulled to the pump and pushed out to the heat exchanger, where its temperature is regulated. The blood is then returned to the body via the ascending aorta.

Alternative Coronary Artery Bypass Graft Techniques

A number of alternative CABG techniques have been developed that may have fewer complications for some groups of patients. Off-pump coronary artery bypass (OPCAB) surgery has been used successfully in many patients. OPCAB involves a standard median sternotomy incision, but the surgery is performed without CPB. A beta-adrenergic blocker may be used to slow the heart rate. The surgeon also uses a myocardial stabilization device to hold the site still for the anastomosis of the bypass graft into the coronary artery while the heart continues to beat (see Fig. 23-11). Research suggests that OPCAB is associated with reduced short-term postoperative morbidity, including stroke and other complications. However, with on-pump CABG, graft patency rate is higher and long-term mortality may be lower (Gaudino et al., 2019).

Minimally invasive surgical techniques that eliminate median sternotomy have also been developed. These endoscopic techniques use smaller incisions via a right or left thoracotomy approach and a robotic system to place bypass grafts. The patient may or may not require CPB (Snyder, 2018). Minimally invasive heart surgery may be considered an acceptable alternative to conventional CABG for select patients, such as those who do not require bypass grafts to several vessels. It is most commonly used to bypass occlusions in the left anterior descending artery (Snyder, 2018). It has allowed patients to recover earlier, require fewer blood transfusions,

experience fewer respiratory complications, and be less likely to experience acute kidney injury (Urden et al., 2019).

The most important criterion when deciding whether a patient needs a CABG or a PCI is the predicted surgical mortality, which takes into consideration the patient's individual characteristics, the anatomic complexity of the coronary lesions, and the ability to achieve revascularization. The cardiac surgeon will assess the following factors to determine risk and the ability to revascularize: clinical history (age, sex, diabetes, hypertension, left ventricular function, arrhythmias), previous cardiovascular events (previous cardiovascular surgery, PCI, MI, or stroke), and disease complexity (number of diseased vessels, concomitant valve disease). In some cases, CABG may still be recommended over PCI for only one lesion to achieve better revascularization (Gaudino et al., 2019).

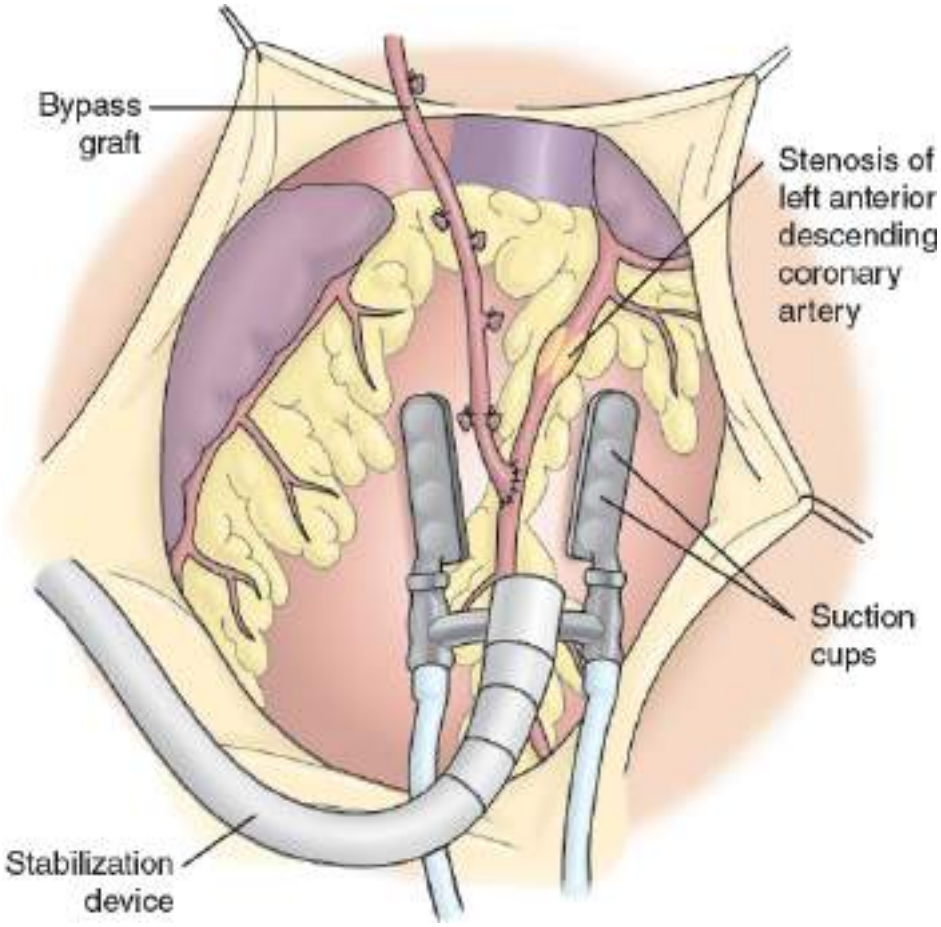

Figure 23-11 • Stabilizer device for off-pump coronary artery bypass surgery.

Complications of Coronary Artery Bypass Graft

CABG may result in complications such as hemorrhage, arrhythmias, and MI (see Table 23-4). The patient may require interventions for more than one complication at a time. Collaboration among nurses, physicians, pharmacists, respiratory therapists, and dietitians is necessary to achieve the desired patient outcomes. Although most patients improve symptomatically following surgery, CABG is not a cure for CAD,

and angina, exercise intolerance, or other symptoms experienced before CABG may recur. Medications required before surgery may need to be continued. Lifestyle modifications recommended before surgery remain important to treat the underlying CAD and for the continued viability of the newly implanted grafts.

Nursing Management

Cardiac surgery patients have many of the same needs and require the same perioperative care as other surgical patients (see Unit 3), as well as some special needs.

Preoperative Management

Comprehensive preoperative medical management prevents complications and improves outcomes. This is particularly important because patients undergoing CABG surgery tend to be older and often have multiple comorbidities. The use of aspirin, beta-blockers, and statins during the preoperative period is associated with better outcomes. Preoperative use of aspirin is associated with a reduction in perioperative morbidity and mortality (Aboul-Hassan, Stankowski, Marczak, et al., 2017). Beta-blockers, when given at least 24 hours before CABG, reduce the incidence of postoperative atrial fibrillation (Urden et al., 2019). Perioperative use of statins has been shown to reduce the rates of postoperative MI, atrial fibrillation, neurologic dysfunction, renal dysfunction, infection, and death (Katsiki, Triposkiadis, Giannoukas, et al., 2018).

Assessing the Patient

Patients are frequently admitted to the hospital the day of the procedure. Therefore, most of the preoperative evaluation is completed in the physician's office and during preadmission testing.

Nursing and medical personnel perform a history and physical examination. Preoperative testing consists of a chest x-ray; ECG; laboratory tests, including coagulation studies; and blood typing and cross-matching. The preoperative history and health assessment should be thorough and well documented because they provide a basis for postoperative comparison. The nurse assesses the patient for disorders that could complicate or affect the postoperative course, such as diabetes, hypertension, and lung disease.

TABLE 23-4 Potential Complications of Cardiac Surgery

Complication	Cause	Assessment and Management
Cardiac Complications		
Hypovolemia (most common cause of decreased cardiac output after cardiac surgery)	Net loss of blood and intravascular volume Vasodilation due to postoperative rewarming Intravascular fluid loss to the interstitial spaces because surgery and anesthesia increase capillary permeability	Arterial hypotension, tachycardia, low CVP, and low PAWP are often seen. Fluid replacement may be prescribed. Replacement fluids include colloid (albumin), packed red blood cells, or crystalloid solution (normal saline, lactated Ringer's solution).
Persistent bleeding	Cardiopulmonary bypass causes platelet dysfunction, and hypothermia alters clotting mechanisms. Surgical trauma causes tissues and blood vessels to ooze bloody drainage. Intraoperative anticoagulant (heparin) therapy. Postoperative coagulopathy may also result from liver dysfunction and depletion of clotting components.	Accurate measurement of wound bleeding and chest tube blood is essential. Drainage should not exceed 200 mL/h for the first 4–6 h. Drainage should decrease and stop within a few days, while progressing from serosanguinous to serous. Serial hemoglobin, hematocrit, and coagulation studies guide therapy. Administration of blood products: packed red blood cells, fresh frozen plasma, platelet concentrate, recombinant factor VII Protamine sulfate may be given to neutralize unfractionated heparin. Administration of desmopressin acetate (DDAVP) to enhance platelet function If bleeding persists, the patient may return to the operating room.
Cardiac tamponade	Fluid and clots accumulate in the pericardial sac, which compress the heart, preventing blood from filling the ventricles.	Signs and symptoms include arterial hypotension, tachycardia, decreased urine output, and ↑ CVP. Arterial pressure waveform may show pulsus paradoxus (decrease of >10 mm Hg systolic blood pressure during inspiration). The chest drainage system is checked to eliminate possible kinks or obstructions in the tubing. Chest x-ray may show a widening mediastinum. Bedside echocardiogram may be done to confirm tamponade. Emergency medical management is required; may include return to surgery.
Fluid overload	IV fluids and blood products increase circulating volume.	High CVP and pulmonary artery pressures, as well as crackles, indicate fluid overload. Diuretics are prescribed, and the rate of IV fluid administration is reduced.

		Alternative treatments include continuous renal replacement therapy and dialysis.
Hypothermia	Low body temperature leads to vasoconstriction, shivering, and arterial hypertension.	Patient is rewarmed gradually after surgery, decreasing vasoconstriction.
Hypertension	Results from postoperative vasoconstriction. It may stretch suture lines and cause postoperative bleeding. The condition is usually transient.	Vasodilators (nitroglycerin, nitroprusside) may be used to treat hypertension. Administer cautiously to avoid hypotension.
Tachyarrhythmias	Increased heart rate is common with perioperative volume changes. Rapid atrial fibrillation commonly occurs during the first few days postoperatively.	If a tachyarrhythmia is the primary problem, the heart rhythm is assessed and medications (e.g., amiodarone, diltiazem) may be prescribed. Antiarrhythmic agents (e.g., beta-blockers) are often given before coronary artery bypass graft to minimize the risk. Cardioversion and defibrillation are alternatives for symptomatic tachyarrhythmias.
Bradycardias	Decreased heart rate due to surgical trauma and edema affecting the cardiac conduction system	Many postoperative patients have temporary pacer wires that can be attached to an external pacemaker to stimulate the heart to beat faster. Less commonly, atropine or other medications may be used to increase heart rate.
Cardiac failure	Myocardial contractility may be decreased perioperatively.	The nurse observes for and reports signs of heart failure, including hypotension, ↑ CVP, ↑ PAWP, venous distention; labored respirations; and edema. Medical management includes diuretics and IV inotropic agents.
MI (may occur intraoperatively or postoperatively)	Portion of the cardiac muscle dies; therefore, contractility decreases. Impaired ventricular wall motion further decreases cardiac output. Symptoms may be masked by the postoperative surgical discomfort or the anesthesia–analgesia regimen.	Careful assessment to determine the type of pain the patient is experiencing; MI is suspected if the mean blood pressure is low with normal preload. Serial electrocardiograms and cardiac biomarkers assist in making the diagnosis (alterations may be due to the surgical intervention).
Pulmonary Complications		
Impaired gas exchange	During and after anesthesia, patients require mechanical assistance to breathe. Anesthetic agents stimulate production of mucus, and chest	Pulmonary complications are detected during assessment of breath sounds, oxygen saturation levels, arterial blood gases, and ventilator readings. Extended periods of mechanical ventilation may be required while

	incision pain may decrease the effectiveness of ventilation. Potential for postoperative atelectasis	complications are treated.
Neurologic Complications		
Neurologic changes; stroke	Thrombi and emboli may cause cerebral infarction, and neurologic signs may be evident when patients recover from anesthesia.	Inability to follow simple commands within 6 h of recovery from anesthetic; weakness on one side of body or other neurologic changes may indicate stroke. Patients who are older or who have renal or hepatic failure may take longer to recover from anesthesia.
Kidney Injury and Electrolyte Imbalance		
Acute kidney injury	May result from hypoperfusion of the kidneys or from injury to the renal tubules by nephrotoxic drugs	May respond to diuretics or may require continuous renal replacement therapy or dialysis. Fluids, electrolytes, and urine output are monitored frequently. May result in chronic kidney disease and require ongoing dialysis.
Electrolyte imbalance	Postoperative imbalances in potassium, magnesium, sodium, calcium, and blood glucose are related to surgical losses, metabolic changes, and the administration of medications and IV fluids.	Monitor electrolytes and basic metabolic studies frequently. Implement treatment to correct electrolyte imbalance promptly (see Chart 23-11).
Other Complications		
Hepatic failure	Surgery and anesthesia stress the liver. Most common in patients with cirrhosis, hepatitis, or prolonged right-sided heart failure.	The use of medications metabolized by the liver must be minimized. Bilirubin and albumin levels are monitored, and nutritional support is provided.
Infection	Surgery and anesthesia alter the patient's immune system. Multiple invasive devices used to monitor and support the patient's recovery may serve as a source of infection.	Monitor for signs of possible infection: body temperature, white blood cell and differential counts, incision and puncture sites, urine (clarity, color, and odor), bilateral breath sounds, sputum (color, odor, amount). Antibiotic therapy may be instituted or modified as necessary. Continuous insulin infusion to maintain blood glucose concentrations to ≤180 mg/dL while avoiding hypoglycemia may reduce the incidence of deep sternal wound infections. Invasive devices are discontinued as soon as they are no longer required. Institutional protocols for maintaining and replacing invasive lines and devices are followed to minimize the risk of infection.

↑, increased; CVP, central venous pressure; IV, intravenous; MI, myocardial infarction; PAWP, pulmonary artery wedge pressure.

Adapted from Urden, L. D., Stacy, K. M., & Lough, M. E. (2019). *Priorities in critical care nursing* (8th ed.). St. Louis, MO: Elsevier.

The health assessment focuses on obtaining baseline physiologic, psychological, and social information. Cognitive status is carefully assessed, as patients with impaired cognitive status will need more assistance after surgery and may require subacute care prior to returning home. Older adults are at a high risk for suffering adverse cognitive outcomes following cardiac surgery (Jones, Matalanis, Mårtensson, et al., 2019). The patient's and family's education needs are identified and addressed. Of particular importance are the patient's usual functional level, coping mechanisms, and available support systems. These factors affect the patient's postoperative course, discharge plans, and rehabilitation.

The status of the cardiovascular system is determined by reviewing the patient's symptoms, including past and present experiences with chest pain, palpitations, dyspnea, intermittent claudication (leg pain that occurs with walking), and peripheral edema. The patient's history of major illnesses; previous surgeries; medication; and the use of illicit and over-the-counter drugs, herbal supplements, alcohol, and tobacco is also obtained. Particular attention is paid to blood glucose control in patients with diabetes because there is a higher incidence of postoperative complications when glycemic control is poor (Gordon, Lauver, & Buck, 2018).

The psychosocial assessment and the assessment of the patient's and family's learning needs are also important. Anticipation of cardiac surgery is a source of great stress to the patient and family, and patients with high anxiety levels have poorer outcomes (Ramesh, Nayak, Pai, et al., 2017). However, some anxiety is expected, and the work of worrying can help patients identify priorities and find coping strategies that help them face the threat of surgery. Questions may be asked to obtain the following information:

- Knowledge and understanding of the surgical procedure, postoperative course, and recovery
- Fears and concerns regarding the surgery and future health status
- Coping mechanisms helpful to the patient
- Support systems available during and following hospitalization

Reducing Fear and Anxiety

The nurse gives the patient and family time and opportunity to express their fears. Topics of concern may be pain, changes in body image, fear of the unknown, and fear of disability or death. It may be helpful to describe the sensations that the patient can expect, including the preoperative sedation, surgical anesthesia, and postoperative pain management. The nurse reassures the patient that the fear of pain is normal, that some pain will be experienced, that medication to relieve pain will be provided, and that the patient will be closely monitored. In addition, the nurse instructs the patient to request analgesic medication before the pain becomes severe. If the patient has concerns about scarring from surgery, the nurse encourages them to discuss this issue and corrects any misconceptions. The patient and family may want to discuss their

fear of the patient dying. After the fear is expressed, the nurse can assure the patient and family that this fear is normal and further explore their feelings. For patients with extreme anxiety or fear and for whom emotional support and education are not successful, antianxiety medication such as lorazepam may be helpful.

Monitoring and Managing Potential Complications

Angina may occur because of increased stress and anxiety related to the forthcoming surgery. The patient who develops angina usually responds to typical therapy for angina, most commonly nitroglycerin. Some patients require oxygen and IV nitroglycerin infusions. Physiologically unstable patients may require preoperative management in a critical care unit.

Providing Patient Education

Prior to surgery, patients and their families are given specific instructions. This includes information on how the patient should take or stop specific medications, including anticoagulant agents, antihypertensive medications, and medications that control diabetes. The patient is instructed to shower with an antiseptic solution such as chlorhexidine gluconate and to apply mupirocin calcium 2% ointment to each nostril to help reduce the risk of surgical site infections (Reiser, Scherag, Forstner, et al., 2017). Cardiac surgical infections are often caused by *Staphylococcus aureus* which is found in the nasal passages. Studies have shown that decolonizing the nasal passage preoperatively is effective in reducing sternal wound infections associated with cardiac surgery (Lemaignen, Armand-Lefevre, Birgand, et al., 2018) (see Chapter 14 for further discussion of preoperative preparation).

Education also includes information about the hospitalization and surgery. The nurse informs the patient and family about the equipment, tubes, and lines that will be present after surgery and their purposes. They should expect monitors, several IV lines, chest tubes, and a urinary catheter. Explaining the purpose and the approximate time that these devices will be in place helps reassure the patient. Most patients remain intubated and on mechanical ventilation for several hours after surgery. It is important for patients to know that this will prevent them from talking, and the nurse should reassure them that the staff will be able to assist them with other means of communication.

The nurse takes care to answer the patient's questions about postoperative care and procedures. After the nurse explains deep breathing and coughing, the use of the incentive spirometer, and foot exercises, the nurse practices these procedures with the patient. The benefit of early and frequent ambulation is discussed. The family's questions at this time usually focus on the length of the surgery, who will discuss the results of the procedure with them after surgery, where to wait during the surgery, the visiting procedures for the critical care unit, and how they can support the patient before surgery and in the critical care unit.

Intraoperative Management

The perioperative nurse performs assessments and prepares the patient as described in Chapters 14 and 15. In addition to assisting with the surgical procedure, perioperative

nurses are responsible for the comfort and safety of the patient.

Possible intraoperative complications include low cardiac output, arrhythmias, hemorrhage, MI, organ failure from shock, and thromboembolic events including stroke (Urden et al., 2019). Astute intraoperative nursing assessment is critical to prevent, detect, and initiate prompt intervention for these complications. Before the chest incision is closed, chest tubes are inserted to evacuate air and drainage from the mediastinum and the thorax.

For the procedural guideline for setup and management of chest drainage systems, go to thepoint.lww.com/Brunner15e.

Temporary epicardial pacemaker electrodes may be implanted on the surface of the right atrium and the right ventricle. These epicardial electrodes can be connected to an external pacemaker if the patient has persistent bradycardia perioperatively (see Chapter 22 for a discussion of pacemakers).

Postoperative Nursing Management

Initial postoperative care focuses on achieving or maintaining hemodynamic stability and recovery from general anesthesia. Care may be provided in the postanesthesia care unit (PACU) or ICU. The immediate postoperative period for the patient who has undergone cardiac surgery presents many challenges to the health care team. All efforts are made to facilitate the transition from the operating room to the ICU or PACU with minimal risk. Specific information about the surgical procedure and important factors about postoperative management are communicated by the surgical team and anesthesia personnel to the critical care or PACU nurse, who then assumes responsibility for the patient's care. Figure 23-12 presents an overview of the many aspects of postoperative care of the cardiac surgical patient.

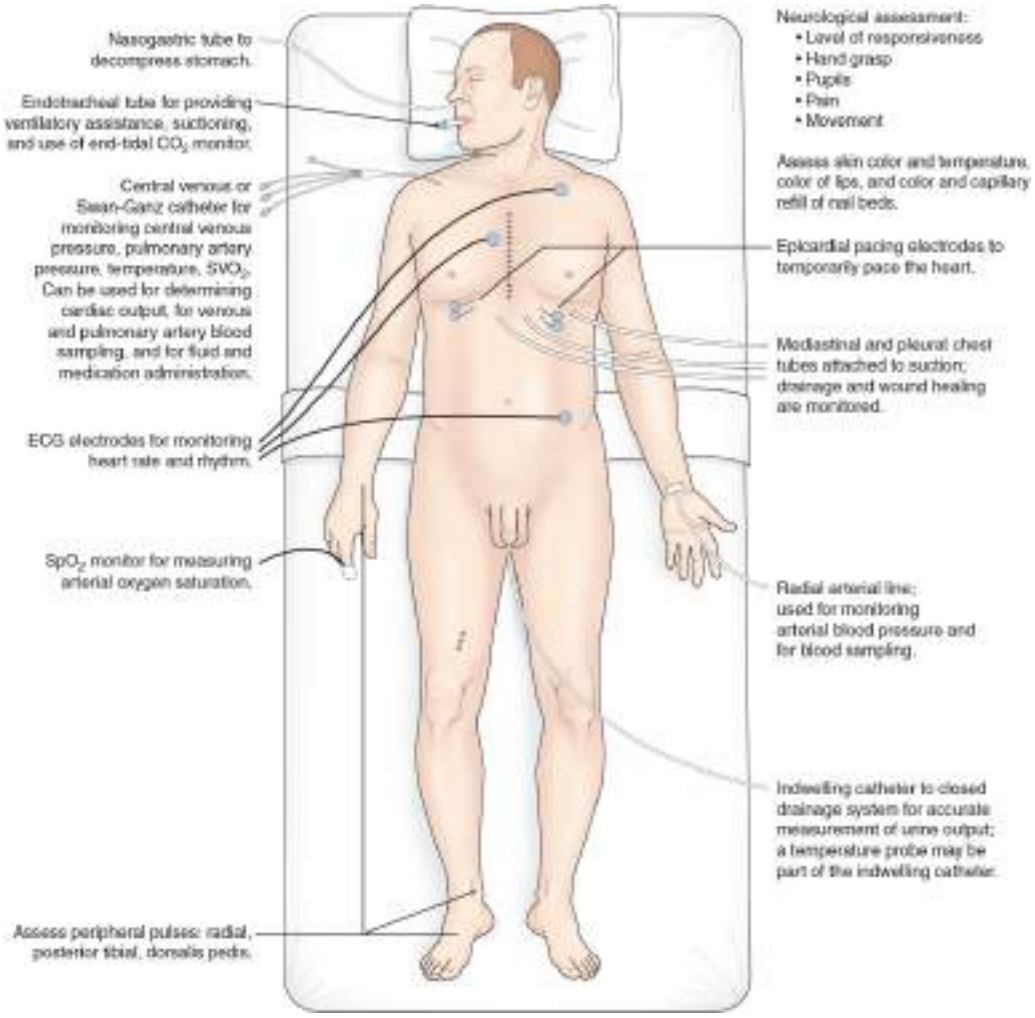

Figure 23-12 • Postoperative care of the patient who has undergone cardiac surgery requires the nurse to be proficient in interpreting hemodynamics, correlating physical assessment data with laboratory results, sequencing interventions, and evaluating progress toward desired outcomes.

After the patient's cardiac status and respiratory status are stable, the patient is transferred to a surgical progressive care unit with telemetry. Care in both the ICU and progressive care unit focuses on monitoring of cardiopulmonary status, pain management, wound care, progressive activity, and nutrition. Education about medications and risk factor modification is emphasized.

A typical plan of postoperative nursing care is presented in Chart 23-11.

Assessing the Patient

When the patient is admitted to the critical care unit or PACU, nursing and medical personnel perform a complete assessment of all systems at least every 4 hours. It is necessary to assess the following parameters:

Neurologic status: level of responsiveness, pupil size and reaction to light, facial symmetry, movement of the extremities, and hand grip strength

Cardiac status: heart rate and rhythm, heart sounds, pacemaker status, arterial blood pressure, central venous pressure (CVP); in select patients, hemodynamic

parameters: pulmonary artery pressure, pulmonary artery wedge pressure (PAWP), cardiac output and index, systemic and pulmonary vascular resistance, mixed venous oxygen saturation ($Sv–O_2$). A pulmonary artery catheter is often used to monitor these parameters. Alternatively, minimally invasive monitoring of stroke volume, systemic vascular resistance, and cardiac output are calculated through pressures obtained in the arterial line (e.g., Vigileo monitor with FloTrac sensor). (See Chapter 21 for a detailed description of hemodynamic monitoring.)

Chart 23-11 **PLAN OF NURSING CARE**

Care of the Patient After Cardiac Surgery

NURSING DIAGNOSIS: Impaired cardiac output associated with blood loss and compromised myocardial function

GOAL: Restoration of cardiac output to maintain organ and tissue perfusion

Nursing Interventions	Rationale	Expected Outcomes
1. Monitor cardiovascular status. Serial readings of blood pressure, other hemodynamic parameters, and cardiac rhythm and rate are obtained, recorded, and correlated with the patient's overall condition.	1. Effectiveness of cardiac output is evaluated by continuous monitoring.	• The following parameters are within the patient's normal ranges: • Arterial pressure • Central venous pressure (CVP) • Pulmonary artery pressures • Pulmonary artery wedge pressure (PAWP) • Heart sounds • Pulmonary and systemic vascular resistance • Cardiac output and cardiac index • Peripheral pulses • Cardiac rate and rhythm • Cardiac biomarkers • Urine output • Skin and mucosal color • Skin temperature
a. Assess arterial blood pressure every 15 minutes until stable; then arterial or cuff blood pressure every 1–4 hours × 24 hours; then every 8–12 hours until hospital discharge.	a. Blood pressure is one of the most important physiologic parameters to monitor; vasoconstriction after cardiopulmonary bypass may require treatment with an IV vasodilator.	
b. Auscultate for heart sounds and rhythm.	b. Auscultation provides evidence of pericarditis (precordial rub), arrhythmias.	
c. Assess peripheral pulses (pedal, tibial, radial).	c. Presence or absence and quality of pulses provide data about cardiac output as well as obstructive lesions.	
d. Monitor hemodynamic parameters to assess cardiac output, volume status, and vascular tone.	d. Rising CVP and PAWP may indicate congestive heart failure or pulmonary edema. Low pressures may indicate need	• <200 mL/h of drainage through chest tubes during first 4–6 hours • Vital signs stable • CVP and other hemodynamic parameters within normal limits

e. Watch for trends in hemodynamics, and note that mechanical ventilation may alter hemodynamics. f. Monitor electrocardiogram (ECG) pattern for cardiac arrhythmias and ischemic changes. g. Assess cardiac biomarker results. h. Measure urine output every ½ to 1 hour at first, then with vital signs. i. Observe buccal mucosa, nail beds, lips, earlobes, and extremities. j. Assess skin; note temperature and color. 2. Observe for persistent bleeding: excessive chest tube drainage of blood; hypotension; low CVP; tachycardia. Prepare to	for volume replacement. e. Trends are more important than isolated readings. Mechanical ventilation increases intrathoracic pressure. f. Arrhythmias may occur with coronary ischemia, hypoxia, bleeding, and acid–base or electrolyte disturbances. ST-segment changes may indicate myocardial ischemia. Pacemaker capture and antiarrhythmic medications are used to maintain heart rate and rhythm and to support blood pressure. g. Elevations may indicate myocardial infarction. h. Urine output <0.5 mL/kg/h indicates decreased renal perfusion and may reflect decreased cardiac output. i. Duskiness and cyanosis may indicate decreased cardiac output. j. Cool moist skin indicates vasoconstriction and decreased cardiac output.	• Urinary output within normal limits • Skin color normal • Respirations unlabored, clear breath sounds • Pain limited to incision

administer blood products, IV fluids. 3. Observe for cardiac tamponade: hypotension; rising CVP and PAWP, pulsus paradoxus; jugular vein distention; decreasing urinary output. Check for diminished amount of blood in chest drainage collection system. Prepare for reoperation. 4. Observe for signs of cardiac failure. Prepare to administer diuretics, IV inotropic agents.	2. Bleeding can result from surgical trauma to tissues, anticoagulant medications, and clotting defects. 3. Cardiac tamponade results from bleeding into the pericardial sac or accumulation of fluid in the sac, which compresses the heart and prevents adequate filling of the ventricles. Decrease in chest drainage may indicate that fluid and clots are accumulating in the pericardial sac. 4. Cardiac failure results from decreased pumping action of the heart; can cause deficient perfusion to vital organs.	

NURSING DIAGNOSIS: Impaired gas exchange associated with chest surgery
GOAL: Adequate gas exchange

Nursing Interventions	Rationale	Expected Outcomes
1. Maintain mechanical ventilation until the patient is able to breathe independently. 2. Monitor ABGs, tidal volume, peak inspiratory pressure, and extubation parameters.	1. Ventilatory support is used to decrease work of the heart, to maintain effective ventilation, and to provide an airway in the event of complications. 2. ABGs and ventilator parameters indicate effectiveness of ventilator and changes that need to be made to improve gas exchange.	• Airway patent • Arterial blood gases (ABGs) within normal range • Endotracheal tube correctly placed, as evidenced by x-ray • Breath sounds clear bilaterally • Ventilator synchronous with respirations • Breath sounds clear after

3. Auscultate chest for breath sounds.	3. Crackles indicate pulmonary congestion; decreased or absent breath sounds may indicate pneumothorax, hemothorax, dislodgement of tube.	suctioning/coughing • Nail beds and mucous membranes pink • Mental acuity consistent with amount of sedatives and analgesics received • Oriented to person; able to respond "yes" and "no" appropriately • Able to be weaned successfully from ventilator
4. Sedate patient adequately, as prescribed, and monitor respiratory rate and depth.	4. Sedation helps the patient to tolerate the endotracheal tube and to cope with mechanical ventilation.	
5. Suction tracheobronchial secretions as needed, using strict aseptic technique.	5. Retention of secretions leads to hypoxia and possible infection.	
6. Assist in weaning and endotracheal tube removal.	6. Extubation decreases risk of pulmonary infections and enhances ability of patient to communicate.	
7. After extubation, promote deep breathing, coughing, and turning. Encourage the use of the incentive spirometer and compliance with breathing treatments. Instruct about incisional splinting with a "cough pillow" to decrease discomfort.	7. Aids in keeping airway patent, preventing atelectasis, and facilitating lung expansion	

NURSING DIAGNOSIS: Risk for hypovolaemia or hypervolaemia and electrolyte imbalance associated with alterations in blood volume
GOAL: Fluid and electrolyte balance

Nursing Interventions	Rationale	Expected Outcomes
1. Monitor fluid and electrolyte balance. a. Accurately document intake	1. Adequate circulating blood volume is necessary for optimal cellular activity; fluid and electrolyte	• Fluid intake and output balanced • Hemodynamic assessment

and output; record urine volume every half hour to 4 hours while in critical care unit; then every 8–12 hours while hospitalized. b. Assess blood pressure, hemodynamic parameters, weight, electrolytes, hematocrit, jugular venous pressure, breath sounds, urinary output, and nasogastric tube drainage. c. Measure postoperative chest drainage; cessation of drainage may indicate kinked or blocked chest tube. Ensure patency and integrity of the drainage system. d. Weigh daily and correlate with intake and output.	imbalance can occur after surgery. a. Provides a method to determine positive or negative fluid balance and fluid requirements b. Provides information about state of hydration c. Excessive blood loss from chest cavity can cause hypovolemia. d. Indicator of fluid balance	parameters negative for fluid overload or hypovolemia • Normal blood pressure with position changes • Absence of arrhythmia • Stable weight • Arterial blood pH 7.35–7.45 • Serum potassium 3.5–5.0 mEq/L (3.5–5.0 mmol/L) • Serum magnesium 1.8–2.6 mg/dL (0.74–1.07 mmol/L) • Serum sodium 135–145 mEq/L (135–145 mmol/L) • Serum calcium 8.8–10.4 mg/dL (2.2–2.6 mmol/L) • Serum glucose ≤180 mg/dL
2. Be alert to changes in serum electrolyte levels. a. Hypokalemia (low potassium) *Effects:* Arrhythmias: premature ventricular contractions, ventricular tachycardia. Observe for	2. A specific concentration of electrolytes is necessary in both extracellular and intracellular body fluids to sustain life. a. *Causes:* Inadequate intake, diuretics, vomiting, excessive nasogastric drainage,	

	specific ECG changes. Administer IV potassium replacement as prescribed.	perioperative stress response
b.	Hyperkalemia (high potassium) *Effects:* ECG changes, tall peaked T waves, wide QRS, bradycardia. Be prepared to administer diuretic or an ion-exchange resin (sodium polystyrene sulfonate); or IV insulin and glucose.	b. *Causes:* Increased intake, hemolysis from cardiopulmonary bypass/mechanical assist devices, acidosis, renal insufficiency. The resin binds potassium and promotes intestinal excretion of it. Insulin assists the cells with glucose and potassium absorption.
c.	Monitor serum magnesium, sodium, and calcium.	c. Low levels of magnesium are associated with arrhythmias. Low levels of sodium are associated with weakness and neurologic symptoms. Low levels of calcium can lead to arrhythmias and muscle spasm.
d.	Hyperglycemia (high blood glucose) *Effects:* Increased urine output, thirst, impaired healing. Administer insulin as prescribed.	d. *Cause:* Stress response to surgery. Affects both patients with diabetes and those without diabetes.

NURSING DIAGNOSIS: Risk for acute confusion associated with alteration in sleep–wake cycle, impaired metabolic functioning, use of multiple medications
GOAL: Prevention of acute confusion/postcardiotomy delirium

Nursing Interventions	Rationale	Expected Outcomes
1. Use measures to prevent postcardiotomy delirium: a. Explain all procedures and the need for patient cooperation. b. Plan nursing care to provide for periods of uninterrupted sleep with patient's normal day–night pattern. c. Promote continuity of care. d. Orient to time and place frequently. Encourage family to visit. e. Assess for medications that may contribute to delirium. 2. Observe for perceptual distortions, hallucinations, disorientation, and paranoid delusions.	1. Postcardiotomy delirium may result from alterations in sleep–wake cycle, impaired metabolic functioning, and use of multiple medications. Normally, sleep cycles are at least 50 minutes long. The first cycle may be as long as 90–120 minutes and then shorten during successive cycles. Sleep deprivation results when the sleep cycles are interrupted or are inadequate in number. 2. Delirium can indicate a serious medical condition such as hypoxia, acid–base imbalance, metabolic abnormalities, and cerebral infarction.	• Cooperates with procedures • Sleeps for long, uninterrupted intervals • Oriented to person, place, time • Experiences no perceptual distortions, hallucinations, disorientation, delusions

NURSING DIAGNOSIS: Acute pain associated with surgical trauma and pleural irritation caused by chest tubes
GOAL: Relief of pain

Nursing Interventions	Rationale	Expected Outcomes

1. Record nature, type, location, intensity, and duration of pain. 2. Encourage routine pain medication dosing for the first 24–72 hours, and observe for side effects of lethargy, hypotension, tachycardia, respiratory depression.	1. Pain and anxiety increase pulse rate, oxygen consumption, and cardiac workload. 2. Analgesia promotes rest, decreases oxygen consumption caused by pain, and aids patient in performing deep-breathing and coughing exercises; pain medication is more effective when taken before pain is severe.	• States pain is decreasing in severity • Restlessness decreased • Vital signs stable • Participates in deep-breathing and coughing exercises • Verbalizes fewer complaints of pain each day • Positions self; participates in care activities • Gradually increases activity

NURSING DIAGNOSIS: Risk for impaired cardiac function associated with alterations in afterload that may compromise renal perfusion
GOAL: Maintenance of adequate cardiac output and renal perfusion

Nursing Interventions	Rationale	Expected Outcomes
1. Assess renal function: a. Measure urine output every half hour to 4 hours in critical care, then every 8–12 hours until hospital discharge. b. Monitor and report lab results: BUN, serum creatinine, serum electrolytes.	1. Renal injury can be caused by deficient perfusion, hemolysis, low cardiac output, and the use of vasopressor agents to increase blood pressure. a. <0.5 mL/kg/h indicates decreased renal function. b. These tests indicate the kidneys' ability to excrete waste products. 2. These agents promote renal function and increase cardiac output and renal blood flow. 3. Provides patient with the opportunity to ask questions and prepare for the procedure	• Urine output consistent with fluid intake; >0.5 mL/kg/h • Urine specific gravity 1.005–1.030 • Blood urea nitrogen (BUN), creatinine, electrolytes within normal limits

2. Prepare to administer rapid-acting diuretics or inotropic drugs (e.g., dobutamine). 3. Prepare patient for dialysis or continuous renal replacement therapy if indicated.		
NURSING DIAGNOSIS: Impaired thermoregulation associated with infection or postpericardiotomy syndrome **GOAL:** Maintenance of normal body temperature		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Assess temperature every hour. 2. Use aseptic technique when changing dressings, suctioning endotracheal tube; maintain closed systems for all IV and arterial lines and for indwelling urinary catheter. 3. Observe for symptoms of postpericardiotomy syndrome. 4. Obtain cultures and other lab work (CBC, ESR); administer antibiotic agents as prescribed. 5. Administer anti-inflammatory agents as directed.	1. Fever can indicate infectious or inflammatory process. 2. Decreases risk of infection 3. Occurs in 10% of patients after cardiac surgery. 4. Antibiotic agents treat documented infection. 5. Anti-inflammatory agents relieve symptoms of inflammation.	• Normal body temperature • Incisions are free of infection and are healing. • Absence of symptoms of postpericardiotomy syndrome: fever, malaise, pericardial effusion, pericardial friction rub, arthralgia
NURSING DIAGNOSIS: Lack of knowledge about self-care activities **GOAL:** Ability to perform self-care activities		

Nursing Interventions	Rationale	Expected Outcomes
1. Develop education plan for patient and family. Provide specific instructions for the following: • Diet and daily weights • Activity progression • Exercise • Deep breathing, coughing, lung expansion exercises • Temperature and pulse monitoring • Medication regimen • Incision care • Access to the emergency medical system	1. Each patient has unique learning needs.	• Patient and family members explain and comply with therapeutic regimen. • Patient and family members identify necessary lifestyle changes. • Has copy of discharge instructions (in the patient's primary language and at appropriate reading level; has an alternate format if indicated) • Keeps follow-up appointments
2. Provide verbal and written instructions; provide several education sessions for reinforcement and answering questions.	2. Repetition promotes learning by allowing for questions and clarification of misinformation.	
3. Involve family in education sessions.	3. Family members responsible for home care are usually anxious and require adequate time for learning. 4. Arrangements for contacts with health care personnel help to allay anxieties.	
4. Provide contact information for surgeon and	5. Learning, recovery, and lifestyle changes continue after discharge from the hospital.	

cardiologist and instructions about follow-up visit with surgeon.

5. Make appropriate referrals: home care agency, cardiac rehabilitation program, community support groups.

Respiratory status: chest movement, breath sounds, ventilator settings (e.g., rate, tidal volume, oxygen concentration, mode such as assist-control, positive end-expiratory pressure, pressure support), respiratory rate, peak inspiratory pressure, percutaneous oxygen saturation (SpO_2), end-tidal carbon dioxide (CO_2), pleural chest tube drainage, arterial blood gases. (See Chapters 17 and 19 for detailed descriptions of respiratory assessment and ventilatory management, respectively.)

Peripheral vascular status: peripheral pulses; color of skin, nail beds, mucosa, lips, and earlobes; skin temperature; edema; condition of dressings and invasive lines

Renal function: urinary output; serum creatinine and electrolytes

Fluid and electrolyte status: strict intake and output, including all IV fluids and blood products, output from all drainage tubes; clinical and laboratory indicators of imbalance

Pain: nature, type, location, and duration; apprehension; response to analgesics

Assessment also includes checking all equipment and tubes to ensure that they are functioning properly: endotracheal tube, ventilator, end-tidal CO_2 monitor, SpO_2 monitor, pulmonary artery catheter, $Sv–O_2$ monitor, arterial and IV lines, IV infusion devices and tubing, cardiac monitor, pacemaker, chest tubes, and urinary drainage system.

As the patient regains consciousness and progresses through the postoperative period, the nurse also assesses indicators of psychological and emotional status. The patient may exhibit behavior that reflects denial or depression or may experience postoperative delirium. Characteristic signs of delirium include transient perceptual illusions, visual and auditory hallucinations, disorientation, and paranoid delusions. Patients who have delirium after cardiac surgery have poorer outcomes than do similar patients without this complication (Jones et al., 2019).

The family's needs also must be assessed. The nurse ascertains how family members are coping with the situation; determines their psychological, emotional, and spiritual needs; and finds out whether they are receiving adequate information about the patient's condition.

Monitoring for Complications

The patient is continuously assessed for impending complications (see Table 23-4). The nurse and the surgical team function collaboratively to prevent complications, to

identify early signs and symptoms of complications, and to institute measures to reverse their progression.

Decreased Cardiac Output

A decrease in cardiac output is always a threat to the patient who has had cardiac surgery, and it can have a variety of causes. Preload alterations occur when too little blood volume returns to the heart as a result of persistent bleeding and hypovolemia. Excessive postoperative bleeding can lead to decreased intravascular volume, hypotension, and low cardiac output. Bleeding problems are common after cardiac surgery because of the effects of CPB, trauma from the surgery, and anticoagulation. Preload can also decrease if there is a collection of fluid and blood in the pericardium (cardiac tamponade), which impedes cardiac filling. Cardiac output is also altered if too much volume returns to the heart, causing fluid overload.

Afterload alterations occur when the arteries are constricted as a result of postoperative hypertension or hypothermia, increasing the workload of the heart. Heart rate alterations from bradycardia, tachycardia, and arrhythmias can lead to decreased cardiac output, and contractility can be altered in cardiac failure, MI, electrolyte imbalances, and hypoxia.

Fluid Volume and Electrolyte Imbalance

Fluid and electrolyte imbalance may occur after cardiac surgery. Nursing assessment for these complications includes monitoring of intake and output, weight, hemodynamic parameters, hematocrit levels, neck vein distention, edema, breath sounds (e.g., fine crackles, wheezing), and electrolyte levels. The nurse reports changes in serum electrolytes promptly so that treatment can be instituted. Especially important are dangerously high or dangerously low levels of potassium, magnesium, sodium, and calcium. Elevated blood glucose levels are common in the postoperative period. Administration of IV insulin is recommended in patients both with and without diabetes to achieve the glycemic control necessary to promote wound healing, decrease infection, and improve survival after surgery (Gordon et al., 2018). Implementing an insulin infusion protocol that targets moderate glycemic control has been demonstrated as effective in treating acute hyperglycemia following cardiac surgery while also decreasing the incidence of hypoglycemia (Gordon et al., 2018).

Impaired Gas Exchange

Impaired gas exchange is another possible complication after cardiac surgery. All body tissues require an adequate supply of oxygen for survival. To achieve this after surgery, an endotracheal tube with ventilator assistance may be used for hours to days. The assisted ventilation is continued until the patient's blood gas values are acceptable and the patient demonstrates the ability to breathe independently. Patients who are stable after surgery may be extubated as early as 2 to 4 hours after surgery, which reduces their discomfort and anxiety and facilitates patient–nurse communication.

While receiving mechanical ventilation, the patient is continuously assessed for signs of impaired gas exchange: restlessness, anxiety, cyanosis of mucous membranes and peripheral tissues, tachycardia, and fighting the ventilator. Breath sounds are assessed often to detect pulmonary congestion and monitor lung expansion. Arterial blood gases, SpO_2, and end-tidal CO_2 are assessed for decreased oxygen and

increased CO_2. Following extubation, aggressive pulmonary interventions such as turning, coughing, deep breathing, and early ambulation are necessary to prevent atelectasis and pneumonia.

Impaired Cerebral Circulation

Hypoperfusion or microemboli during or following cardiac surgery may produce injury to the brain. Brain function depends on a continuous supply of oxygenated blood. The brain does not have the capacity to store oxygen and must rely on adequate continuous perfusion by the heart. The nurse observes the patient for signs and symptoms of cerebral hypoxia: restlessness, confusion, dyspnea, hypotension, and cyanosis. An assessment of the patient's neurologic status includes the level of consciousness, response to verbal commands and painful stimuli, pupil size and reaction to light, facial symmetry, movement of the extremities, and hand grip strength. The nurse documents any indication of a change in status and reports abnormal findings to the surgeon because they may signal the onset of a complication such as a stroke.

Maintaining Cardiac Output

Ongoing evaluation of the patient's cardiac status continues as the nurse monitors the effectiveness of cardiac output through clinical observations and routine measurements: serial readings of blood pressure, heart rate, CVP, arterial pressure, and pulmonary artery pressures.

Renal function is related to cardiac function, as blood pressure and cardiac output drive glomerular filtration; therefore, urinary output is measured and recorded. Urine output less than 0.5 mL/kg/h may indicate a decrease in cardiac output or inadequate fluid volume.

Body tissues depend on adequate cardiac output to provide a continuous supply of oxygenated blood to meet the changing demands of the organs and body systems. Because the buccal mucosa, nail beds, lips, and earlobes are sites with rich capillary beds, they are observed for cyanosis or duskiness as possible signs of reduced cardiac output. Distention of the neck veins when the head of the bed is elevated to 30 degrees or more may signal right-sided heart failure.

Arrhythmias may develop due to decreased perfusion to or irritation of the myocardium from surgery. The most common arrhythmias encountered during the postoperative period are atrial fibrillation, bradycardias, tachycardias, and ectopic beats (Urden et al., 2019). Continuous observation of the cardiac monitor for arrhythmias is essential.

The nurse reports any indications of decreased cardiac output promptly. The assessment data are used to determine the cause of the problem. After a diagnosis has been made, the primary provider and the nurse work collaboratively to restore cardiac output and prevent further complications. When indicated, blood components; fluids; and antiarrhythmics, diuretics, vasodilators, or vasopressors are prescribed. If additional interventions are necessary, such as the placement of an intra-aortic balloon pump, the patient and family are prepared for the procedure.

Promoting Adequate Gas Exchange

To ensure adequate gas exchange, the patency of the endotracheal tube is assessed and maintained. The tube must be secured to prevent it from slipping out or down into the right mainstem bronchus. Suctioning is necessary when crackles or coughing is present.

For the procedural guideline for performing tracheal suction, go to thepoint.lww.com/Brunner15e.

Arterial blood gas determinations are compared with baseline data, and changes are reported to the primary provider promptly.

When the patient's hemodynamic parameters stabilize, body position is changed every 1 to 2 hours. Frequent changes of patient position provide for optimal pulmonary ventilation and perfusion, allowing the lungs to expand more fully.

Physical assessment and arterial blood gas results guide the process of weaning the patient from the ventilator. The nurse assists with the weaning process and eventually with the removal of the endotracheal tube. After extubation, the nurse encourages deep breathing and coughing at least every 1 to 2 hours to clear secretions, open the alveolar sacs, and promote effective ventilation. See Chapter 19 for discussion of weaning the patient from the ventilator.

Maintaining Fluid and Electrolyte Balance

To promote fluid and electrolyte balance, the nurse carefully assesses the intake and output to determine positive or negative fluid balance. It is necessary to record all fluid intake, including IV, nasogastric tube, and oral fluids, as well as all output, including urine, nasogastric drainage, and chest drainage.

Hemodynamic parameters (e.g., blood pressure, CVP, cardiac output) are correlated with intake, output, and weight to determine the adequacy of hydration and cardiac output. Serum electrolytes are monitored, and the patient is observed for signs of potassium, magnesium, sodium, or calcium imbalance (see Chapter 10).

Indications of dehydration, fluid overload, or electrolyte imbalance are reported promptly, and the primary provider and nurse work collaboratively to restore fluid and electrolyte balance and monitor the patient's response to therapies.

Minimizing Confusion

Some patients exhibit abnormal behaviors and acute confusion that occur with varying intensity and duration. The risk of delirium is high in patients who have undergone cardiac surgery and increases with patients' age (Jones et al., 2019; Smulter, Lingehall, Gustafson, et al., 2019; see the Nursing Research Profile in Chart 23-12). Clinical manifestations of postoperative delirium include restlessness, agitation, visual and auditory hallucinations, and paranoia. The delirium typically appears after a 2- to 5-day stay in an ICU. Patients are assessed for this problem with tools such as the Confusion Assessment Method for the ICU (CAM-ICU) (Price,

Garvan, Hizel, et al., 2017) (see Chapter 8, Chart 8-7, for discussion of CAM). The CAMU-ICU scale assesses for key indicators of delirium such as disorganized thinking and inattention. When this testing is positive, further assessment of the patient's physiologic and psychological status is required. Presumed causes of postoperative delirium include anxiety, sleep deprivation, increased sensory input, medications, and physiologic problems such as hypoxemia and metabolic imbalance (Blair, Mehmood, Rudnick, et al., 2019). Treatment includes correction of identified physiologic problems such as metabolic and electrolyte imbalances. In addition, behavioral interventions are used (e.g., frequent reorientation). Sedative medications such as haloperidol were once thought to reduce agitation and improve survival, but recent studies note that use of haloperidol causes oversedation and does not reliably treat or prevent delirium (Blair et al., 2019). The delirium often resolves after the patient is transferred from the unit, but nonetheless can be associated with negative outcomes including cognitive and functional decline, longer lengths of hospital stay, and higher mortality (Delaney, Hammond, & Litton, 2018).

Chart 23-12 **NURSING RESEARCH PROFILE**

Use of a Postoperative Delirium Screening Scale in Older Adults After Cardiac Surgery

Smulter, N., Lingehall, H. C., Gustafson, Y., et al. (2019). The use of a screening scale improves the recognition of delirium in older patients after cardiac surgery: A retrospective observational study. *Journal of Clinical Nursing, 28*(11-12), 2309–2318.

Purpose

Postoperative delirium (POD) is a frequent occurrence in older patients undergoing cardiac surgery. However, it is often not recognized by health care providers and therefore may go undiagnosed. The purpose of this study was to assess whether the use of a delirium screening tool by nurses postoperatively will improve the recognition and diagnosis of POD.

Design

This study was a retrospective observational analysis. Seventy eight patients aged 70 and older who had cardiac surgery were diagnosed with POD. Nurses used the Nursing Delirium Screening Scale (Nu-DESC) to screen for delirium symptoms. This scale uses five items to assess for delirium: disorientation, inappropriate behavior, inappropriate communication, illusions and hallucinations, and psychomotor retardation. Each item is graded from 0 to 2 with a maximum score of 10. A Nu-DESC score of 2 or greater is thought to indicate the presence of delirium. The screening was conducted three times daily, beginning post-op day 1 through discharge.

Data describing the incidence and nature of POD from the clinical database and discharge summaries were retrospectively collected. This information was compared to the results of symptom screening using the Nu-DESC.

Findings

POD was correctly identified in 41 of 78 (52.6%) patients. “Inappropriate behavior” was the most common descriptor used by nurses and physicians within discharge summaries. Terminology like “confused,” “aggressive/restless,” and “disoriented” were commonly used to describe delirium symptoms. The cause and specific treatment of delirium was not addressed within the discharge summaries

Screening using the Nu-DESC identified 56 of 78 (72%) patients with POD. Use of the Nu-DESC showed greater sensitivity in identifying symptoms of delirium than the information documented within the discharge summaries and database.

Nursing Implications

Delirium is a serious complication that is underdiagnosed in patients after cardiac surgery and, when present, not well documented. Use of a validated screening scale, such as the Nu-DESC, can improve the ability of nurses to recognize delirium in postoperative patients.

For all postoperative patients, basic comfort measures are used in conjunction with prescribed analgesics and sedatives to promote rest. Invasive lines and tubes are discontinued as soon as possible. Patient care is coordinated to provide undisturbed periods of rest. As the patient’s condition stabilizes and the patient is disturbed less frequently for monitoring and therapeutic procedures, rest periods can be extended.

Uninterrupted sleep is provided as much as possible, especially during the patient's normal hours of sleep.

Careful explanations of all procedures and of the patient's role in facilitating them help keep the patient positively involved throughout the postoperative course. Continuity of care is desirable; a familiar face and a nursing staff with a consistent approach help the patient feel safe. The patient's family should be welcomed at the bedside. A well-designed and individualized plan of nursing care can assist the nursing team in coordinating its efforts for the emotional well-being of the patient.

Relieving Pain

Patients who have had cardiac surgery may have pain in the peri-incisional area or throughout the chest, shoulders, and back. Pain results from trauma to the chest wall and irritation of the pleura by the chest tubes as well as incisional pain from peripheral vein or artery graft harvest sites.

The nurse assesses patients for verbal and nonverbal indicators of pain and records the nature, type, location, and duration of the pain. To reduce the amount of pain, the nurse encourages the patient to accept medication on a regular basis. The addition of adjunctive pain relievers (anti-inflammatory agents, muscle relaxants) to opioids decreases the amount of opioids required for pain relief and increases patient comfort. Patients report the most pain during coughing, turning, and moving. Physical support of the incision with a folded bath blanket or small pillow during deep breathing and coughing helps minimize pain. The patient should then be able to participate in respiratory exercises and to progressively increase self-care. Patient comfort improves after removal of the chest tubes.

Pain produces distress, which may stimulate the central nervous system to release catecholamines, resulting in constriction of the arterioles and increased heart rate. This can cause increased afterload and decreased cardiac output. Opioids alleviate pain and induce sleep and feelings of well-being, which reduce the metabolic rate and oxygen demands. After the administration of opioids, it is necessary to document observations indicating relief of apprehension and pain in the patient's record. The nurse observes the patient for any adverse effects of opioids, including respiratory depression, hypotension, constipation, ileus, or urinary retention. If respiratory depression occurs, an opioid antagonist (e.g., naloxone) may be required (see Chapter 9 for further discussion of nonpharmacologic pain interventions).

Maintaining Adequate Tissue Perfusion

The nurse routinely palpates peripheral pulses (e.g., pedal, tibial, femoral, radial, brachial) to assess for arterial obstruction. If a pulse is absent in any extremity, the cause may be prior catheterization of that extremity, chronic peripheral vascular disease, or a thromboembolic obstruction. The nurse immediately reports newly identified absence of any pulse.

Thromboembolic events can result from vascular injury, dislodgment of a clot from a damaged valve, loosening of mural thrombi, or coagulation problems. Air embolism can result from CPB or central venous cannulation. Symptoms of embolization vary according to site. The usual embolic sites are the lungs, coronary arteries, mesentery, spleen, extremities, kidneys, and brain. The patient is observed for the onset of the following:

- Acute onset of chest pain and respiratory distress, as occur in pulmonary embolus or MI
- Abdominal or back pain, as occur in mesenteric emboli
- Pain, cessation of pulses, blanching, numbness, or coldness in an extremity
- One-sided weakness and pupillary changes, as occur in stroke

The nurse promptly reports any of these symptoms.

Venous stasis, which can cause venous thromboembolism (e.g., deep vein thrombosis, pulmonary embolism), may occur after surgery. It can be prevented by using the following measures:

- Apply sequential pneumatic compression devices as prescribed.
- Discourage crossing of legs.
- Avoid elevating the knees on the bed.
- Omit pillows in the popliteal space.
- Begin passive exercises followed by active exercises to promote circulation and prevent venous stasis.

Inadequate renal perfusion can occur as a complication of cardiac surgery. One possible cause is low cardiac output. Trauma to blood cells during CPB can cause hemolysis of red blood cells, which then occlude the renal glomeruli. The use of vasopressor agents to increase blood pressure may constrict the renal arterioles and reduce blood flow to the kidneys.

Nursing management includes accurate measurement of urine output. An output less than 0.5 mL/kg/h may indicate hypovolemia or renal insufficiency. The primary provider may prescribe fluids to increase cardiac output and renal blood flow, or IV diuretics may be given to increase urine output. The nurse should be aware of the patient's blood urea nitrogen, serum creatinine, glomerular filtration rate, and serum electrolyte levels. The nurse should report abnormal levels promptly, because it may be necessary to adjust fluids and the dose or type of medication given. If efforts to maintain renal perfusion are ineffective, the patient may require continuous renal replacement therapy or dialysis (see Chapter 48).

Maintaining Normal Body Temperature

Patients are usually hypothermic when admitted to the critical care unit following the cardiac surgical procedure. Because induced hypothermia from CPB and anesthesia lower the patient's core temperature, the patient must be gradually warmed to a normal temperature. This is accomplished partially by the patient's own basal metabolic processes and often with the assistance of heated air blanket systems. While the patient is hypothermic, shivering and hypertension are common. Lowering the blood pressure with a vasodilator such as nitroprusside may be necessary. These problems typically resolve as warming occurs.

After cardiac surgery, the patient is at risk for developing elevated body temperature as a result of tissue inflammation or infection. The inflammatory/immune response to surgery includes the release of cytokines that cause fever (Norris, 2019). The resultant increase in metabolic rate increases tissue oxygen demands and increases cardiac workload. Antipyretics and other measures are used to lower body temperature.

Common sites of postoperative infection include the lungs, urinary tract, incisions, and intravascular catheters. Meticulous care is used to prevent contamination at the sites of catheter and tube insertions. Aseptic technique is used when changing dressings and when providing endotracheal tube and catheter care. Clearance of pulmonary secretions is accomplished by frequent repositioning of the patient, suctioning, and chest physical therapy, as well as educating and encouraging the patient to breathe deeply and cough. All invasive lines and tubes are discontinued as soon as possible after surgery to avoid infection.

Postpericardiotomy syndrome may occur in patients who undergo cardiac surgery. The syndrome is characterized by fever, pericardial pain, pleural pain, dyspnea, pericardial effusion, pericardial friction rub, and arthralgia. These signs and symptoms may occur days to weeks after surgery, often after the patient has been discharged from the hospital.

Postpericardiotomy syndrome must be differentiated from other postoperative complications (e.g., infection, incisional pain, MI, pulmonary embolus, bacterial endocarditis, pneumonia, atelectasis). Treatment depends on the severity of the signs and symptoms. Use of colchicine and anti-inflammatory agents may produce an improvement in symptoms (Lehto, Kiviniemi, Gunn, et al., 2018).

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

Depending on the type of surgery and postoperative progress, the patient may be discharged from the hospital 3 to 5 days after surgery. Following recovery from the surgery, patients can expect fewer symptoms from CAD and an improved quality of life. CABG has been shown to increase the lifespan of high-risk patients, including those with left main artery blockages and left ventricular dysfunction with multivessel blockages (Urden et al., 2019).

Although the patient may be eager to return home, the patient and family usually are apprehensive about this transition. Family members often express the fear that they are not capable of caring for the patient at home or that they are unprepared to handle complications that may occur.

The nurse helps the patient and family set realistic, achievable goals. An education plan that meets the patient's individual needs is developed with the patient and family. Specific instructions are provided about incision care; signs and symptoms of infection; diet; activity progression and exercise; deep breathing, incentive spirometry, and tobacco use cessation; weight and temperature monitoring; the medication regimen; and follow-up visits with home health nurses, the rehabilitation personnel, the surgeon, and the cardiologist or internist.

Some patients have difficulty learning and retaining information after cardiac surgery. The patient may experience recent memory loss, short attention span, difficulty with simple math, poor handwriting, and visual disturbances. Patients with these difficulties often become frustrated when they try to resume normal activities. The patient and family are reassured that the difficulty is almost always temporary and will subside, usually in 6 to 8 weeks. In the meantime, instructions are given to

the patient at a slower pace than normal, and a family member assumes responsibility for making sure that the prescribed regimen is followed.

Chart 23-13 **HOME CARE CHECKLIST**

Discharge After Cardiac Surgery

At the completion of education, the patient and/or caregiver will be able to:

- Name the procedure that was performed and identify any permanent changes in anatomic structure or function as well as changes in ADLs, IADLs, roles, relationships, and spirituality.
- Identify interventions and strategies (e.g., durable medical equipment, adaptive equipment) used in recovery period.
- Describe ongoing postoperative therapeutic regimen, including diet and activities to perform (e.g., walking and breathing exercises) and to limit or avoid (e.g., lifting weights, driving a car, contact sports).
- State the name, dose, side effects, frequency, and schedule for all medications.
- State how to obtain medical supplies and carry out dressing changes, wound care, and other prescribed regimens.
- Identify durable medical equipment needs, proper usage, and maintenance necessary for safe utilization.
- Describe signs and symptoms of complications.
- State time and date of follow-up appointments.
- Relate how to reach the primary provider with questions or complications.
- Identify community resources for peer and caregiver/family support:
  - Identify sources of support (e.g., friends, relatives, faith community)
  - Identify contact information of support groups for people and their caregivers/families
- Identify the need for health promotion (e.g., weight reduction, cessation of tobacco use, stress management), disease prevention, and screening activities

ADLs, activities of daily living; IADLs, independent activities of daily living.

Continuing and Transitional Care

Arrangements are made for home, community-based, or transitional care when appropriate. Because the hospital stay is relatively short, it is particularly important for the nurse to assess the patient's and family's ability to manage care in the home. The nurse making a home visit continues the education process (see Chart 23-13), monitors vital signs and incisions, assesses for signs and symptoms of complications, and provides support for the patient and family. Additional interventions may include dressing changes, diet counseling, and tobacco use cessation strategies. Patients and families need to know that cardiac surgery did not cure the patient's underlying heart disease process. Lifestyle changes for risk factor reduction are essential, and

medications taken before surgery to control problems such as blood pressure and hyperlipidemia will still be necessary.

The nurse encourages the patient to contact the surgeon, cardiologist, or office nurse with problems or questions. This provides the patient and family with reassurance that professional support is available. The patient is expected to have at least one follow-up visit with the surgeon.

Education does not end at the time of discharge from the hospital, transitional, or home health care. Many patients and families benefit from supportive programs, including cardiac rehabilitation. These programs provide monitored exercise; instructions about diet and stress reduction; information about resuming work, driving, and sex; assistance with tobacco use cessation; and support groups for patients and families. Hospital or community-based support groups provide information as well as an opportunity for families to share experiences.

CRITICAL THINKING EXERCISES

1 ipc You have been assigned to care for a 64-year-old woman who was admitted last night complaining of fatigue and mild shortness of breath. She tells you that she does not understand why the doctors are so concerned about her heart. She states, "there is nothing wrong with my heart. I am just tired. What's all the fuss about?" What education would you provide to the patient about women and heart disease? What clinical manifestations can indicate heart disease in women? What laboratory and diagnostic studies would you expect to be done for this patient? Which members of the interprofessional team would you want to involve in her care?

2 pq You are assigned to care for a 56-year-old man who is scheduled for a drug eluting stent today. You receive report from the cardiac catheter lab nurse that the patient tolerated the procedure well, is currently stable, and will be returning shortly to your unit. How will you prioritize care for this patient once he returns to his room? What assessments will you do first? What complications is he most at risk of developing and how will you know if they are occurring? What patient education should be initiated and when?

3 ebp You have been asked to provide an educational in-service to a group of nursing students on how to care for a patient presenting with a myocardial infarction (MI). One of the students asks you to explain how you determine if the patient is having an NSTEMI or a STEMI. How do you respond? According to evidence-based guidelines, what medications are used in the initial management of patients with an acute MI? According to these guidelines, under what conditions would a patient receive thrombolytic therapy rather than undergo a percutaneous coronary intervention?

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

American Diabetes Association, www.diabetes.org/
American Heart Association, www.heart.org
Framingham Heart Study, www.framinghamheartstudy.org
National Heart, Lung, and Blood Institute, https://www.nhlbi.nih.gov/

24 Management of Patients with Structural, Infectious, and Inflammatory Cardiac Disorders

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Define valvular disorders of the heart and describe the pathophysiology, clinical manifestations, as well as the medical and nursing management of patients with mitral and aortic disorders.
2. Differentiate between the different types of cardiac valve repair and replacement procedures used to treat valvular problems and the care needed by patients who undergo these procedures.
3. Identify the pathophysiology, clinical manifestations, as well as the medical and nursing management of patients with cardiomyopathies.
4. Describe the pathophysiology, clinical manifestations, as well as the medical and nursing management of patients with infections of the heart.
5. Use the nursing process as a framework for care of the patient with a cardiomyopathy or the patient with pericarditis.

NURSING CONCEPTS

Infection
Inflammation
Perfusion

GLOSSARY

annuloplasty: repair of a cardiac valve's outer ring

aortic valve: semilunar valve located between the left ventricle and aorta

autograft: heart valve replacement made from the patient's own heart valve (e.g., pulmonic valve excised and used as an aortic valve)

bioprosthesis: heart valve replacement made of tissue from an animal heart valve (*synonym:* heterograft)

cardiomyopathy: disease of the heart muscle

chordae tendineae: nondistensible fibrous strands connecting papillary muscles to atrioventricular (mitral, tricuspid) valve leaflets

commissurotomy: splitting or separating fused cardiac valve leaflets

ejection fraction: percentage of the end-diastolic blood volume ejected from the ventricle with each heartbeat

homograft: heart valve replacement made from a human heart valve (*synonym:* allograft)

leaflet repair: repair of a cardiac valve's movable "flaps" (leaflets)

mitral valve: atrioventricular valve located between the left atrium and left ventricle

orthotopic transplantation: the recipient's heart is removed and a donor heart is grafted into the same site

prolapse: (of a valve): stretching of an atrioventricular heart valve leaflet into the atrium during systole

pulmonic valve: semilunar valve located between the right ventricle and pulmonary artery

regurgitation: backward flow of blood through a heart valve (*synonym:* insufficiency)

stenosis: narrowing or obstruction of a cardiac valve's orifice

total artificial heart: mechanical device used to aid a failing heart, replacing the right and left ventricles

tricuspid valve: atrioventricular valve located between the right atrium and right ventricle

valve replacement: insertion of either a mechanical prosthetic valve or a bioprosthetic, homograft, or autograft tissue valve at the site of a malfunctioning heart valve to restore normal blood flow through the heart

valvuloplasty: repair of a stenosed or regurgitant cardiac valve by commissurotomy, annuloplasty, or leaflet repair (or a combination of procedures)

ventricular assist device: mechanical device used to aid a failing right or left ventricle

Structural, infectious, and inflammatory disorders of the heart present many challenges for the patient, family, and health care team. Various mechanisms, heart valve disorders, cardiomyopathies, and infectious diseases of the heart alter cardiac output. Treatments for these disorders may be noninvasive or invasive. Noninvasive treatments often consist of medication therapy, diet changes, and activity modification. Invasive treatments include valve repair or replacement, ventricular assist devices (VADs), total artificial hearts (TAHs), cardiac transplantation, or other surgical procedures. Nurses have an integral role in the care of patients with structural, infectious, and inflammatory cardiac conditions.

VALVULAR DISORDERS

Valves of the heart control blood flow through the heart into the pulmonary artery and aorta by opening and closing in response to blood pressure changes during the cardiac cycle (systole, or heart contraction, and diastole, or relaxation of the heart).

Atrioventricular valves separate the atria from the ventricles and include the **tricuspid valve**, which separates the right atrium from the right ventricle, and the **mitral valve**, which separates the left atrium from the left ventricle. The tricuspid valve has three leaflets; the mitral valve has two. Both valves have **chordae tendineae**, which are nondistensible fibrous strands that anchor valve leaflets to papillary muscles of the ventricles.

Semilunar valves are located between the ventricles and their corresponding arteries. The **pulmonic valve** lies between the right ventricle and the pulmonary artery; the **aortic valve** lies between the left ventricle and the aorta. Figure 24-1 shows valves in the closed position (also refer to Chapter 21, Fig. 21-1 to review the structure of a normal heart).

When any heart valve does not close or open properly, blood flow is affected. When valves do not close completely, blood flows backward through the valve, a condition called **regurgitation** (also referred to as insufficiency). When valves do not open completely, a condition called **stenosis**, blood flow through the valve is reduced.

Regurgitation and stenosis may affect any heart valve. The mitral valve may also **prolapse** (i.e., stretching of the valve leaflet into the atrium during systole). For patients without symptoms, heart valve conditions may be monitored without treatment. If a patient has symptoms related to a valve disorder, treatment is based on the severity of symptoms, and patients may need to make lifestyle changes, take medications, or undergo repair or replacement of the valve. Disorders of the mitral and aortic valve typically cause more symptoms, require treatment, and cause more complications than

disorders of the tricuspid and pulmonic valves. Regurgitation and stenosis may occur at the same time in the same or different valves (Fig. 24-2).

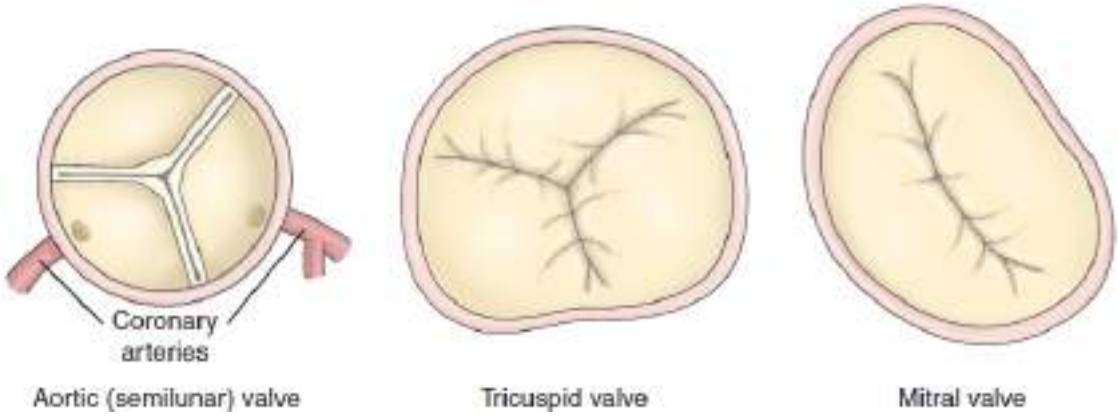

Figure 24-1 • Valves of the heart (aortic or semilunar, tricuspid, and mitral) in closed positions.

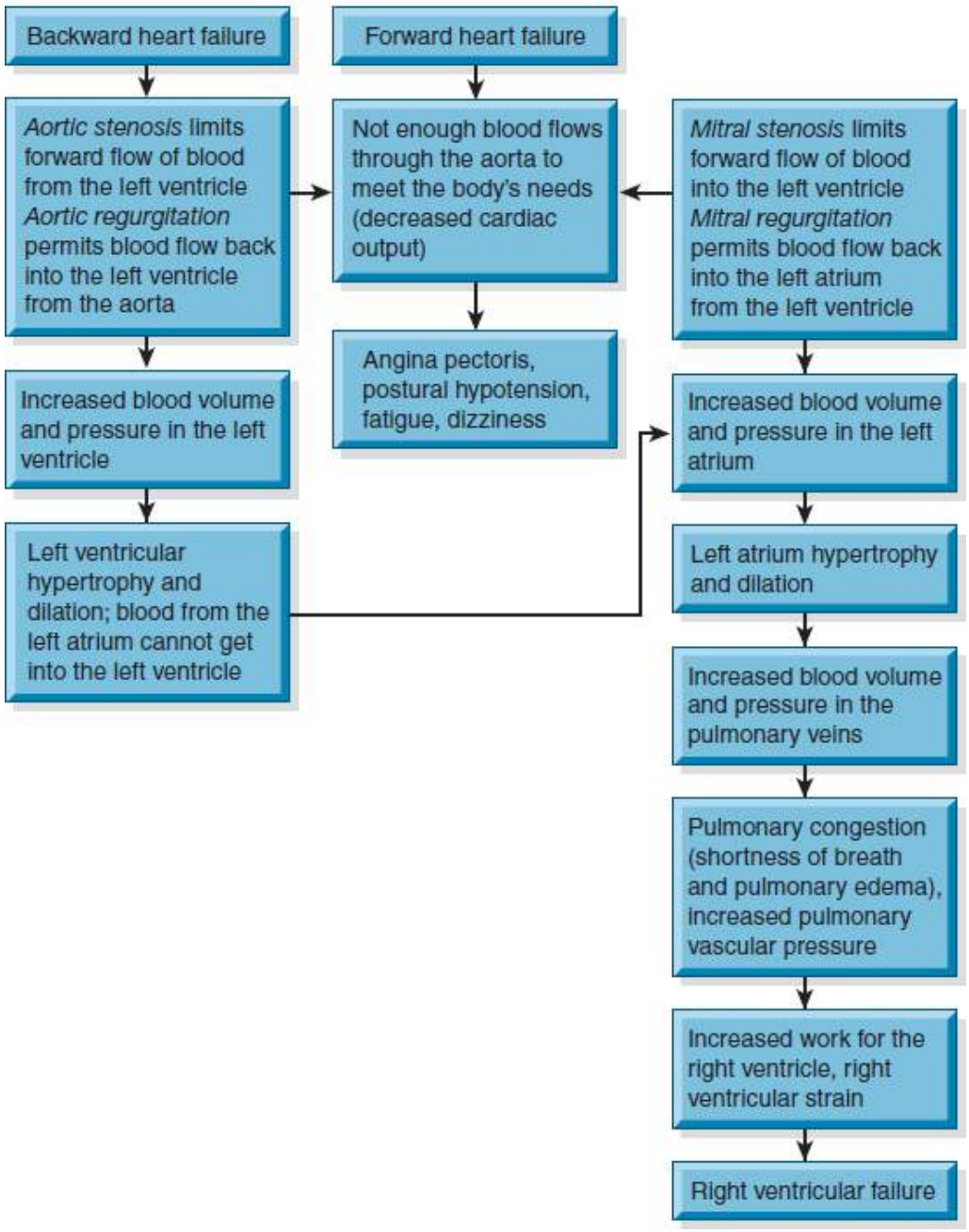

Figure 24-2 • Pathophysiology. Left-sided heart failure as a result of aortic and mitral valvular heart disease and development of right ventricular failure.

Mitral Valve Prolapse

Mitral valve prolapse is a deformity that usually produces no symptoms. Rarely, it progresses and can result in sudden death (Han, Ha, Teh, et al., 2018;

Nalliah, Mahajan, Elliott, et al., 2019). This condition occurs in up to 2.5% of the general population and twice as frequently in women as in men (Han et al., 2018). In most cases, there is no clear cause, but it has been associated with inherited connective tissue disorders, causing enlargement of one or both of the mitral valve leaflets (Asher, Chen, & Kallish, 2018; Wozniak-Mielczarek, Sabiniewicz, Drezek-Nojowicz, et al., 2019). The annulus often dilates; chordae tendineae and papillary muscles may elongate or rupture.

Pathophysiology

In mitral valve prolapse, a portion of one or both mitral valve leaflets balloons back into the atrium during systole. Rarely, ballooning stretches the leaflet to the point that the valve does not remain closed during systole. Blood then regurgitates from the left ventricle back into the left atrium. Although uncommon, mitral valve prolapse can result in mitral regurgitation, which can cause heart enlargement, atrial fibrillation, pulmonary hypertension, or heart failure (Ma, Igata, Strachan, et al., 2019).

Clinical Manifestations

Most people with mitral valve prolapse never have symptoms. A small number of patients will have fatigue, shortness of breath, lightheadedness, dizziness, syncope, palpitations, chest pain, or anxiety. To date, there has been no consensus about the cause of symptoms. Patients may report fatigue, regardless of activity level and amount of rest or sleep, as well as shortness of breath, palpitations, and chest pain (Althunayyan, Petersen, Lloyd, et al., 2019).

Assessment and Diagnostic Findings

Often, the first and only sign of mitral valve prolapse is an extra heart sound, referred to as a mitral click. A systolic click is an early sign that a valve leaflet is ballooning into the left atrium. In addition to the mitral click, a murmur of mitral regurgitation may be heard if the valve opens during systole and blood flows back into the left atrium. If mitral regurgitation exists, a patient may experience signs and symptoms of heart failure (see Chapter 25). Echocardiography is used to diagnose and monitor progression of mitral valve prolapse (Han et al., 2018).

Medical Management

Medical management is directed at controlling symptoms. If a patient who reports palpitations is found to have an arrhythmia, the patient may be advised

to eliminate caffeine and alcohol from the diet and to stop the use of tobacco products as well as electronic nicotine delivery systems (ENDS), including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars. Most patients do not require medication, but some are prescribed antiarrhythmic medications (see Chapter 22, Table 22-1). Prophylactic antibiotics are not recommended prior to dental or invasive procedures (Nishimura, Otto, Bonow, et al., 2017).

Patients who have chest pain related to mitral valve prolapse rarely require medical therapies, such as nitrates, calcium channel blockers, or beta-blockers. Heart failure, if present, is treated as it would be for any other case of heart failure (see Chapter 25). Patients with severe mitral regurgitation and symptomatic heart failure may require mitral valve repair or replacement (discussed later in this chapter).

Nursing Management

The nurse educates the patient about the diagnosis and the possibility that the condition is hereditary. First-degree relatives (e.g., parents, siblings) may be advised to have screening cardiac evaluations or echocardiograms. Because most patients with mitral valve prolapse are asymptomatic, the nurse explains the need to inform the patient's primary provider about any symptoms that may develop. The nurse encourages the patient to read product labels, particularly on over-the-counter products such as cough medicine, because these products may contain alcohol, caffeine, ephedrine, and epinephrine, which may produce arrhythmias and other symptoms. The nurse also explores diet, activity, sleep, and other lifestyle factors that may correlate with symptoms. (Treatment of arrhythmias, chest pain, heart failure, or other complications of mitral valve prolapse is described in Chapters 22 and 25.) Women diagnosed with mitral valve prolapse without mitral regurgitation or other complications may complete pregnancies without close cardiac monitoring and can safely proceed with vaginal deliveries (Yuan & Yan, 2016).

Mitral Regurgitation

Mitral regurgitation is a condition in which blood flows from the left ventricle back into the left atrium during systole. Often, the edges of mitral valve leaflets do not close completely during systole because leaflets and chordae tendineae have thickened and become fibrotic, resulting in abnormal contraction. Mitral regurgitation may be chronic or, less commonly, acute. The most common causes of mitral valve regurgitation in developed countries are degenerative changes of the mitral valve (including mitral valve prolapse) and ischemia of the left ventricle (Harb & Griffin, 2017). The most common cause

in developing countries is rheumatic heart disease and its sequelae (Negi, Mahajan, Rana, et al., 2018).

Other conditions that lead to chronic mitral regurgitation include pathologic myxomatous changes, which enlarge and stretch the left atrium and ventricle, causing leaflets and chordae tendineae to stretch or rupture (Harb & Griffin, 2017). Infective endocarditis may cause acute mitral regurgitation through leaflet perforation, or scarring following an infection that may cause retraction of leaflets or chordae tendineae (Watanabe, 2019). Collagen vascular diseases (e.g., systemic lupus erythematosus), cardiomyopathy, and ischemic heart disease may result in changes in the left ventricle, causing papillary muscles, chordae tendineae, or leaflets to stretch, shorten, or rupture. These conditions are often referred to as functional, or secondary, mitral regurgitation (Dziadzko, Dziadzko, Medina-Inojosa, et al., 2019).

Pathophysiology

Mitral regurgitation may result from problems with one or more leaflets, chordae tendineae, the annulus, or the papillary muscles. A mitral valve leaflet may shorten or tear, and chordae tendineae may elongate, shorten, or tear. The annulus may be stretched by heart enlargement, as in functional mitral regurgitation, or it may be deformed by calcification. A papillary muscle may rupture, stretch, or be pulled out of position by changes in the ventricular wall (e.g., scar from a myocardial infarction, ventricular dilation). Papillary muscles may be unable to contract because of ischemia, a condition referred to as ischemic mitral regurgitation. Regardless of the cause, the effect is backward blood flow into the atrium during systole.

In this disorder, each beat of the left ventricle pushes blood backward into the left atrium, adding to blood flowing in from the lungs. This excess blood causes the left atrium to stretch and eventually thicken, or hypertrophy, then dilate. Over time, blood coming in from the ventricle prevents blood flow from the lungs into the atrium. As a result, the lungs become congested, eventually adding extra strain to the right ventricle. During diastole, the increased blood volume from the atrium fills the ventricle. The volume overload causes ventricular hypertrophy. Eventually, the ventricle dilates, and systolic heart failure develops.

Clinical Manifestations

Chronic mitral regurgitation is often asymptomatic, but acute mitral regurgitation (e.g., resulting from a myocardial infarction) usually manifests as severe and sudden congestive heart failure (Harb & Griffin, 2017). Dyspnea, fatigue, and weakness are the most common symptoms. Palpitations, shortness of breath on exertion, and cough from pulmonary congestion also occur.

Assessment and Diagnostic Findings

The systolic murmur of mitral regurgitation is a blowing sound best heard at the apex. The murmur may radiate to the left axilla (Harb & Griffin, 2017). The pulse may be regular, or it may be irregular because of extrasystolic beats or atrial fibrillation. Echocardiography is used to diagnose and monitor progression of this disorder (Nishimura et al., 2017).

Medical Management

Patients with mitral regurgitation who develop pulmonary congestion are managed with medications used for heart failure. Patients with mitral regurgitation and heart failure benefit from afterload reduction (arterial dilation) by treatment with angiotensin-converting enzyme (ACE) inhibitors (e.g., captopril, lisinopril) or angiotensin receptor blockers (ARBs) (e.g., losartan, valsartan), direct arterial dilators (e.g., hydralazine), and beta-blockers (e.g., carvedilol, metoprolol) (see Chapter 25, Table 25-3). Symptoms of heart failure also are an indication to consider surgical intervention by mitral **valvuloplasty** (i.e., surgical repair of the valve) or **valve replacement** (replacement of the dysfunctional valve with either a mechanical valve or a type of tissue valve; discussed later in this chapter) (Nishimura et al., 2017).

Mitral Stenosis

Mitral stenosis results in reduced blood flow from the left atrium into the left ventricle. It is usually caused by rheumatic endocarditis, which progressively thickens mitral valve leaflets and chordae tendineae, causing the leaflets to fuse together (Negi et al., 2018). Eventually, the mitral valve orifice narrows and progressively obstructs blood flow into the ventricle.

Pathophysiology

Normally, the mitral valve orifice is as wide as the diameter of three fingers. In severe mitral stenosis, the orifice narrows to the width of a pencil. Because of increased resistance through the narrowed valve orifice, the left atrium is less able to push blood into the left ventricle. This results in increased residual blood volume in the left atrium, which over time causes left atrial hypertrophy and dilation. Decreased blood flow into the left ventricle leads to reduced ventricular filling and decreased cardiac output. A stenotic valve fails to protect pulmonary veins from backward flow of blood from the atrium, resulting in congestion of the pulmonary circulation. The right ventricle must then contract against abnormally high pulmonary arterial pressure and is subjected to excessive strain. Over time, the right ventricle hypertrophies,

enlarges, and eventually fails. If the heart rate increases, diastole is shortened; thus, the amount of time for forward flow of blood decreases, and more blood backs into the pulmonary veins. Therefore, as the heart rate increases, cardiac output further decreases, and pulmonary pressures increase.

Clinical Manifestations

Often, the first symptom of mitral stenosis is dyspnea on exertion (DOE) caused by pulmonary venous hypertension. Symptoms do not usually develop until after the valve opening is reduced by one third to one half its usual size (Harb & Griffin, 2017). Patients may experience progressive fatigue and decreased exercise tolerance because of low cardiac output. An enlarged left atrium may create pressure on the left bronchial tree, resulting in a dry cough or wheezing. In cases of severe mitral stenosis with significant pulmonary congestion, patients may expectorate blood (i.e., hemoptysis) or experience palpitations, orthopnea, paroxysmal nocturnal dyspnea (PND), or repeated respiratory infections. Increased blood volume and pressure cause the left atrium to dilate, hypertrophy, and become electrically unstable, which may result in patients developing atrial arrhythmias (Negi et al., 2018).

Assessment and Diagnostic Findings

Patients with mitral stenosis will have a low-pitched, rumbling diastolic murmur, best heard at the apex. Patients may have a weak and irregular pulse if they develop atrial fibrillation and may have signs or symptoms of heart failure (Nishimura et al., 2017). Echocardiography is used to diagnose and quantify the severity of mitral stenosis. Electrocardiography (ECG), exercise testing, and cardiac catheterization with angiography may be used to help determine the severity of mitral stenosis.

Prevention

Since rheumatic heart disease may result in mitral stenosis, prevention is aimed at decreasing the risk of contracting and providing early treatment for bacterial infections (see prevention of endocarditis later in this chapter). Prevention of acute rheumatic fever depends on effective antibiotic treatment of group A streptococcal infection (Nishimura et al., 2017). Antibiotic prophylaxis for recurrent rheumatic fever with rheumatic carditis may require 10 or more years of antibiotic coverage (e.g., penicillin G intramuscularly every 4 weeks, penicillin V orally twice daily, sulfadiazine orally daily, or erythromycin orally twice daily) (Szczygielska, Hernik, Kolodziejczyk, et al., 2018).

Medical Management

Congestive heart failure is treated as described in Chapter 25. Patients with severe left atrial dilation in mitral stenosis may benefit from anticoagulant medications to decrease the risk of developing atrial thrombi. If atrial fibrillation develops, cardioversion may be attempted to restore normal sinus rhythm. If unsuccessful, the ventricular rate is controlled with beta-blockers, digoxin, or calcium channel blockers; furthermore, patients will require anticoagulation for thromboembolism prevention (January, Wann, Calkins, et al., 2019). Patients with severe mitral stenosis are advised to avoid strenuous activities, competitive sports, and pregnancy, all of which increase heart rate (Nishimura et al., 2017). Surgical intervention consists of valvuloplasty, usually a **commissurotomy** (i.e., splitting or separating leaflets) to open the fused commissure of the valve. The *commissure* is the site where valve leaflets meet. Percutaneous transluminal valvuloplasty or valve replacement may be performed.

Aortic Regurgitation

Aortic regurgitation is backward flow of blood into the left ventricle from the aorta during diastole. It may be caused by a congenital valve abnormality (e.g., a bicuspid aortic valve), inflammatory lesions that deform aortic valve leaflets, or dilation of the aorta, preventing complete closure of the aortic valve. Chronic or acute aortic regurgitation may also be caused by infections such as rheumatic endocarditis or syphilis, or by a dissecting aortic aneurysm resulting in dilation or tearing of the ascending aorta, blunt chest trauma, or deterioration of a surgically replaced aortic valve (Akinseye, Pathak, & Ibebuogu, 2018; Nishimura et al., 2017).

Pathophysiology

During diastole, blood is normally delivered into the left atrium from the aorta. In aortic regurgitation, blood flows back into the left ventricle, which will dilate to accommodate increased blood volume. Over time, the left ventricle hypertrophies to expel more blood with above-normal force, thus increasing systolic blood pressure. Arteries attempt to compensate for higher pressures by reflex vasodilation; peripheral arterioles relax, reducing peripheral resistance and diastolic blood pressure.

Clinical Manifestations

Aortic regurgitation, also called aortic insufficiency, develops without symptoms in most patients. Some patients are aware of a pounding or forceful

heartbeat, especially in the head or neck. Patients who develop left ventricular hypertrophy may have visible or palpable arterial pulsations at the carotid or temporal arteries due to increased force and blood volume. As aortic regurgitation worsens, DOE and fatigue follow; there may eventually be signs and symptoms of progressive left ventricular failure including increased shortness of breath, orthopnea, or PND (Akinseye et al., 2018).

Assessment and Diagnostic Findings

A high-pitched, blowing diastolic murmur is heard at the third or fourth intercostal space at the left sternal border. The difference between systolic and diastolic pressures (i.e., the pulse pressure) may be widened in patients with aortic regurgitation. One characteristic sign is the water hammer (Corrigan's) pulse, in which the pulse strikes a palpating finger with a quick, sharp stroke and then collapses (Pabba & Boudi, 2019). The diagnosis may be confirmed by echocardiography (preferably transesophageal), cardiac magnetic resonance imaging (MRI), or cardiac catheterization. Patients with symptoms usually have echocardiograms every 6 months, and those without symptoms have echocardiograms every 2 to 5 years (Nishimura et al., 2017).

Prevention

Prevention of aortic regurgitation is primarily based on prevention of and treatment for bacterial infections (see prevention of endocarditis later in this chapter). The same strategies aimed at preventing acute and recurrent rheumatic fever previously described for the patient with mitral stenosis apply to patients with aortic regurgitation.

Medical Management

A patient who is symptomatic or has developed a significant decrease in left ventricular function is advised to avoid physical exertion, competitive sports, and isometric exercise until the valve has been replaced (Gati, Malhotra, & Sharma, 2019). If arrhythmias and heart failure occur, they are treated as described in Chapters 22 and 25. Controlling high blood pressure in patients with aortic regurgitation can improve forward blood flow through the heart. ACE inhibitors and dihydropyridine calcium channel blockers may be recommended for management of hypertension; these are effective at reducing afterload. Beta-blockers are less commonly used, due to concern that a lower heart rate may actually increase blood pressure through negative chronotropic effects (Akinseye et al., 2018). Patients who are symptomatic should be instructed to restrict sodium intake to prevent volume overload and will require valve replacement (Nishimura, Otto, Bonow, et al., 2014).

The treatment of choice is aortic valve replacement or valvuloplasty (described later), preferably performed before left ventricular failure occurs. Surgery is recommended for any patient with significant left ventricular dilation, regardless of the presence or absence of symptoms (Nishimura et al., 2014). Surgery is also recommended for any patient who is symptomatic (Flint, Wunderlich, Shmueli, et al., 2019).

Aortic Stenosis

Aortic valve stenosis is narrowing of the orifice between the left ventricle and aorta. In adults, stenosis is usually caused by degenerative calcification. Calcification may be caused by proliferative and inflammatory changes that occur in response to years of normal mechanical stress, similar to changes that occur in atherosclerotic cardiovascular disease (Joseph, Naqvi, Giri, et al., 2017). Congenital leaflet malformations or an abnormal number of leaflets (i.e., one or two rather than three) are less common causes. Rheumatic endocarditis may cause adhesions or fusion of the commissures and valve ring, stiffening of the cusps, and calcific nodules on the cusps.

Pathophysiology

Typically, aortic stenosis progresses gradually over several years to several decades. As the valve orifice narrows, the left ventricle overcomes obstruction by contracting more slowly and more forcibly. Obstruction to left ventricular outflow increases pressure on the left ventricle, so the ventricular wall hypertrophies. When these compensatory mechanisms are insufficient to allow for normal heart function, clinical signs and symptoms of heart failure will develop (Joseph et al., 2017).

Clinical Manifestations

Many patients with aortic stenosis are asymptomatic. Often, the first symptom to appear is DOE, caused by increased pulmonary venous pressure due to a dilating left ventricle. Over time, left ventricular failure may occur, causing orthopnea, PND, and pulmonary edema. Reduced blood flow to the brain may cause dizziness, and in more severe aortic stenosis, syncope. Patients may also report angina pectoris, which is caused by limited blood flow into the coronary arteries, decreased time in diastole to allow for myocardial perfusion, and simultaneously increased oxygen demand of the hypertrophied left ventricle. Blood pressure is usually normal but may be low. In the setting of decreased blood flow, there may be a low pulse pressure (30 mm Hg or less).

Assessment and Diagnostic Findings

On physical examination, a loud, harsh systolic murmur is heard over the aortic area (i.e., right second intercostal space) and may radiate to the carotid arteries and apex of the left ventricle. The murmur may be described as low pitched, crescendo–decrescendo, rough, rasping, and vibrating (Libby, Zipes, Bonow, et al., 2018). An S_4 sound may be heard (see Chapter 21 for discussion of heart sounds). By having the patient lean forward during auscultation and palpation, especially during exhalation, the murmur may be accentuated. There may also be a palpable vibration extending from the base of the heart (second intercostal space next to the sternum and above the suprasternal notch) and up along the carotid arteries. The vibration is caused by turbulent blood flow across the narrowed valve orifice.

Cardiac imaging is used to diagnose and monitor the progression of aortic stenosis. This may consist of echocardiography, cardiac MRI, or computed tomography (CT) scanning (Lindman, Dweck, Lancellotti, et al., 2019). Patients with symptoms usually have echocardiograms every 6 to 12 months, and those without symptoms have echocardiograms every 2 to 5 years, depending on how severely the orifice is narrowed (Lindman et al., 2019; Nishimura et al., 2014). Left ventricular hypertrophy may be seen on a 12-lead ECG or an echocardiogram. Once aortic stenosis has progressed sufficiently to consider surgical intervention, left-sided heart catheterization is needed to measure the severity of the valvular abnormality and to evaluate the coronary arteries. Pressure measurements are taken from the left ventricle and base of the aorta. The systolic pressure in the left ventricle is considerably higher than that in the aorta during systole. Graded exercise studies (stress tests) to assess exercise capacity are performed with caution for patients with severe aortic stenosis due to the high risk of inducing ventricular tachycardia or fibrillation, and should not be performed on symptomatic patients (Joseph et al., 2017).

Prevention

Prevention of aortic stenosis is primarily focused on controlling risk factors for proliferative and inflammatory responses—namely, through treating diabetes, hypertension, hypercholesterolemia, and elevated triglycerides, and avoiding tobacco products and ENDS (see prevention of endocarditis later in this chapter).

Medical Management

Medications are prescribed to treat arrhythmias or left ventricular failure (see Chapters 22 and 25). Definitive treatment for aortic stenosis is replacement of the aortic valve, which may be done surgically or nonsurgically. Nonsurgical

valve replacement, known as transcatheter aortic valve replacement (TAVR), is described in more detail later in this chapter. Patients who are symptomatic and are not candidates for valve replacement may benefit from one- or two-balloon percutaneous valvuloplasty procedures, which can provide symptom relief (Sandhu, Krishnamoorthy, Afif, et al., 2017).

Nursing Management: Valvular Heart Disorders

The nurse educates the patient with valvular heart disease about the diagnosis, progressive nature of the disease, and treatment plan. The patient is instructed to report new symptoms or changes in symptoms to the primary provider. The nurse also educates the patient that an infectious pathogen, usually a bacterium, can adhere to a diseased heart valve more readily than to a normal valve. Once attached to the valve, the infectious agent multiplies, resulting in endocarditis and further damage to the valve. In addition, the nurse educates the patient about how to minimize the risk of developing infective endocarditis (discussed later in this chapter).

The nurse measures the patient's heart rate, blood pressure, and respiratory rate, compares these results with previous data, and notes any changes. Heart and lung sounds are auscultated, and peripheral pulses palpated. The nurse assesses the patient with valvular heart disease for the following:

- Signs and symptoms of heart failure, such as fatigue, DOE, decreased activity tolerance, an increase in coughing, hemoptysis, multiple respiratory infections, orthopnea, and PND (see Chapter 25)
- Arrhythmias, by palpating the patient's pulse for strength and rhythm (i.e., regular or irregular) and asking whether the patient has experienced palpitations or felt forceful heartbeats (see Chapter 22)
- Symptoms such as dizziness, syncope, increased weakness, or angina pectoris (see Chapter 23)

The nurse collaborates with the patient to develop a medication schedule and provides education about the name, dosage, actions, adverse effects, and any drug–drug or drug–food interactions of prescribed medications for heart failure, arrhythmias, angina pectoris, or other symptoms. Specific precautions are emphasized, such as the risk to patients with aortic stenosis who experience angina pectoris and take nitroglycerin. The venous dilation that results from nitroglycerin use decreases blood return to the heart, thus decreasing cardiac output and increasing the risk of syncope and decreased coronary artery blood flow. The nurse educates the patient about the importance of attempting to relieve the symptoms of angina with rest and relaxation before taking nitroglycerin and to anticipate potential adverse effects.

For patients with heart failure, the nurse provides education on taking a daily weight and reporting sudden weight gain, as defined by the primary provider. The nurse may assist the patient with planning activity and rest periods to allow symptom relief while preventing deconditioning or loss of function. Care of patients treated with valvuloplasty or surgical valve replacement is described later in this chapter.

SURGICAL MANAGEMENT: VALVE REPAIR AND REPLACEMENT PROCEDURES

Valvuloplasty

Repair, rather than replacement, of a cardiac valve is referred to as valvuloplasty. The recommended procedure for valvuloplasty will depend on the cause and type of valve dysfunction. Repair may be made to commissures between the leaflets in a procedure known as commissurotomy, to the annulus of the valve by **annuloplasty** (i.e., specifically, repair of the cardiac valve's outer ring), or to leaflets. Transesophageal echocardiogram (TEE) is usually performed at the conclusion of a valvuloplasty to evaluate the effectiveness of the procedure.

Some valvuloplasty procedures are open-heart surgeries, which are performed under general anesthesia and usually use cardiopulmonary bypass. However, there are now several valvuloplasty procedures which utilize nonsurgical, or percutaneous, techniques; these do not require general anesthesia or cardiopulmonary bypass and can be performed in a cardiac catheterization laboratory or hybrid room. A hybrid room is an operating room with imaging capability (e.g., fluoroscopy, CT, MRI) and interventional devices for open, minimally invasive, image-guided and catheter-based procedures. Percutaneous partial cardiopulmonary bypass is used in some cardiac catheterization laboratories and hybrid rooms. (Cardiopulmonary bypass is described in Chapter 23.)

Commissurotomy

Valve leaflets may adhere to one another and close the commissure (i.e., stenosis). Less commonly, leaflets adhere to one another in a manner which creates stenosis as well as regurgitation, or backward blood flow. A commissurotomy is performed to separate the fused leaflets.

Closed Commissurotomy/Balloon Valvuloplasty

Commissurotomy is usually used for mitral valve stenosis. The preferred method is percutaneous transvenous mitral commissurotomy, which may be used for patients with congenital mitral stenosis, severe calcified mitral stenosis, left atrial thrombus, moderate to severe coexisting mitral regurgitation, or in patients with coexisting moderate to severe tricuspid regurgitation who would also benefit from tricuspid valve repair (Nishimura et al., 2014).

Most often used for mitral and aortic valve stenosis, balloon valvuloplasty is less commonly used to treat tricuspid and pulmonic valve stenosis. With more widely available percutaneous valve repair and replacement procedures, balloon valvuloplasty is becoming a less common procedure in the United States (Kumar, Paniagua, Hira, et al., 2016). Balloon valvuloplasty may still be used for mitral valve stenosis in younger patients, and for patients with complex medical conditions that place them at high risk for complications of more extensive surgical procedures. The procedure is contraindicated for patients with left atrial or ventricular thrombus, severe aortic root dilation, significant mitral valve regurgitation, and severe valvular calcification (Nishimura et al., 2014).

Balloon valvuloplasty (Fig. 24-3) is performed in a cardiac catheterization laboratory. The patient may receive light or moderate sedation and a local anesthetic. Mitral balloon valvuloplasty involves advancing one or two catheters into the right atrium, through the atrial septum into the left atrium, across the mitral valve, and into the left ventricle. A guidewire is placed through each catheter, and the original catheter is removed. Most often a specially designed balloon catheter is placed over the guidewire and positioned with the balloon across the mitral valve. The balloon has three sections with progressively greater resistance to inflation. The balloon first expands in the ventricle to help position the catheter at the valve. The second section of the balloon expands above the valve, holding the catheter across the valve. Finally, the middle section of the balloon expands in the valve orifice opening the commissures. Alternately, two balloons are used. Guidewires may be advanced into the aorta to stabilize the balloons' positions. These single-section balloons are inflated simultaneously and expand their entire length. The advantage of two balloons is that each is smaller than the one large balloon, making smaller atrial septal defects. As the two balloons are inflated, they usually do not completely occlude the valve, thereby permitting some forward flow of blood during the inflation period. Balloons are inflated with a dilute angiographic solution for 10 to 30 seconds. Multiple inflations usually are required to achieve the desired results (Hermann & Mack, 2019).

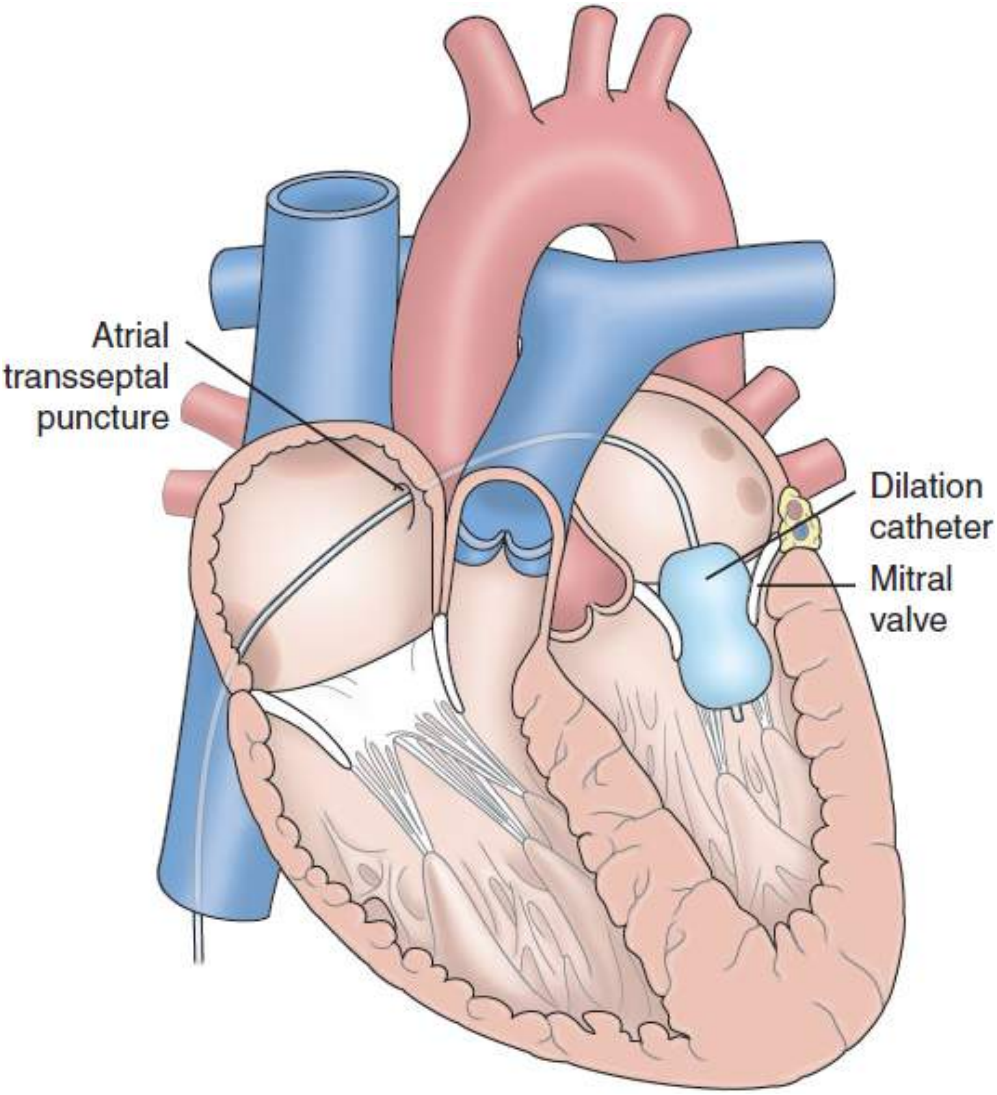

Figure 24-3 • Balloon valvuloplasty. Cross-section of heart illustrating the dilation catheter placed through an atrial transseptal puncture and across the mitral valve. The Inoue-Balloon inflates in three stages: first below the valve, then above, and finally in the valve orifice (this diagram shows the first two sections inflated).

All patients will have some degree of mitral regurgitation following mitral balloon valvuloplasty. Other possible complications include bleeding from the catheter insertion sites, emboli resulting in complications such as strokes, and, rarely, left-to-right atrial shunts through the atrial septal defect created during the procedure.

Aortic balloon valvuloplasty is usually performed by introducing a catheter through the aorta, across the aortic valve, and into the left ventricle; less commonly, it may be performed by passing the balloon or balloons through the atrial septum. The one- or two-balloon technique can be used for treating aortic stenosis. Balloons are inflated for 15 to 60 seconds, and inflation is usually repeated multiple times. Possible complications include aortic

regurgitation, emboli, ventricular perforation, rupture of the aortic valve annulus, ventricular arrhythmia, mitral valve damage, and bleeding from the catheter insertion sites. The aortic valve procedure is not as effective as the mitral valve procedure, and the rate of restenosis is approximately 50% in the first 6 months after the procedure. It is usually used for palliation of symptoms in patients who are not suitable candidates for TAVR, but may sometimes be used as a bridge to TAVR (Hermann & Mack, 2019; Kumar et al., 2016).

Open Commissurotomy

Since percutaneous commissurotomy has fewer risks with similar outcomes, open commissurotomy has become less commonly used in recent decades. The patient is under general anesthesia, and a midsternal or left thoracic incision is made. Cardiopulmonary bypass is initiated, and an incision is made into the heart. The valve is exposed, and a scalpel, finger, balloon, or dilator is used to open the commissures. One advantage of directly visualizing the valve and surrounding structures is that a thrombus or calcifications may be removed. Chordae or papillary muscles may also be inspected and surgically repaired as necessary.

Annuloplasty

The junction at which valve leaflets connect to the heart wall is an annulus. Annuloplasty refers to repair of the valve annulus, resulting in narrowing of the valve orifice. It is used for valvular regurgitation. For the mitral valve, there may be damage or rupture of the chordae tendineae resulting in severe mitral regurgitation, which is an indication for urgent valve repair by annuloplasty with resuspension of the chordae tendineae. General anesthesia and cardiopulmonary bypass are required for most annuloplasties.

There are two annuloplasty techniques. One technique uses an annuloplasty ring (Fig. 24-4), which may be rigid/semirigid or flexible. Leaflets of the valve are sutured to a ring, creating an annulus of the desired size. When the ring is in place, tension created by moving blood and the contracting heart is borne by the ring rather than by the valve or a suture line, thereby preventing progressive regurgitation.

A second technique to tighten the annulus involves folding elongated tissue over onto itself in leaflets or tacking leaflets to the atrium or each other with sutures. Because the valve's leaflets and suture lines are subjected to direct forces of the blood and heart muscle movement, the repair may degenerate more quickly than one using an annuloplasty ring (Maisano, Skantharaja, Denti, et al., 2019).

Leaflet Repair

Damage to cardiac valve leaflets may result from stretching, shortening, or tearing. **Leaflet repair** for elongated, ballooning, or other excess tissue leaflets is achieved by removing the extra tissue. Elongated tissue may be tucked and sutured, a technique called plication. A wedge of tissue may be cut from the middle of the leaflet and the gap sutured closed (i.e., leaflet resection) (Fig. 24-5). After short chordae are released, leaflets often unfurl and resume their normal function, allowing the valve to close during systole. A leaflet may be extended by suturing a piece of pericardium to it. A pericardial or synthetic patch may be used to repair holes in the leaflets.

Valve Replacement

Valve replacement is preferred for patients with valves with anatomy which decreases the chance of success with repair; this includes valves that have extensive calcification, or with severely fibrotic or fused leaflets, chordae tendineae, or papillary muscles. Ideally, a multidisciplinary team (e.g., cardiologists, cardiac thoracic surgeons, structural valve interventionalists, anesthesiologists, nurses) will work together with the patient to determine candidacy for surgical versus more minimally invasive replacement (Nishimura et al., 2014). General anesthesia and cardiopulmonary bypass are used for surgical valve replacements. The standard surgical procedure is performed through a median sternotomy (i.e., incision through the sternum), although the mitral valve may be approached through a right thoracotomy incision.

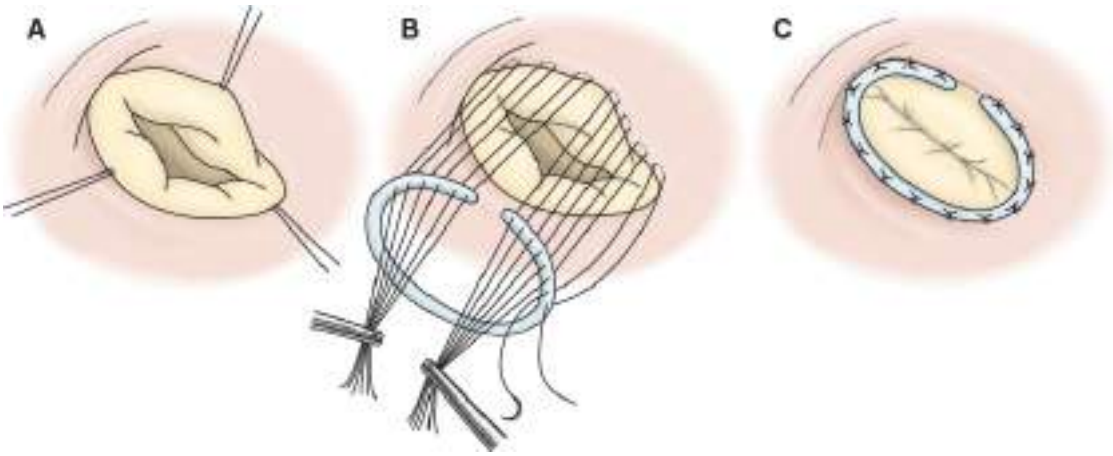

Figure 24-4 • Annuloplasty ring insertion. **A.** Mitral valve regurgitation; leaflets do not close. **B.** Insertion of an annuloplasty ring. **C.** Completed valvuloplasty; leaflets close.

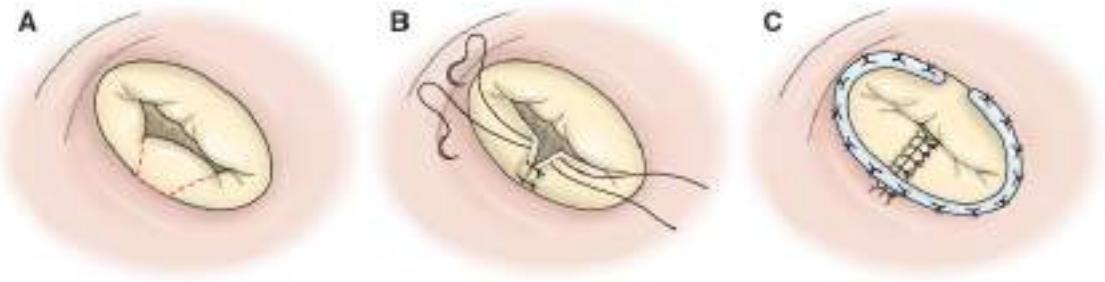

Figure 24-5 • Valve leaflet resection and repair with a ring annuloplasty. **A.** Mitral valve regurgitation; the section indicated by *dashed lines* is excised. **B.** Approximation of edges and suturing. **C.** Completed valvuloplasty, leaflet repair, and annuloplasty ring.

Mitral and aortic valve replacements may be performed with minimally invasive techniques that do not involve cutting through the length of the sternum. Instead, a 2- to 4-inch incision is made in only the upper or lower half of the sternum or between ribs, or performed percutaneously. Some minimally invasive procedures are robot assisted; surgical instruments are connected to a robot, and the surgeon, watching a video display, uses a joystick to control the robot and surgical instruments. With these procedures, patients have lower rates of bleeding, pain, infection, and scarring, and shorter length of stay in the hospital (Nishimura et al., 2014).

After the valve is visualized, leaflets of the aortic or pulmonic valve are removed, but some or all of the mitral valve structures (leaflets, chordae, and papillary muscles) are left in place to help maintain the shape and function of the left ventricle after mitral valve replacement. Sutures are placed around the annulus and then through the valve prosthesis. The replacement valve is slid down the suture into position and tied into place (Fig. 24-6). The patient is weaned from cardiopulmonary bypass, the quality of the surgical repair is often assessed with color flow Doppler TEE, and then surgery is completed.

TAVR, a minimally invasive aortic valve replacement procedure, may be performed in a catheterization laboratory or hybrid room. It does not involve cardiopulmonary bypass or sternotomy. TAVR was traditionally used only for patients who could not safely undergo surgical valve replacement, but more recently has been recommended for patients who have intermediate or even low risk (Nishimura et al., 2017). With the patient under general anesthesia, a balloon valvuloplasty is performed. Then, a bioprosthetic (tissue) replacement valve (Fig. 24-7A,B) attached to a catheter is inserted percutaneously, positioned at the aortic valve, and implanted. The MitraClip has been approved as a transcatheter procedure to treat degenerative forms of mitral regurgitation. This procedure is currently used primarily in patients with severe symptomatic mitral regurgitation and high surgical risk, but increasingly is considered even for lower-risk patients. The procedure creates a mechanical bridge between two leaflets and has demonstrated decreased regurgitant flow, resulting in

fewer symptoms, and decreased rates of hospitalization for heart failure (Dahl & Ailawadi, 2018).

In patients requiring valve replacement or repair, the heart had gradually adjusted to the pathology; surgery abruptly "corrects" the way blood flows through the heart and may result in complications related to the sudden changes in intracardiac pressures. All prosthetic valve replacements create a degree of stenosis when they are implanted in the heart. Usually, the stenosis is mild and does not affect heart function. If valve replacement was for a stenotic valve, blood flow through the heart is often improved, and signs and symptoms of heart failure resolve in a few hours or days. If valve replacement was for a regurgitant valve, it may take months for the chamber into which blood had been regurgitating to achieve its optimal postoperative function. Signs and symptoms of heart failure resolve gradually as heart function improves. Patients are at risk for many postoperative complications, such as bleeding, thromboembolism, infection, heart failure, hypertension, arrhythmias, hemolysis, and mechanical obstruction of the valve.

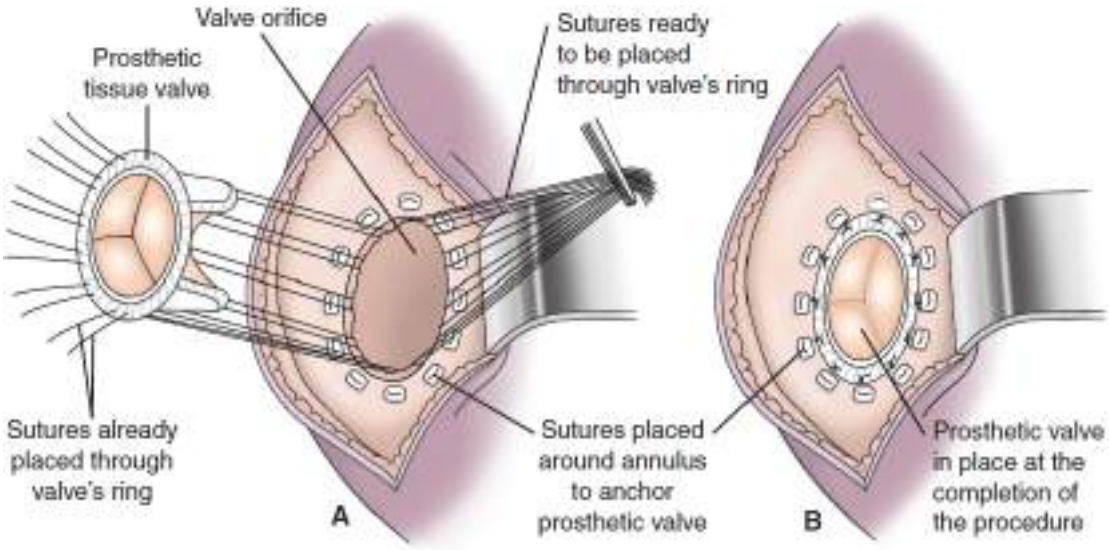

Figure 24-6 • Valve replacement. **A.** The native valve is trimmed, and the prosthetic valve is sutured in place. **B.** Once all sutures are placed through the ring, the surgeon slides the prosthetic valve down the sutures and into the natural orifice. Sutures are then tied off and trimmed.

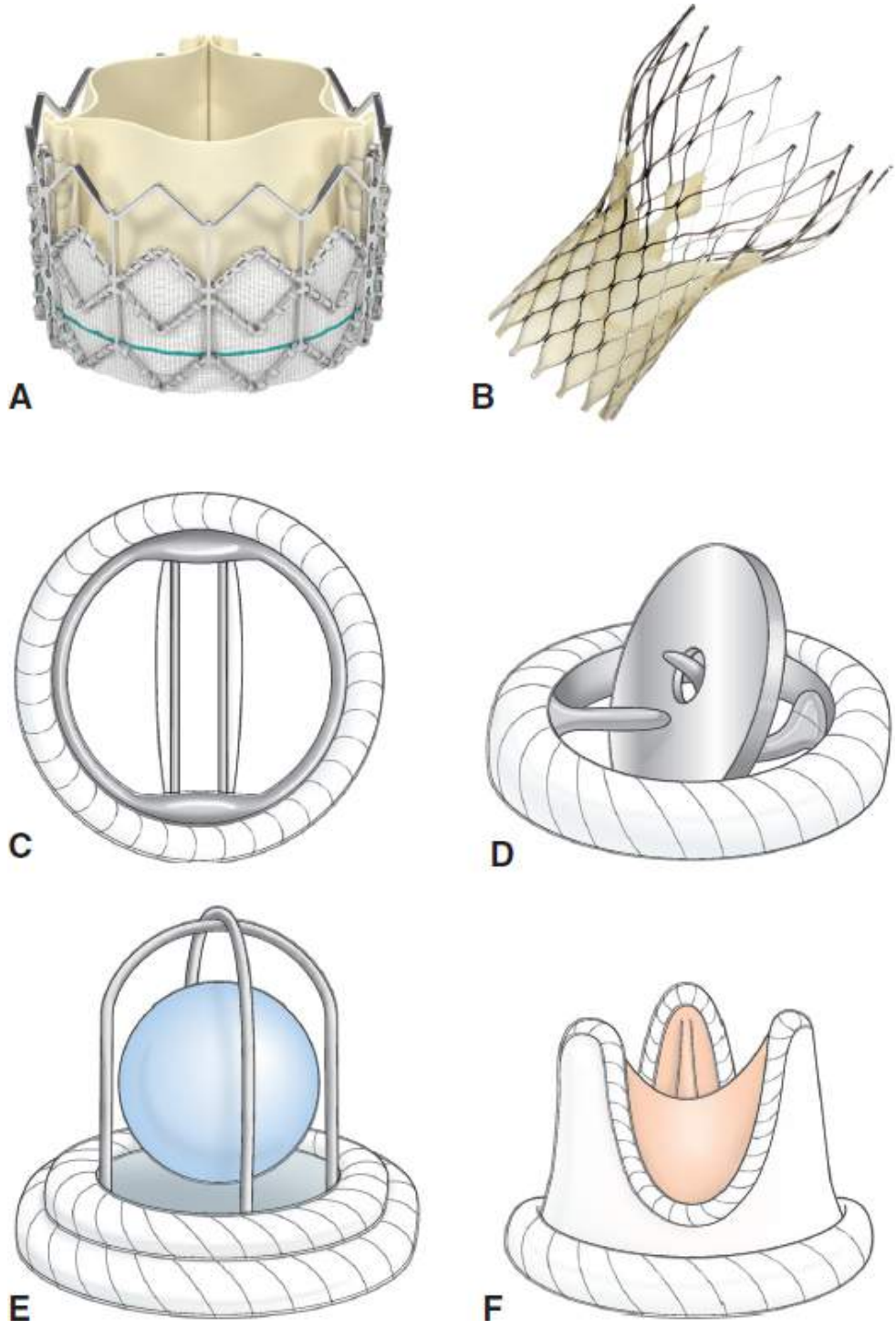

Figure 24-7 • Common mechanical and tissue valve replacements. **A.** Transcatheter aortic valve (Edwards SAPIEN transcatheter heart valve, tissue). Used with the permission of Edwards Lifesciences LLC, Irvine, CA; Edwards SAPIEN and SAPIEN are trademarks of Edwards Lifesciences Corporation. **B.** Transcatheter aortic valve (Medtronic The CoreValve® system, tissue). Used with the permission of Medtronic. The CoreValve System® CoreValve is a registered trademark of Medtronic CV Luxembourg S.A.R.L.). **C.** Bileaflet (St. Jude, mechanical). **D.** Tilting disc valve (Medtronic-Hall,

mechanical). **E.** Caged ball valve (Starr-Edwards, mechanical). **F.** Porcine bioprosthesis valve (Carpenter-Edwards, tissue).

Several types of mechanical and tissue valve prostheses may be used (Chikwe & Castillo, 2017) (Fig. 24-7).

Mechanical Valves

Mechanical valves are of the bileaflet (Fig. 24-7C), tilting disc (Fig. 24-7D), or caged ball (Fig. 24-7E) design and are thought to be more durable than tissue prosthetic valves (Fig. 24-7F); therefore, they often are used for younger patients. These valves also are used for patients requiring valve replacement who also have kidney injury, hypercalcemia, endocarditis, or sepsis, since mechanical valves do not deteriorate or become infected as easily as tissue valves. Significant complications associated with mechanical valves are thromboemboli and complications that can be associated with long-term use of required anticoagulants (see Chapter 26 for further discussion).

Tissue Valves

There are three types of tissue valves: bioprostheses, homografts, and autografts. Tissue valves are less likely than mechanical valves to generate thromboemboli, and long-term anticoagulation is not required. Tissue valves are not as durable as mechanical valves and require replacement more rapidly (Chikwe & Castillo, 2017; Nishimura et al., 2014).

Bioprostheses

Bioprostheses are valves made from animal tissues (i.e., heterografts) used for aortic, mitral, and tricuspid valve replacement. They are not thrombogenic; therefore, patients do not need long-term anticoagulation therapy. They are used for women of childbearing age to avoid potential complications of long-term anticoagulation associated with menses, placental transfer to a fetus, and delivery of a child. They also are considered for patients older than 70 years and others who cannot tolerate long-term anticoagulation. Most bioprostheses are from pigs (porcine), but some are from cows (bovine) or horses (equine). They may be stented or nonstented. Viability is 7 to 15 years.

Homografts

Homografts, also called allografts (i.e., human valves), are obtained from cadaver tissue donations and are used for aortic and pulmonic valve replacement. The aortic valve and a portion of aorta or the pulmonic valve and a portion of pulmonary artery are harvested and stored cryogenically.

Homografts are not always available and are very expensive. They last for about 10 to 15 years and are typically used in younger patients who require replacement of the valve root (Tudorache, Horke, Cebotari, et al., 2016).

Autografts

Autografts (i.e., autologous valves) are obtained by excising the patient's own pulmonic valve and a portion of the pulmonary artery for use as the aortic valve. Anticoagulation is unnecessary because the valve is the patient's own tissue and is not thrombogenic. The autograft is an alternative for children (it may grow as the child grows), women of childbearing age, young adults, patients with a history of peptic ulcer disease, and people who cannot tolerate anticoagulation. Aortic valve autografts have remained viable for more than 20 years (Mazine, El-Hamamsy, Verma, et al., 2018). If pulmonary vascular pressures are normal, some surgeons elect not to then replace the pulmonic valve. Patients can recover without a valve between the right ventricle and pulmonary artery.

However, most aortic valve autograft procedures are double valve replacement procedures with a homograft pulmonic valve replacement also performed. If there is recurrent valve dysfunction after this procedure, patients may undergo further corrective surgery, often in the form of a reversal of the original homograft. In patients who are older and for whom this may no longer be an option, replacement with a prosthetic valve may be considered (Hussain, Majdalany, Dunn, et al., 2018).

Nursing Management: Valvuloplasty and Valve Replacement

The nurse assists the patient and family to prepare for the procedure, reinforces and supplements explanations provided by the primary provider, and provides psychosocial support. (See Chapters 14 through 16 for care of the surgical patient.)

Patients who have undergone percutaneous balloon valvuloplasty with or without percutaneous valve replacement may be admitted to a telemetry unit or intensive care unit (ICU). The nurse assesses for signs and symptoms of heart failure and emboli (see Chapter 25), auscultates the chest for changes in heart sounds at least every 4 hours, and provides the patient with the same care as for postprocedure cardiac catheterization or percutaneous transluminal coronary angioplasty (see Chapter 23). After undergoing percutaneous balloon valvuloplasty, the patient usually remains in the hospital for 24 to 48 hours.

Patients who have undergone surgical valvuloplasty or valve replacements are admitted to the ICU. Care focuses on recovery from anesthesia and

hemodynamic stability. Vital signs are assessed every 5 to 15 minutes and as needed until the patient recovers from anesthesia or sedation, and then are assessed according to unit protocol. Intravenous (IV) medications may be used to increase or decrease blood pressure, to treat arrhythmias, to increase or decrease heart rate; and, their effects are monitored. Medications are gradually decreased until they are no longer required, or the patient takes the needed medication by another route (e.g., oral, topical). Patient assessments are conducted every 1 to 4 hours and as needed, with attention to neurologic, respiratory, and cardiovascular systems (see Chapter 23, Chart 23-11).

After the patient has recovered from anesthesia and sedation, is hemodynamically stable without the use IV medications, and has stable physical assessment parameters, they are usually transferred to a telemetry unit, typically within 24 to 72 hours of surgery. Nursing care continues as for most postoperative patients, including wound care and patient education regarding diet, activity, medications, and self-care. The patient usually is discharged from the hospital in 3 to 7 days.

The nurse educates the patient about anticoagulant therapy, explaining the need for frequent follow-up appointments and blood laboratory studies. Patients who take warfarin have individualized target international normalized ratios, usually between 2 and 3.5 for mitral valve replacement and 1.8 and 2.2 for aortic valve replacement. Patients who have been treated with an annuloplasty ring or a tissue valve replacement usually require anticoagulation for only 3 months unless there are other risk factors such as atrial fibrillation or a history of thromboembolism. Aspirin is prescribed with warfarin for patients with bioprostheses or at high risk for embolic events (e.g., history of embolic event or having two or more preexisting conditions: diabetes, hypertension, coronary artery disease, congestive heart failure, older than 75 years) (Nishimura et al., 2014). The nurse provides education about all prescribed medications, including the name of medication, dosage, actions, prescribed schedule, potential adverse effects, and any drug–drug or drug–food interactions.

Patients with a mechanical valve prosthesis (including annuloplasty rings and other prosthetic materials used in valvuloplasty) require education to prevent infective endocarditis. Patients may be at risk for infective endocarditis, caused by bacteria entering the bloodstream and adhering to abnormal valve structures or prosthetic devices. The nurse educates the patient about how to minimize the risk of developing infective endocarditis (see prevention of endocarditis later in this chapter).

Transitional, home health, office, or clinic nurses help reinforce all new information and self-care instructions with patients and families for 4 to 8 weeks after the procedure (Chart 24-1). An echocardiogram may be performed 3 to 4 weeks after hospital discharge to further evaluate the effects and results of surgery. The echocardiogram also provides a baseline for future comparison

if cardiac symptoms or complications develop. Echocardiograms usually are repeated every 1 to 2 years.

Cardiomyopathy

Cardiomyopathy is disease of the heart muscle that is associated with cardiac dysfunction. It is classified according to the structural and functional abnormalities of the heart muscle: dilated cardiomyopathy (DCM), hypertrophic cardiomyopathy (HCM), restrictive cardiomyopathy (RCM), arrhythmogenic right ventricular cardiomyopathy/dysplasia (ARVC/D), and unclassified cardiomyopathy (Elliott, Andersson, Arbustini, et al., 2008). A patient may have pathology representing more than one of these classifications, such as a patient with HCM with restrictive physiology. *Ischemic cardiomyopathy* is a term frequently used to describe an enlarged heart caused by coronary artery disease, which is usually accompanied by heart failure (see Chapter 25). In 2006, the American Heart Association proposed a set of Contemporary Classifications for cardiomyopathies, which continues to be in widespread use. Under this classification system, cardiomyopathies are divided into two major groups based on predominant organ involvement. These include *primary cardiomyopathies* (genetic, nongenetic, and acquired), which are focused primarily on the heart muscle, and *secondary cardiomyopathies,* which show myocardial involvement secondary to the influence of a vast list of disease processes that include, but are not limited to, amyloidosis, Fabry disease, sarcoidosis, and scleroderma (Maron, Towbin, Thiene, et al., 2006). This chapter focuses on the primary cardiomyopathies.

Pathophysiology

The pathophysiology of all cardiomyopathies is a series of events that culminate in impaired cardiac output. Decreased stroke volume stimulates the sympathetic nervous system and the renin–angiotensin–aldosterone response, resulting in increased systemic vascular resistance and increased sodium and fluid retention, which place an increased workload on the heart. Often, the decrease in cardiac output can be seen on echocardiogram as a decrease in **ejection fraction**, expressed as a percentage of the end-diastolic blood volume ejected from the ventricle with each heartbeat. These alterations can lead to heart failure (see Chapter 25).

Chart 24-1 **HOME CARE CHECKLIST**

Discharge After Valve Replacement

At the completion of education, the patient and/or caregiver will be able to:

- Name the procedure that was performed, any complications that occurred, and identify any permanent changes in anatomic structure or function as well as changes in ADLs, IADLs, roles, relationships, and spirituality.
- Identify interventions and strategies (e.g., durable medical equipment, adaptive equipment) used in recovery period.
- Describe ongoing postoperative therapeutic regimen, including diet and activities to perform (e.g., walking and breathing exercises) and to limit or avoid (e.g., lifting weights, driving a car, contact sports).
- State the name, dose, side effects, frequency, and schedule for all medications, including anticoagulant.
  - Identify the need to take anticoagulant for prescribed length of time
  - Take anticoagulant at same time each day
  - Keep appointments for laboratory tests, if indicated
  - Avoid injury that can cause bleeding
  - Report signs that could suggest occult bleeding to primary provider (e.g., bleeding gums, petechiae formation, tarry stools)
- State how to obtain medical supplies and carry out dressing changes, wound care, and other prescribed regimens.
- Identify durable medical equipment needs, proper usage, and maintenance necessary for safe utilization.
- Describe signs and symptoms of complications, including infective endocarditis, if at risk.
  - Report fevers, chills, clusters of petechiae, malaise, and weight loss to primary provider
- Engage in activities aimed at preventing infective endocarditis, as indicated:
  - Notify all health care providers of surgery and possible need for antibiotic prophylaxis preprocedure, if endorsed by primary provider
  - Practice good oral hygiene, including brushing, flossing, and regular appointments with dental hygienist
- State time and date of follow-up appointments.
- Relate how to reach the primary provider with questions or complications.
- Identify community resources for peer and caregiver/family support:
  - Identify sources of support (e.g., friends, relatives, faith community)
  - Identify the contact details for support services for patients and their caregivers/families

- Identify the need for health promotion (e.g., weight reduction, smoking cessation, stress management), disease prevention, and screening activities

ADL, activities of daily living; IADL, independent activities of daily living.

Concept Mastery Alert

Sodium is the major electrolyte involved with cardiomyopathy. Cardiomyopathy often leads to heart failure, which develops, in part, from fluid overload. Fluid overload is often associated with elevated sodium intake.

Dilated Cardiomyopathy

DCM is the most common form of cardiomyopathy, with a general prevalence of between 1 in 250 and 1 in 2500 (Merlo, Cannata, Gobbo, et al., 2018). DCM is distinguished by significant dilation of the ventricles without simultaneous hypertrophy and systolic dysfunction (Fig. 24-8). The ventricles have elevated systolic and diastolic volumes but a decreased ejection fraction.

Microscopic examination of the muscle tissue shows diminished contractile elements (actin and myosin filaments) of the muscle fibers and diffuse necrosis of myocardial cells. The result is poor systolic function. The structural changes decrease the amount of blood ejected from the ventricle with systole, increasing the amount of blood remaining in the ventricle after contraction. Less blood is then able to enter the ventricle during diastole, increasing end-diastolic pressure and eventually increasing pulmonary and systemic venous pressures. Altered valve function, usually regurgitation, can result from an enlarged stretched ventricle. Poor blood flow through the ventricle may also cause ventricular or atrial thrombi, which may embolize to other locations in the body.

More than 75 conditions and diseases may cause DCM, including pregnancy, hypertension, heavy alcohol intake, viral infection (e.g., influenza), chemotherapeutic medications (e.g., daunorubicin, doxorubicin), thyrotoxicosis, myxedema, persistent tachycardia, and Chagas disease. When the causative factor cannot be identified, the diagnosis is idiopathic DCM which accounts for 20% to 30% of nonischemic DCM cases (McNally & Mestroni, 2017; Merlo et al., 2018). Familial DCM accounts for approximately 30% to 50% of all DCM cases and approximately 40% of familial DCM cases have a definitive genetic etiology (McNally & Mestroni, 2017). An elucidation of family history by the nurse is therefore a very important component of the assessment process. Early diagnosis and treatment can prevent or delay significant symptoms and sudden death from DCM.

Hypertrophic Cardiomyopathy

The estimated prevalence of HCM is 0.16% to 0.29% of the adult population (Marian & Braunwald, 2017). HCM is an autosomal dominant genetic disorder that leads to increased heart muscle size and mass, especially along the septum (see Fig. 24-8) but can involve other areas of the heart. The phenotypic expression of the disease is age dependent. HCM is the leading cause of sudden death in adolescents and young adults, particularly in athletes (Marian & Braunwald, 2017). 12-lead ECGs, physical examinations, and echocardiograms are used to screen for the disease.

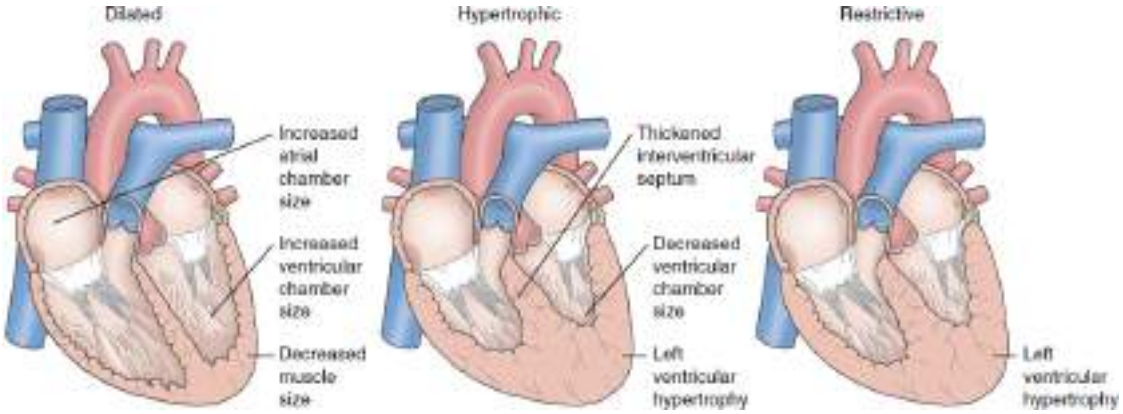

Figure 24-8 • Cardiomyopathies that lead to congestive heart failure. Adapted from Anatomical Chart Company. (2010). *Atlas of pathophysiology* (3rd ed.). Ambler, PA: Lippincott Williams & Wilkins.

Patients with a suspected diagnosis of HCM should undergo genetic testing; if negative, the diagnosis is not completely ruled out. If genetic testing is positive for known HCM genetic mutations, first-degree relatives should also be tested for the genetic mutation found in the patient. In patients that have positive genetic testing, but are asymptomatic for cardiomyopathy, annual screening with an ECG, physical examination and echocardiogram should be done, as the likelihood of clinical progression increases with increasing age. The phenotype typically manifests sometime between adolescence and the fifth decade of life (Marian & Braunwald, 2017).

Cardiac muscle cells normally lie parallel to and end to end with each other. The hypertrophied cardiac muscle cells are disorganized, oblique, and perpendicular to each other, decreasing the effectiveness of contractions. In HCM, the coronary arteriole walls are thickened, which decrease the internal diameter of the arterioles. The narrow arterioles restrict the blood supply to the myocardium, causing numerous small areas of ischemia and necrosis. The necrotic areas of the myocardium ultimately fibrose and scar, further impeding ventricular contraction and possibly increasing the risk of arrhythmias such as ventricular tachycardia and ventricular fibrillation (see Chapter 22).

Increased thickness of the heart muscle reduces the size of the ventricular cavities and causes the ventricles to take a longer time to relax after systole. During the first part of diastole, it is more difficult for the ventricles to fill with blood. The atrial contraction at the end of diastole becomes critical for ventricular filling and systolic contraction.

HCM can lead to obstruction of the left ventricular outflow tract (LVOT) if there is systolic anterior motion of the mitral valve that abuts the mitral valve against the hypertrophied septum during systole (Marian & Braunwald, 2017; Nishimura, Seggewiss, & Schaff, 2017). LVOT obstruction is a dynamic process that is dependent on both the volume of blood in the left ventricle as well as the ability of the myocytes to contract. Approximately one third of patients with HCM have LVOT obstruction at rest that worsens with provocation, another one third do not have obstruction at rest, but can get obstruction with provocation (e.g., exercise or the Valsalva maneuver), and roughly one third of patients have no LVOT obstruction even with provocation (Marian & Braunwald, 2017). Obstruction of the LVOT can lead to syncope, ventricular arrhythmias, dyspnea, and heart failure. The presence of a systolic ejection murmur can be indicative of LVOT, and echocardiography is then indicated to confirm its presence. Hydration, beta-blockers, calcium channel blockers, and lifestyle modification can be used to minimize LVOT obstruction. In particular, patients should avoid activities that can cause rapid alterations to preload (e.g., hot tubs, saunas, prolonged hot showers) (Nishimura et al., 2017). However, patients that do not respond to medical therapy should be considered for surgical myectomy or alcohol septal ablation to decrease the size of the hypertrophied septum and thereby eliminate LVOT obstruction.

Restrictive Cardiomyopathy

RCM is the least common type of cardiomyopathy (Muchtar, Blauwet, & Gertz, 2017; Pereira, Grogan, & Dec, 2018). RCM is characterized by diastolic dysfunction caused by rigid ventricular walls that impair diastolic filling and ventricular stretch (see Fig. 24-8). A rigid ventricle alters the curve in the Frank–Starling law (see Chapter 21) and leads to the rapid rise of filling pressures despite only small increases in blood volume. However, chamber size and systolic function are usually normal. Arrhythmias and conduction disturbances are common. Signs and symptoms are similar to constrictive pericarditis (see later discussion) and include dyspnea, nonproductive cough, and chest pain. Echocardiography may be useful in differentiating between these two conditions.

Generally, RCM is either due to an inherited or acquired disease that may be systemic. There are four general categories for the causes of RCM: infiltrative disease, storage disease, noninfiltrative, and endomyocardial.

An example of an infiltrative disease that may cause RCM is amyloidosis, in which amyloid, a misfolded protein, is deposited between cardiomyocytes. An inherited storage disease that can lead to RCM is hemochromatosis, in which iron deposits in the heart lead to cardiac stiffness. Scleroderma is a noninfiltrative connective tissue disorder that can cause RCM. Certain cancer treatments, such as radiation and use of various chemotherapeutic agents (e.g., anthracyclines) can cause endomyocardial damage that leads to RCM (Muchtar et al., 2017). Often, endomyocardial biopsy is needed to determine the etiology; treatment is then directed at the underlying cause.

Arrhythmogenic Right Ventricular Cardiomyopathy/Dysplasia

ARVC/D is an uncommon form of inherited heart muscle disease. The prevalence is estimated to be between 1 in 2000 and 1 in 5000 people in the general population (Bennett, Haqqani, Berruezo, et al., 2019). ARVC/D occurs when the myocardium is progressively infiltrated and replaced by fibrous scar and adipose tissue. Infiltration of fibrous and adipose tissue leads to ventricle dilatation, poor contractility, and arrhythmias.

Initially, only localized areas of the right ventricle are affected, but as the disease progresses, the entire heart is affected. Because of this typical pathologic progression, there is a move to change the name of this cardiomyopathy to a more general term of arrhythmogenic cardiomyopathy (ACM) to recognize the left ventricular involvement (Bennett et al., 2019).

In patients with ARVC/D, palpitations or syncope may develop between 15 and 40 years of age. Sudden cardiac death may also be the first presentation. Diagnosis is made based on the ECG, echocardiogram, cardiac MRI, and family history. Since this is a genetic disorder, patients that are diagnosed are referred to a genetic counselor for testing. However, genetic testing can be negative in up to 50% of patients (Bennett et al., 2019). If a genetic mutation is identified, first-degree relatives of the patient should undergo genetic testing. Patients affected by arrhythmias may benefit from having an implantable cardioverter defibrillator (ICD) placed (see Chapter 22).

Unclassified Cardiomyopathies

Unclassified cardiomyopathies are different from or have characteristics of more than one of the previously described types and are caused by fibroelastosis, noncompacted myocardium, systolic dysfunction with minimal dilation, and mitochondrial diseases. Examples of unclassified cardiomyopathies can include left ventricular noncompaction and stress-induced (Takotsubo) cardiomyopathy (Elliott et al., 2008).

Clinical Manifestations

Patients with cardiomyopathy may remain stable and without symptoms for many years. As the disease progresses, so do the symptoms. Frequently, dilated or restrictive cardiomyopathy is first diagnosed when the patient presents with signs and symptoms of heart failure (e.g., DOE, fatigue, PND, cough [especially with exertion or at night], orthopnea, peripheral edema, early satiety, nausea; see Chapter 25). The patient also may experience chest pain, palpitations, dizziness, nausea, and syncope with exertion.

Assessment and Diagnostic Findings

Physical examination at early stages may reveal tachycardia and extra heart sounds (e.g., S_3, S_4). Patients with DCM may have diastolic murmurs, and patients with DCM and HCM may have systolic murmurs. With disease progression, examination also reveals signs and symptoms of heart failure (e.g., crackles on pulmonary auscultation, jugular vein distention, pitting edema of dependent body parts, hepatomegaly [i.e., enlarged liver]).

Diagnosis is usually made from findings disclosed by the patient history and by ruling out other causes of heart failure such as myocardial infarction. The echocardiogram is one of the most helpful diagnostic tools because the structure and function of the ventricles can be observed easily. Cardiac MRI may also be used, particularly to assist with the diagnosis of HCM and ARCV/D. ECG may demonstrate arrhythmias (atrial fibrillation, ventricular arrhythmias) and changes consistent with left ventricular hypertrophy (left axis deviation, wide QRS, ST changes, inverted T waves). In ARVC/D, the ECG may show QRS widening, T-wave inversions in leads V_1–V_4, and ventricular ectopy. Additionally, there is often a small epsilon wave at the end of the QRS (Bennett et al., 2019). The chest x-ray reveals heart enlargement and possibly pulmonary congestion. Cardiac catheterization, coronary CT, or stress testing is often used to rule out coronary artery disease as a causative factor. Endomyocardial biopsy may be performed to analyze myocardial cells, particularly in RCM.

Medical Management

Medical management is directed toward identifying and managing possible underlying or precipitating causes; correcting the heart failure with medications, a low sodium diet, and an exercise/rest regimen (see Chapter 25); and controlling arrhythmias with antiarrhythmic medications and possibly with an implanted electronic device, such as an ICD (see Chapter 22). If the patient has signs and symptoms of congestion, fluid intake may be limited to 2 L each day. However, patients with HCM should avoid dehydration and may need beta-blockers to maintain cardiac output and minimize the risk of LVOT obstruction during systole. Anticoagulants are no longer routinely prescribed.

For some patients with DCM, biventricular pacing (also known as cardiac resynchronization therapy or CRT) increases the ejection fraction and reverses some of the structural changes in the myocardium (see Chapter 22).

As noted previously, some forms of cardiomyopathy are inherited/genetic. Any family history of cardiomyopathy should be noted when the nurse is taking a family health history. In appropriate cases, the patient should be referred to a genetic counselor for testing. If genetic mutations are found, it is recommended that first-degree relatives also be tested. Unfortunately, there are currently some problems with patients receiving insurance reimbursement for genetic testing in the United States.

Surgical Management

When heart failure progresses and medical treatment is no longer effective, surgical intervention, including heart transplantation, is considered. However, because of the limited number of organ donors, many patients die waiting for transplantation. In some cases, a VAD is implanted to support the failing heart until a suitable donor heart becomes available (see later discussion).

Left Ventricular Outflow Tract Surgery

When patients with HCM and LVOT obstruction become symptomatic despite optimal medical therapy or cannot tolerate medical therapy, surgery is considered. The most common procedure done is a myectomy (sometimes referred to as a myotomy–myectomy or the Morrow procedure), in which some of the heart tissue is excised. Septal tissue approximately 1 cm wide and deep is cut from the enlarged septum below the aortic valve. The length of septum removed typically extends to the papillary muscles. Possible complications include complete heart block and subsequent pacemaker dependence, ventricular septal defects, or failure to adequately alleviate the obstruction. Surgical mortality rates are reportedly between less than 1% and as high as 16% (Nishimura et al., 2017).

Heart Transplantation

Because of advances in surgical techniques and immunosuppressive therapies, heart transplantation is now a therapeutic option for patients with end-stage heart disease. Cyclosporine and tacrolimus are some of the more common immunosuppressants that decrease the body's rejection of foreign proteins, such as transplanted organs. Unfortunately, these drugs also decrease the body's ability to resist infections and increase the risk of various cancers, and a satisfactory balance must be achieved between suppressing rejection and avoiding infection. In 2017, there were 3273 heart transplants performed in the United States (Scientific Registry of Transplant Recipients, 2017).

Cardiomyopathy, ischemic heart disease, valvular disease, rejection of previously transplanted hearts, and congenital heart disease are the most common indications for transplantation. Typical candidates have severe symptoms uncontrolled by medical therapy, no other surgical options, and a prognosis of less than 1 to 2 years to live. A multidisciplinary team screens the candidate before recommending the transplantation procedure. The person's age, pulmonary status, other chronic health conditions, psychosocial status, family support, infections, history of other transplantations, adherence to therapeutic regimens, and current health status are considered. The United Network for Organ Sharing (UNOS), a national organization that is regulated by the U.S. government, is charged with maintaining organ transplant waiting lists and allocating donor organs. When a donor heart becomes available, UNOS generates a list of potential recipients on the basis of ABO blood group compatibility, the body sizes of the donor and the potential recipient, age, severity of illness, length of time on the waiting list, and the geographic locations of the donor and potential recipient (Organ Procurement and Transplant Network [OPTN], 2019). Some patients are candidates for more than one organ transplant (e.g., heart–lung, heart–kidney, heart–liver).

Orthotopic transplantation is the most common surgical procedure for cardiac transplantation. Some surgeons prefer to remove the recipient's heart but leave a portion of the recipient's atria (with the vena cava and pulmonary veins) in place, which is known as the biatrial technique. However, this technique has been modified to a more common approach called the *bicaval technique.* This technique includes removal of the recipient's heart, and the implantation of the donor heart with intact atria at the vena cava and pulmonary veins (Fig. 24-9) (Kittleson, Patel, & Kobashigawa, 2017). This newer approach is associated with decreased AV valve regurgitation, arrhythmias, and conduction abnormalities.

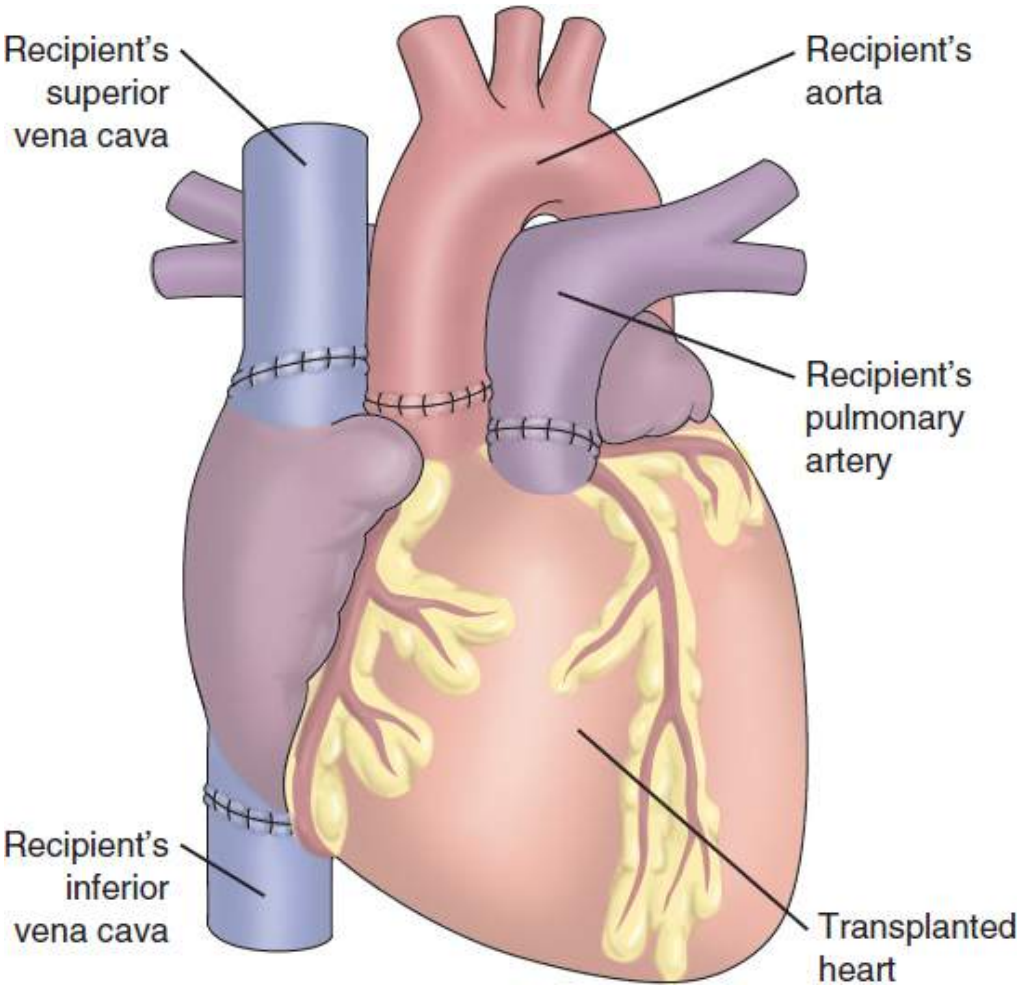

Figure 24-9 • Orthotopic method of heart transplantation.

Patients who have had heart transplantations are constantly balancing the risk of rejection with the risk of infection and diseases such as cancer. They must adhere to a complex regimen of diet, medications, activity, follow-up laboratory studies, biopsies of the transplanted heart (to diagnose rejection), and clinic visits. There are three classes of medications that are prescribed for a transplant patient to help minimize rejection: corticosteroids (e.g., prednisone), calcineurin inhibitors (tacrolimus, cyclosporine), and antiproliferative agents (mycophenolate mofetil, azathioprine, or sirolimus).

The transplanted heart has no nerve connections (i.e., denervated heart) to the recipient's body, so the sympathetic and vagus nerves do not affect the transplanted heart. The resting rate of the transplanted heart is approximately 90 to 110 bpm, but it increases gradually if catecholamines are in the circulation. Patients must gradually increase and decrease their exercise (i.e., extended warm-up and cool-down periods), because 20 to 30 minutes may be required to achieve the desired heart rate. Atropine does not increase the heart rate of transplanted hearts, and digoxin does not decrease the heart rate in atrial fibrillation. Additionally, many patients who have had heart transplantations do

not experience angina with ischemia and may present with congestive heart failure, silent myocardial infarction, or sudden death without a prior history of coronary artery disease (Kittleson et al., 2017).

In addition to rejection and infection, complications may include accelerated atherosclerosis of the coronary arteries (i.e., cardiac allograft vasculopathy, accelerated graft atherosclerosis, transplant coronary artery disease). Both immunologic and nonimmunologic factors cause arterial injury and inflammation of the coronary arteries. The arterial smooth muscle proliferates, and there is hyperplasia of the coronary artery intima, accelerating atherosclerosis along the entire length of the coronary arteries (Stehlik, Kobashigawa, Hunt, et al., 2018). Hypertension may occur in patients taking cyclosporine or tacrolimus due to the effect these medications have on the kidneys. Osteoporosis is a frequent side effect of the antirejection medications as well as pretransplantation dietary insufficiency and medications. Patients with a long-term sedentary lifestyle are at greater risk for osteoporosis. Posttransplantation lymphoproliferative disease and cancer of the skin and lips are the most common malignancies after transplantation, possibly caused by immunosuppression. Weight gain, obesity, diabetes, dyslipidemias (e.g., hypercholesterolemia), hypertension, and kidney failure, as well as central nervous system, respiratory, and gastrointestinal disturbances, may be adverse effects of corticosteroids or other immunosuppressants. Toxicity from immunosuppressant medications may occur as well. For patients receiving their transplanted hearts after the year 2000, the median survival is more than 12 years (Stehlik et al., 2018).

In the first year after transplantation, patients respond to the psychosocial stresses imposed by organ transplant in various ways. Most report a higher quality of life and can return to activities of daily living and to work with little to no functional limitations (Stehlik et al., 2018). Some have significant feelings of indebtedness to the donor, or experience guilt that someone had to die for them to be able to live, which can negatively affect their adherence to the medical regimen (Shemesh, Peles-Bortz, Peled, et al., 2017) (see Chart 24-2 Nursing Research Profile: Factors Affecting Nonadherence After Heart Transplant).

Mechanical Assist Devices and Total Artificial Hearts

The use of cardiopulmonary bypass in cardiovascular surgery and the possibility of performing heart transplantation in patients with end-stage cardiac disease, as well as the desire for a treatment option for patients who are not transplant candidates, have increased the need for mechanical assist devices. Patients who cannot be weaned from cardiopulmonary bypass and patients in cardiogenic shock may benefit from a period of mechanical heart assistance. The most commonly used device is the intra-aortic balloon pump

(see Chapter 11). This pump decreases the work of the heart during contraction but does not perform the actual work of the heart.

Ventricular Assist Devices

More complex devices that perform some or all of the pumping function for the heart are now being used. These more sophisticated **ventricular assist devices** can circulate as much blood per minute as the heart, if not more (Fig. 24-10). There are short- and long-term devices available, depending on the indication. Each VAD is used to support one ventricle, although in some instances, two VAD pumps may be used for biventricular support. Additionally, some VADs can be combined with an oxygenator; the combination is called *extracorporeal membrane oxygenation (ECMO)*. The oxygenator–VAD combination is used for the patient whose heart cannot pump adequate blood through the body or when the lungs fail to oxygenate the blood despite supplemental oxygen or ventilation.

VADs may be external, internal (i.e., implanted) with an external power source, or completely internal, and they may generate a pulsatile or continuous blood flow. There are four types of VADs: pneumatic, electric or electromagnetic, axial flow, and centrifugal. Pneumatic VADs are external or implanted pulsatile devices with a flexible reservoir housed in a rigid exterior. The reservoir usually fills with blood drained from the atrium or ventricle. The device then forces pressurized air into the rigid housing, compressing the reservoir and returning the blood to the circulation, usually into the aorta. Electric or electromagnetic VADs are similar to pneumatic VADs, but instead of using pressurized air to return the blood to the circulation, one or more flat metal plates are pushed against the reservoir. Generally, pulsatile VADs have been replaced by the newer generation of axial and centrifugal pumps. The axial and centrifugal pumps have lower rates of pump thrombus formation and are of smaller device sizes. Axial flow VADs use a rotary mechanism (an impeller) to create nonpulsatile blood flow. The impeller spins rapidly within the VAD, creating a vacuum that pulls blood into the VAD and then pushes the blood out into the systemic circulation—the process is similar to a fan spinning in a tunnel, pulling air in one end of the tunnel and pushing it out the other. Centrifugal VADs are nonpulsatile devices that consist of a single moving impeller that is suspended in the pump housing by a combination of magnetic and hydrodynamic forces. The impeller rotates and pulls blood into the pump housing and ejects the blood out to the systemic circulation (Kittleson et al., 2017).

Chart 24-2 **NURSING RESEARCH PROFILE**

Factors Affecting Nonadherence After Heart Transplant

Shemesh, Y., Peles-Bortz, A., Peled, Y., et al. (2017). Feelings of indebtedness and guilt toward donor and immunosuppressive medication adherence among heart transplant (HTx) patients, as assessed in a cross-sectional study with the Basel Assessment of Adherence to Immunosuppressive Medications Scale (BAASIS). *Clinical Transplantation, 31*(10). doi:10.1111/ctr.13053

Purpose

The purpose of this study was to assess immunosuppression medication adherence among patients who had heart transplants and to test if adherence was affected by feelings of indebtedness and guilt toward the donor.

Design

This was a descriptive correlational study with a cross-sectional design. It utilized a convenience sample consisting of 102 patients who had heart transplants and who engaged in outpatient follow up at the Sheba Medical Center in Israel. Participants were 76.5% male, 65.3% were born in Israel, and had a mean age of 56.66 y at the time of the study. The five-item BAASIS survey was used to assess adherence in the past 4 wks as it related to timing of medication intake, self-altering the prescribed dosage, and stopping or missing medication doses. Feelings of guilt and indebtedness were assessed with two survey questions via a Likert scale. Medical record review was also utilized. Data were evaluated using a variety of statistical analyses, which included *t*-tests, correlation analyses, and logistic regression analysis.

Findings

Sixty-four percent of participants reported nonadherence with immunosuppression within the previous 4 wks. Age, time since transplant, and feelings of guilt were statistically associated with variance in adherence. An increase in age was associated with an increase in adherence, whereas an increase in time since transplant and feelings of guilt were associated with an increase in nonadherence.

Nursing Implications

Nonadherence to immunosuppression is associated with an increase in morbidity and mortality among patients with heart transplants. Nurses should assess patients' adherence to immunosuppression and be aware of the various factors that may influence adherence. Understanding what can contribute to nonadherence, such as feelings of guilt, enables the nurse to attempt to alleviate those feelings and thereby improve patient adherence and transplant outcomes.

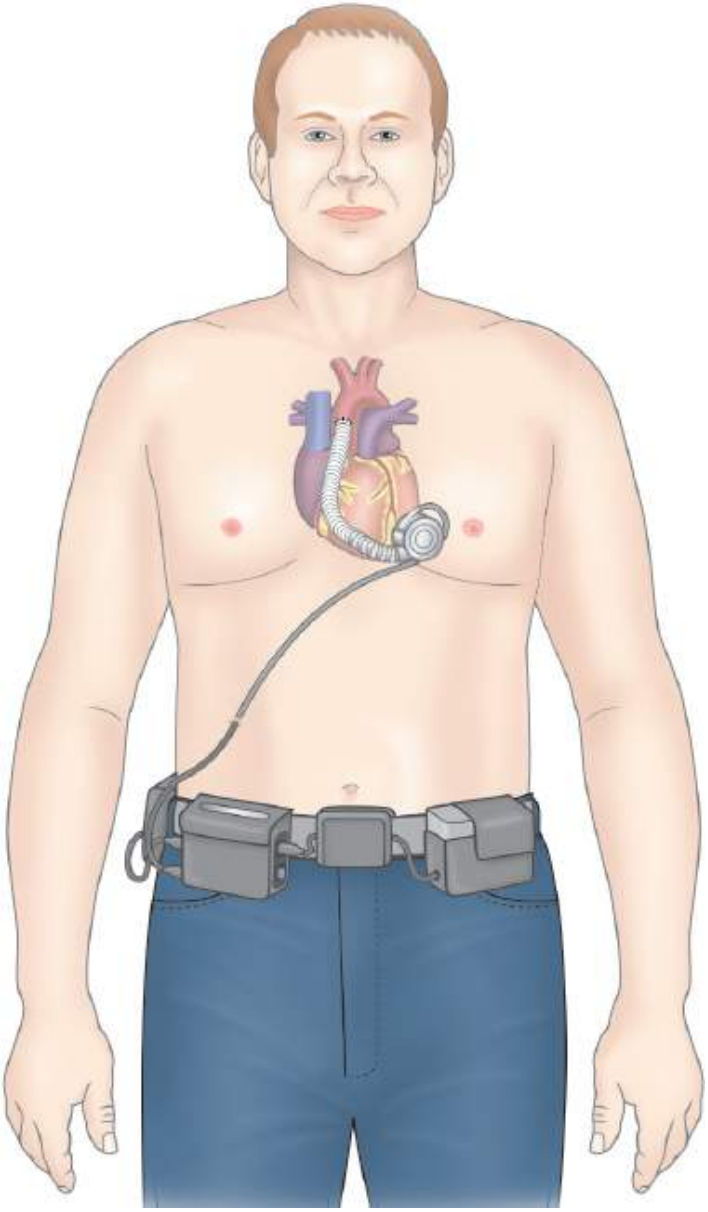

Figure 24-10 • Left ventricular assist device. Reproduced with permission of Medtronic.

VADs may be used as (1) a "bridge to recovery" for patients who require temporary assistance for reversible ventricular failure, (2) a "bridge to transplant" for patients with end-stage heart failure until a donor organ becomes available for transplant, and (3) "destination therapy" for patients with end-stage heart failure who are not candidates for or decline heart transplantation and have the VAD implanted for permanent use (Kittleson et al., 2017). As patients spend an increased length of time on the transplant list and more VADs are being implanted, destination therapy now accounts for 50% of patients on mechanical circulatory support (Han, Acker, & Atluri, 2018). Thus, the volume of patients with VADs in the community is rapidly expanding and it is important that first responders and other providers are

familiar with the basics of VAD management and equipment (Cook, Colvin, Francis, et al., 2017). In some instances, the patient may request deactivation of the VAD, which may cause ethical controversy (Chart 24-3).

Chart 24-3 **ETHICAL DILEMMA**

Can an Adult with a Left Ventricular Assist Device (LVAD) Have the LVAD Deactivated?

Case Scenario

You work on a cardiac intensive care unit (CICU) and are assigned to care for J.J., a 75-year-old man with an extensive cardiac history who received a left ventricular assist device (LVAD) 10 mo ago. When the device was implanted, J.J. knew the treatment was a destination therapy (i.e., a final treatment option) since he was not a candidate for a heart transplant. The goal was to improve his quality of life. However, this is now his 12th hospitalization since the LVAD was activated, and J.J. now questions the purported benefit of the LVAD. During morning rounds with the cardiologist, J.J. tells you, the cardiologist, his wife, and adult daughter that he feels that the quality of his life is poor and not going to improve. He pointedly asks the cardiologist to deactivate the device, saying that he realizes this will lead to his death. J.J. is mentally competent (i.e., possesses the mental capacity to understand the ramifications of his request). J.J.'s family, the cardiologist, and you are all stakeholders in this decision and each of you express reluctance at honoring his request.

Discussion

Many ethical dilemmas are inherent in this scenario. Although the LVAD is internally implanted, the control switch to deactivate the device is external. Some bioethicists argue that since the device has an external component, deactivating the device is similar to withdrawing treatment, which is ethical. Others argue that it becomes an integrated body part once it is implanted; therefore, to remove it is consistent with euthanasia. There is an obligation to respect J.J.'s autonomy and self-determination, especially since he has the capacity to make these decisions (i.e., he is mentally competent). Yet, there is a "slippery slope" at play here in terms of the principle of nonmaleficence.

Analysis

- Identify the ethical principles that are in conflict in this case (see Chapter 1, Chart 1-7). Which principle do you think should have preeminence as you work to resolve the conflicting emotions between J.J., his family, and the health care team?
- What arguments would you offer *in favor of* removal of the LVAD?
- What arguments would you offer *against* removal of the LVAD?
- Do you believe deactivation of an LVAD is the same as withdrawal of other life-sustaining treatments (e.g., extubation)? Do you believe deactivation of an LVAD constitutes euthanasia?
- Assume that J.J. is determined competent to make this decision and the deactivation is scheduled. Discuss the implications of this procedure on the stakeholders including you, the cardiologist, and the patient's wife and daughter. Do you have the right to refuse to

participate in the procedure? Identify what resources might be of help to you as you grapple with making the best decision for all stakeholders.

References

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Resources

See Chapter 1, Chart 1-10 for Steps of an Ethical Analysis and Ethics Resources.

Total Artificial Hearts

Total artificial hearts are designed to replace both ventricles. Only one TAH has been approved by the U.S. Food and Drug Administration (FDA) as a bridge to transplant, the SynCardia TAH, and it requires the removal of the patient's heart for implant. Although there has been some short-term success, the long-term results have been disappointing. Researchers hope to develop a device that can be permanently implanted and will eliminate the need for donated human heart transplantation for end-stage cardiac disease. The CARMAT TAH is undergoing early clinical trials in Europe; it features biocompatible materials (Ewald, Milano, & Rogers, 2019).

Complications of VADs and TAHs include bleeding disorders, hemorrhage, thromboemboli, hemolysis, infection, kidney injury, right-sided heart failure, multisystem failure, and mechanical failure. Nursing care of patients with these mechanical assist devices focuses on assessment for and minimization of these complications as well as providing emotional support and education about the device and the underlying cardiac disease.

NURSING PROCESS

The Patient with Cardiomyopathy

Assessment

Nursing assessment for the patient with cardiomyopathy begins with a detailed history of the presenting signs and symptoms. The nurse identifies possible etiologic factors, such as heavy alcohol intake, recent illness or pregnancy, family history of sudden death or history of the disease in immediate family members. If the patient reports chest pain, a thorough review of the pain, including its precipitating factors, is warranted. The review of systems includes the presence of orthopnea, PND, and syncope or dyspnea with exertion. The number of pillows needed to sleep, usual weight, any weight change, and limitations on activities of daily living are assessed. The American College of Cardiology and American Heart Association Stages of Heart Failure classification is utilized to help identify disease progression, and the New York Heart Association Functional Classification for heart failure is determined based on the severity of the patient's symptoms (see Chapter 25, Tables 25-1 and 25-2). The patient's usual diet is evaluated to determine the need to reduce sodium intake, optimize nutrition, or supplement with vitamins.

Because of the chronicity of cardiomyopathy, the nurse conducts a careful psychosocial history, exploring the impact of the disease on the patient's role within the family and community. Identification of perceived stressors helps the patient and the health care team to implement activities that relieve anxiety associated with changes in health status. Very early on, the patient's support systems are identified, and members are encouraged to become involved in the patient's care and therapeutic regimen. The assessment addresses the effect the diagnosis has had on the patient and members of their support system and the patient's emotional status. Findings from a recent meta-analysis suggest that 19% of patients with heart failure meet criteria for depressive disorders and 21.5% have significant symptoms of depression (Celano, Villegas, Albanese, et al., 2018). Various screening tools are available to assess symptoms associated with heart failure, including depression, though no one screening tool has emerged as the generally accepted standard.

The physical assessment focuses on signs and symptoms of heart failure. The baseline assessment includes key components such as:

- Vital signs
- Calculation of pulse pressure and identification of pulsus paradoxus
- Current weight and any weight gain or loss
- Detection by palpation of the point of maximal impulse, often shifted to the left

- Cardiac auscultation for a systolic murmur and S_3 and S_4 heart sounds
- Pulmonary auscultation for crackles
- Measurement of jugular vein distention
- Assessment of edema and its severity

Diagnosis

Nursing Diagnoses

Based on the assessment data, major nursing diagnoses may include the following:

- Impaired cardiac output associated with structural disorders caused by cardiomyopathy or to arrhythmia from the disease process and medical treatments
- Risk for impaired cardiac function, ineffective tissue perfusion, and impaired peripheral tissue perfusion associated with decreased peripheral blood flow (resulting from impaired cardiac output)
- Impaired gas exchange associated with pulmonary congestion caused by myocardial failure (resulting from impaired cardiac output)
- Activity intolerance associated with impaired cardiac output or excessive fluid volume, or both
- Anxiety associated with the change in health status and in role functioning
- Powerlessness associated with disease process
- Able to perform self care associated with medication and diet therapies

Collaborative Problems/Potential Complications

Potential complications may include the following:

- Heart failure
- Ventricular arrhythmias
- Atrial arrhythmias
- Cardiac conduction defects
- Pulmonary or cerebral embolism
- Valvular dysfunction

These complications are discussed earlier in this chapter and in Chapters 22 and 25.

Planning and Goals

The major goals for patients include improvement or maintenance of cardiac output, increased activity tolerance, reduction of anxiety, effective management of the self-care program, increased sense of power with decision making, and absence of complications.

Nursing Interventions

Improving Cardiac Output and Peripheral Blood Flow

During a symptomatic episode, rest is indicated. Many patients with DCM find that sitting up with their legs down is more comfortable than lying down in a bed. This position is helpful in pooling venous blood in the periphery and reducing preload. Assessing the patient's oxygen saturation at rest and during activity may assist with determining a need for supplemental oxygen. Oxygen usually is given through a nasal cannula when indicated.

Ensuring that medications are taken as prescribed is important to preserving adequate cardiac output. The nurse may assist the patient with planning a schedule for taking medications and identifying methods to remember to follow it, such as associating the time to take a medication with an activity (e.g., eating a meal, brushing teeth) or obtaining a pillbox.

It is also important to ensure that the patient receives or chooses food selections that are appropriate for a low sodium diet. One way to monitor a patient's response to treatment is to determine the patient's weight every day and identify any significant change. Another indication of the effect of treatment involves assessment of shortness of breath after activity and comparison to before treatment, as well as a change in the number of pillows needed to comfortably sleep. Patients with low cardiac output may need assistance keeping warm and frequently changing position to stimulate circulation and reduce the possibility of skin breakdown.

Increasing Activity Tolerance and Improving Gas Exchange

The nurse plans the patient's activities so that they occur in cycles, alternating rest with activity periods. This benefits the patient's physiologic status, and it helps educate the patient about the need for planned cycles of rest and activity. For example, after taking a bath or shower, the patient should plan to sit and read a newspaper or engage in other relaxing activities. Suggesting that the patient sit while chopping vegetables, drying their hair, or shaving helps the patient learn to balance rest with activity. The nurse also makes sure that the patient recognizes the symptoms indicating the need for rest and actions to take when the symptoms occur. Patients with HCM, ARVC/D, or RCM must avoid strenuous activity, isometric exercises, and competitive sports.

Reducing Anxiety

Spiritual, psychological, and emotional support may be indicated for patients, families, and significant others. Interventions are directed toward eradicating or alleviating perceived stressors. Patients receive appropriate information about cardiomyopathy and self-management activities. It is important to provide an atmosphere in which patients feel free to verbalize concerns and receive assurance that their concerns are legitimate. If the

patient is awaiting transplantation or facing death, it is necessary to allow time to discuss these issues. Providing the patient with realistic hope helps reduce anxiety while they await a donor heart. The nurse helps the patient, family, and significant others with anticipatory grieving.

Decreasing the Sense of Powerlessness

Patients often go through a grieving process when cardiomyopathy is diagnosed. The patient is assisted in identifying the things in life that they have lost (e.g., foods that the patient enjoyed eating but are high in sodium, the ability to engage in an active lifestyle, the ability to play sports, the ability to lift grandchildren) and their emotional responses to the loss (e.g., anger, feelings of sadness). The nurse assists the patient in identifying the amount of control that they still have over life, such as making food choices, managing medications, and working with the patient's primary provider to achieve the best possible outcomes. A diary in which the patient records food selections and weight may help with understanding the relationship between sodium intake and weight gain and give patients a sense of control over their disease. Some patients can manage a self-titrating diuretic regimen in which they adjust the dose of diuretic to their symptoms.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care. A key part of the plan of nursing care involves educating patients about the medication regimen, symptom monitoring, and symptom management (Chart 24-4). The nurse plays an integral role as the patient learns to balance lifestyle and work while accomplishing therapeutic activities. Helping patients cope with their disease status helps them adjust their lifestyles and implement a self-care program at home. Attainment of a goal, no matter how small, also promotes the patient's sense of well-being.

Continuing and Transitional Care. The nurse reinforces previous education and performs ongoing assessment of the patient's symptoms and progress. The nurse also assists the patient and family to adjust to lifestyle changes. Patients are taught to read nutrition labels, to maintain a record of daily weights and symptoms, and to organize daily activities to increase activity tolerance. In addition, the nurse assesses the patient's response to recommendations about diet and fluid intake and to the medication regimen and stresses the signs and symptoms that should be reported to the primary provider. Because of the risk of arrhythmia, it may be necessary to educate the patient's family about cardiopulmonary resuscitation and the use of an automated external defibrillator (see Chapter 25). Women are often advised to avoid pregnancy, but each case is assessed individually. The nurse assesses the psychosocial needs of the patient and family on an ongoing

basis. There may be concerns and fears about the prognosis, changes in lifestyle, effects of medications, and the possibility of others in the family having the same condition; these concerns often increase the patient's anxiety and interfere with effective coping strategies. Establishing trust is vital to the nurse's relationship with patients who are chronically ill and with these patients' families. This is particularly significant when the nurse is involved with a patient and family in discussions about end-of-life decisions. Patients who have significant symptoms of heart failure or other complications of cardiomyopathy may benefit from transitional or home care.

Evaluation

Expected patient outcomes may include:

1. Maintains or improves cardiac function
   a. Exhibits heart and respiratory rates within normal limits

Chart 24-4 **HOME CARE CHECKLIST**

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of cardiomyopathy on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- Identify interventions and strategies (e.g., durable medical equipment, adaptive equipment) used in adapting to any permanent or temporary changes in structure or function.
- State the name, dose, side effects, frequency, and schedule for all medications.
- Take or administer medications daily, exactly as prescribed.
- Monitor effects of medication such as changes in breathing and edema.
- Know signs and symptoms of arrhythmia formation (e.g., lightheadedness, dizziness, orthostatic hypotension, racing heartbeats, diaphoresis, confusion):
  - Identify how to initiate emergency response.
  - Demonstrate skill set in cardiopulmonary resuscitation.
  - Demonstrate use of an automated external defibrillator.
- Weigh self daily at the same time with same clothes.
- Restrict sodium intake to no more than 2 g/day:
  - Adapt diet by examining nutrition labels to check sodium content per serving.
  - Avoid canned or processed foods, eating fresh or frozen foods.
  - Consult the written diet plan and the list of permitted and restricted foods.
  - Avoid salt use.
  - Avoid excesses in eating and drinking.
- Participate in prescribed activity program:
  - Participate in a daily exercise program, with walking and other activities, provided they do not cause unusual fatigue or dyspnea.
  - Conserve energy by balancing activity with rest periods.
  - Avoid strenuous activity, isometric exercises, and competitive sports.
- Develop methods to manage and prevent stress:
  - Avoid tobacco.
  - Avoid alcohol.
  - Engage in social and diversional activities.
- Identify community resources for peer and caregiver/family support:

- Identify sources of support (e.g., friends, relatives, faith community).
- Identify the contact details for support services for patients and their caregivers/families.
- State meeting locations and times.

- Report immediately to the primary provider or clinic any of the following:
  - Gain in weight of 2–3 lb (0.9–1.4 kg) in 1 d, or 5 lb (2.3 kg) in 1 wk
  - Unusual shortness of breath with activity or at rest
  - Increased swelling of ankles, feet, or abdomen
  - Persistent cough
  - Loss of appetite
  - Development of restless sleep; increase in number of pillows needed to sleep
  - Profound fatigue
- State how to reach primary provider with questions or complications.
- State time and date of follow-up appointments and diagnostic tests.
- Identify the need for health promotion, disease prevention, and screening activities.

ADL, activities of daily living; IADL, independent activities of daily living.

   b. Reports decreased dyspnea and increased comfort; maintains or improves gas exchange
   c. Reports no weight gain; appropriate weight for height
   d. Maintains or improves peripheral blood flow
2. Maintains or increases activity tolerance
   a. Carries out activities of daily living (e.g., brushes teeth, feeds self)
   b. Reports increased tolerance to activity
3. Is less anxious
   a. Discusses prognosis freely
   b. Verbalizes fears and concerns
   c. Participates in support groups if appropriate
   d. Demonstrates appropriate coping mechanisms
4. Decreases sense of powerlessness
   a. Identifies emotional response to diagnosis
   b. Discusses control that they have
5. Effectively manages self-care program
   a. Takes medications according to prescribed schedule
   b. Modifies diet to accommodate sodium and fluid recommendations

c. Modifies lifestyle to accommodate activity and rest behavior recommendations
d. Identifies signs and symptoms to be reported to health care professionals

INFECTIOUS DISEASES OF THE HEART

Any of the heart's three layers may be affected by an infectious process. Infections are named for the layer of the heart most involved in the infectious process: infective endocarditis (endocardium), myocarditis (myocardium), and pericarditis (pericardium) (see Chapter 21, Fig. 21-1). Rheumatic endocarditis is a unique infective endocarditis syndrome. Diagnosis of infection is made primarily on the basis of the patient's symptoms and echocardiography. Ideal management for all infectious diseases is prevention. IV antibiotics usually are necessary once an infection has developed in the heart.

Rheumatic Endocarditis

Acute rheumatic fever, which occurs most often in school-age children, may develop after an episode of group A beta-hemolytic streptococcal pharyngitis (Chart 24-5). Patients with rheumatic fever may develop rheumatic heart disease as evidenced by a new heart murmur, cardiomegaly, pericarditis, and heart failure. Prompt and effective treatment of "strep" throat with antibiotics can prevent development of rheumatic fever. Streptococcus is spread by direct contact with oral or respiratory secretions. Although bacteria are the causative agents, malnutrition, overcrowding, poor hygiene, and lower socioeconomic status may predispose individuals to rheumatic fever. The incidence of rheumatic fever in developed countries has decreased and it is now primarily a disease of the developing world (Cannon, Roberts, Milne, et al., 2017). As noted earlier in the chapter, rheumatic heart disease may lead to mitral valve stenosis or regurgitation that remains an issue in adulthood. Further information about rheumatic fever and rheumatic endocarditis can be found in pediatric nursing books.

Chart 24-5

Rheumatic Fever

Rheumatic fever is a preventable disease. Diagnosing and effectively treating streptococcal pharyngitis can prevent rheumatic fever and, therefore, rheumatic heart disease. Signs and symptoms of streptococcal pharyngitis include:

- Sore throat that can start very quickly
- Pain when swallowing
- Fever
- Red and swollen tonsils, sometimes with white patches or streaks of pus
- Petechiae (tiny, red spots) on the roof of the mouth (the soft or hard palate)
- Swollen lymph nodes in the front of the neck

If signs and symptoms of streptococcal pharyngitis are present, a rapid strep test is necessary to make an accurate diagnosis. If the test is negative but strep throat is still suspected, then a throat culture can be done. For adults, it is usually not necessary to do a throat culture following a negative rapid strep test. Adults are generally not at risk for getting rheumatic fever following a strep throat infection. All patients with a positive rapid strep test or throat cultures positive for streptococcal pharyngitis must adhere to the prescribed antibiotic treatment. Penicillin or amoxicillin are typical first-line antibiotics used. Completing the course of prescribed antibiotics minimizes the risk of developing rheumatic fever (and subsequent rheumatic heart disease).

Adapted from Centers for Disease Control and Prevention (CDC). (2018). *Strep throat: All you need to know*. Retrieved on 12/3/2019 at: www.cdc.gov/groupastrep/diseases-public/strep-throat.html

Infective Endocarditis

Infective endocarditis is a microbial infection of the endothelial surface of the heart. The disease is rare, but it has a high mortality rate; approximately 14% to 22% of patients die during their hospital stay, and up to 40% of patients die within 1 year of diagnosis (Kaura, Byrne, Fife, et al., 2017). It usually develops in older adults, or in people with prosthetic heart valves or cardiac devices. Staphylococcal endocarditis infections of valves in the right side of the heart are common among adults who use illicit IV drugs (Baddour, Wilson, Bayer, et al., 2015). Hospital-acquired infective endocarditis occurs most often in patients with debilitating disease or indwelling catheters and in patients who are receiving hemodialysis or prolonged IV fluid or antibiotic therapy (Chart 24-6).

Pathophysiology

A deformity or injury of the endocardium leads to accumulation of fibrin and platelets (clot formation) on the endocardium. Infectious organisms, usually staphylococci or streptococci, invade the clot and endocardial lesion. Infection most frequently results in platelets, fibrin, blood cells, and microorganisms that cluster as vegetations on the endocardium. Vegetations may embolize to other vessels throughout the body. As the clot on the endocardium continues to expand, the infecting organism is covered by new clot and concealed from the body's normal defenses. Infection may erode through the endocardium into underlying structures (e.g., valve leaflets), causing tears or other deformities of valve leaflets, dehiscence of prosthetic valves, deformity of chordae tendineae, or mural abscesses.

Chart 24-6 RISK FACTORS

Infective Endocarditis

- Prosthetic cardiac valves or prosthetic material used for cardiac valve repair
- Implanted cardiac devices (e.g., pacemaker, implanted cardioverter defibrillator)
- History of bacterial endocarditis (even without heart disease)
- Congenital heart disease:
  - Unrepaired cyanotic disease, including patients with palliative shunts and conduits
  - Repaired with prosthetic material or device either by surgery or catheter intervention during the first 6 mo after the procedure
  - Repaired with residual defects at the site or adjacent to the site of a prosthetic patch or device
- Cardiac transplant recipients with valvulopathy
- IV drug abuse
- Body piercing (especially oral, nasal, and nipple), branding, and tattooing
- Hemodialysis

Adapted from Nishimura, R. A., Otto, C. M., Bonow, R. O., et al. (2014). 2014 AHA/ACC guidelines for the management of patients with valvular heart disease. *Journal of the American College of Cardiology, 63*(22), e57–e185.

Clinical Manifestations

Onset of infective endocarditis usually is insidious. Signs and symptoms develop from toxic effects of the infection, destruction of heart valves, and embolization of fragments of vegetative growths on the endocardium. Primary presenting symptoms of infective endocarditis are fever and a heart murmur. Fever may be intermittent or absent, especially in patients who are receiving antibiotics or corticosteroids, in older adults, and in those who have heart failure or kidney injury. A heart murmur may be absent initially but develops in 85% of patients (Karchmer, 2018). Murmurs that worsen over time may indicate progressive damage and extension of the infectious vegetation (Baddour et al., 2015).

In addition to fever and heart murmur, clusters of petechiae may be found on the body. Small, painful nodules (Osler nodes) may be present in pads of fingers or toes. Irregular, red or purple, painless flat macules (Janeway lesions) may be present on palms, fingers, hands, soles, and toes. Hemorrhages with pale centers (Roth spots) caused by emboli may be observed in fundi of the eyes. Splinter hemorrhages (i.e., reddish-brown lines and streaks) may be seen under the proximal half of fingernails and toenails. Petechiae may appear in conjunctiva and mucous membranes.

Systemic embolization occurs in 22% to 50% of patients. It can occur at any time and may even be a presenting symptom. Up to 65% of emboli target the central nervous system and the majority of those are to the middle cerebral artery, effectively causing an embolic stroke. Metastatic foci of infection can also occur from embolization; for example, patients may develop a splenic abscess that requires splenectomy (Baddour et al., 2015).

Heart failure is the most frequent complication of infective endocarditis and may result from perforation of a valve leaflet, rupture of chordae, blood flow obstruction due to vegetations, or intracardiac shunts from dehiscence of prosthetic valves. It indicates a poor prognosis with medical therapy alone and is an indication for surgery (Alpert & Klotz, 2017).

Assessment and Diagnostic Findings

Although characteristics described previously may indicate infective endocarditis, signs and symptoms may indicate other diseases as well. Vague complaints of malaise, anorexia, weight loss, cough, and back and joint pain may be mistaken for influenza. Virulence of the causative organism usually correlates with the speed and degree of symptom development. A definitive diagnosis is made when a microorganism is found in two separate blood cultures and there is evidence of vegetation on imaging of the heart (e.g., echocardiogram). At least two sets of blood cultures (with each set including one aerobic and one anaerobic culture) drawn from different venipuncture sites

over a 24-hour period (each set at least 2 hours apart), should be obtained before administration of any antibiotics (Karchmer, 2018). Negative blood cultures do not definitely rule out infective endocarditis. Patients may have elevated white blood cell (WBC) counts. In addition, patients may be anemic, have a positive rheumatoid factor, and an elevated erythrocyte sedimentation rate (ESR) or C-reactive protein.

Echocardiography may assist in diagnosis by demonstrating a mass on a valve, prosthetic valve, or supporting structures and by identifying vegetations, abscesses, new prosthetic valve dehiscence, or new regurgitation. An echocardiogram may reveal development of heart failure. TEE may provide additional data when transthoracic imaging is nondiagnostic; this method of echocardiography is superior in assessing vegetations and perivalvular complications (Karchmer, 2018).

Prevention

Antibiotic prophylaxis had been traditionally recommended in patients at high risk (e.g., those with previous infective endocarditis, prosthetic heart valves, patients with heart transplant and valve regurgitation, some patients with congenital heart disease) before and sometimes after dental procedures that involved manipulation of gingival tissue or periapical area of teeth or perforation of oral mucosa. Antibiotic prophylaxis was also indicated for patients at high risk having procedures which involved the airway, and procedures which involved manipulation of infected tissue (e.g., wound débridement). The latest U.S. guidelines assert that prophylaxis in patients at high risk is reasonable but admit that the data are mixed regarding whether prophylaxis really decreases rates of infective endocarditis (Nishimura et al., 2017).

Patients at high risk should practice good oral hygiene. Poor dental hygiene can lead to bacteremia, particularly in the setting of a dental procedure. Severity of oral inflammation and infection is a significant factor in the incidence and degree of bacteremia. Regular professional oral care combined with personal oral care may reduce the risk of bacteremia. Recommended ongoing personal oral care includes using a manual or electronic toothbrush, dental floss, and other plaque removing devices (Nishimura et al., 2017).

Any patient at risk with a fever of more than 7 days' duration should report that finding to a primary provider; patients should not self-medicate with antibiotics or stop taking them before the prescribed dosage has been completed (Nishimura et al., 2017).

Increased vigilance is also required in patients with IV catheters and during invasive procedures. To minimize the risk of infection, nurses must ensure meticulous hand hygiene, site preparation, and aseptic technique during insertion and maintenance procedures. All catheters, tubes, drains, and other

devices are removed as soon as they are no longer needed or no longer function.

Medical Management

The objective of treatment is to eradicate invading organisms through adequate doses of an appropriate antibiotic. Antibiotic therapy usually is given intravenously for 2 to 6 weeks. Parenteral therapy is given in doses that produce a high serum concentration for a significant period to ensure eradication of the dormant bacteria within dense vegetations. This therapy is often delivered in the patient's home and is monitored by a home health nurse. Serum levels of the antibiotic and blood cultures are monitored to gauge effectiveness of therapy. If there is insufficient bactericidal activity, increased dosages of the antibiotic are prescribed or a different antibiotic is used. After adequate antibiotic therapy is initiated, the infective organism is usually eliminated. The patient should begin to feel better, regain an appetite, and have less fatigue. During this time, patients require psychosocial support because although they feel well, they may find themselves confined to the hospital or home with restrictive IV therapy.

Surgical Management

Surgical intervention may be required if the patient develops heart failure or an intracardiac abscess, or the patient has recurrent systemic embolizations, or the infection does not respond to medications. Surgical interventions include valve repair and replacement, débridement of vegetations, débridement and closure of an abscess, and closure of a fistula. Surgical valve replacement greatly improves the prognosis for patients with severe symptoms from damaged heart valves. Most patients who have prosthetic valve endocarditis require repeat valve replacement (Alpert & Klotz, 2017).

Nursing Management

The nurse monitors the patient's temperature at regular intervals, because the course of fever is one indication of treatment effectiveness. However, febrile reactions also may occur as a result of medication. The nurse administers antibiotic, antifungal, or antiviral medication as prescribed and educates the patient to take them as prescribed. Timing of antimicrobial medication administration is critical to maintain therapeutic drug levels. Fever often increases fatigue; rest periods should be planned and activities spaced to provide rest between activities. Good infection control and prevention practices include appropriate hand hygiene by both patients and caregivers. Nonsteroidal anti-inflammatory drugs (NSAIDs) may be prescribed as

antipyretics or to decrease the discomfort of fever. Patients may be more comfortable with a light layer of linens and exposure of their skin to air. They may be cooled with a fan, tepid water baths, or cloth compresses; if shivering or piloerection occurs, these interventions should be discontinued due to increased oxygen consumption and potential to further increase of body temperature.

Heart sounds are assessed. A new or worsening murmur may indicate dehiscence of a prosthetic valve, rupture of an abscess, or injury to valve leaflets or chordae tendineae (Baddour et al., 2015). The nurse monitors for signs and symptoms of systemic embolization, or, for patients with right-sided heart endocarditis, for signs and symptoms of pulmonary infarction and infiltrates. In addition, the nurse assesses signs and symptoms of organ damage such as stroke, meningitis, heart failure, myocardial infarction, glomerulonephritis, and splenomegaly.

Patient care is directed toward management of infection. Long-term IV antimicrobial therapy often is necessary; therefore, many patients have peripherally inserted central catheters or other long-term IV access. All invasive lines and wounds must be assessed daily for redness, tenderness, warmth, swelling, drainage, or other signs of infection. The patient and family are educated about activity restrictions, medications, and signs and symptoms of infection. Patients with infective endocarditis are at high risk for another episode of infective endocarditis. If the patient has undergone surgical treatment, the nurse provides postoperative care and instructions (see Chapters 16 and 23).

As appropriate, the home health nurse supervises and monitors IV antibiotic therapy delivered in the home setting and educates the patient and family about prevention and health promotion. The nurse provides the patient and family with emotional support and facilitates coping strategies during the prolonged course of infection and antibiotic treatment.

Myocarditis

Myocarditis, an inflammatory process involving the myocardium, can cause heart dilation, thrombi on the heart wall (mural thrombi), infiltration of circulating blood cells around the coronary vessels and between the muscle fibers, and degeneration of the muscle fibers themselves. Mortality varies with the severity of symptoms. Most patients with mild symptoms recover completely; however, some patients develop cardiomyopathy and heart failure.

Pathophysiology

Myocarditis usually results from an infectious source, be it viral (e.g., coxsackieviruses A and B, human immune deficiency virus, influenza A), bacterial, rickettsial, fungal, parasitic, metazoal, protozoal (e.g., Chagas disease), or spirochetal. It also may be immune related, occurring after acute systemic infections such as rheumatic fever, or it may be related to an autoimmune disorder. It may also result from an inflammatory reaction to toxins such as pharmacologic agents used in the treatment of other diseases (Arbustini, Agozzino, Favalli, et al., 2017). It may begin in one small area of the myocardium and then spread throughout the myocardium. The degree of myocardial inflammation and necrosis determines the degree of interstitial collagen and elastin destruction. The greater the destruction, the greater is the hemodynamic effect and resulting signs and symptoms. It is thought that DCM and HCM are latent manifestations of myocarditis.

Clinical Manifestations

The symptoms of acute myocarditis depend on the type of infection, the degree of myocardial damage, and the capacity of the myocardium to recover. Patients may be asymptomatic, with an infection that resolves on its own. However, they may develop mild to moderate symptoms and seek medical attention, often reporting fatigue and dyspnea, syncope, palpitations, and occasional discomfort in the chest and upper abdomen. The most common symptoms are flulike. Patients may also sustain sudden cardiac death or quickly develop severe congestive heart failure in fulminant myocarditis.

Assessment and Diagnostic Findings

Assessment of the patient may reveal no detectable abnormalities; as a result, the illness can go undiagnosed. Patients may be tachycardic or may report chest pain. An endomyocardial biopsy can provide the definitive diagnosis (Arbustini et al., 2017), but cardiac MRI is being used more often as a diagnostic tool because of its noninvasive approach (Lakdawala, Stevenson, & Loscalzo, 2018). With contrast, cardiac MRI may be diagnostic and can guide clinicians to sites for endomyocardial biopsies, which may be also indicated to find an organism or its genome, an immune process, or a radiation reaction causing the myocarditis. Patients without any abnormal heart structure (at least initially) may suddenly develop arrhythmias or ST–T-wave changes. If the patient has structural heart abnormalities (e.g., systolic dysfunction), a clinical assessment may disclose cardiac enlargement, faint heart sounds (especially S_1), pericardial friction rub, a gallop rhythm, or a systolic murmur. The WBC count, C-reactive protein, leukocyte count, and ESR may be elevated.

Medical Management

Patients are given specific treatment for the underlying cause if it is known (e.g., penicillin for hemolytic streptococci) and are placed on bed rest to decrease cardiac workload. Bed rest also helps decrease myocardial damage and the complications of myocarditis. In young patients with myocarditis, activities, especially athletics, should be limited for a 6-month period or at least until heart size and function have returned to normal. Physical activity is increased slowly, and the patient is instructed to report any symptoms that occur with increasing activity, such as a rapidly beating heart. If heart failure or arrhythmia develops, management is essentially the same as for all causes of heart failure and arrhythmias (see Chapters 25 and 22, respectively). Although they are known for their anti-inflammatory effects, NSAIDs should not be used for pain control; they have been implicated in increased cardiac injury and viral replication in animal studies (Lakdawala et al., 2018).

Nursing Management

The nurse assesses for resolution of tachycardia, fever, and any other clinical manifestations. The cardiovascular assessment focuses on signs and symptoms of heart failure and arrhythmias. Patients with arrhythmias should have continuous cardiac monitoring with personnel and equipment readily available to treat life-threatening arrhythmias.

Quality and Safety Nursing Alert

Patients with myocarditis are sensitive to digitalis. Nurses must closely monitor these patients for digitalis toxicity, which is evidenced by a new onset of arrhythmia, anorexia, nausea, vomiting, headache, and malaise. The primary provider should be notified immediately if this is suspected.

Anti-embolism stockings and passive and active exercises should be used because embolization from venous thrombosis and mural thrombi can occur, especially in patients on bed rest. In some patients, pharmacologic prophylaxis may also be indicated (see Chapter 26).

Pericarditis

Pericarditis refers to an inflammation of the pericardium, which is the membranous sac enveloping the heart. It accounts for 5% of emergency room visits for chest pain (Adler, Charron, Imazio, et al., 2015; Imazio, Gaita, &

LeWinter, 2015). Classification of pericarditis may be acute, chronic, or recurrent. The etiology of pericarditis can be infectious or noninfectious (Imazio & Gaita, 2015). For example, pericarditis may occur after pericardiectomy (opening of the pericardium) following cardiac surgery. Pericarditis also may occur 10 days to 2 months after acute myocardial infarction (Dressler syndrome).

Pathophysiology

Causes underlying or associated with pericarditis are listed in Chart 24-7. The inflammatory process of pericarditis may lead to an accumulation of fluid in the pericardial sac (pericardial effusion) and increased pressure on the heart, leading to cardiac tamponade (see Chapter 25). Frequent or prolonged episodes of pericarditis also may lead to thickening and decreased elasticity of the pericardium, or scarring may fuse the visceral and parietal pericardium. These conditions restrict the heart's ability to fill with blood (constrictive pericarditis). The pericardium may become calcified, further restricting ventricular expansion during ventricular filling (diastole). With less filling, the ventricles pump less blood, leading to decreased cardiac output and signs and symptoms of heart failure. Restricted diastolic filling may result in increased systemic venous pressure, causing peripheral edema and hepatic failure.

Clinical Manifestations

Pericarditis may be asymptomatic. The most characteristic symptom of pericarditis is chest pain, although pain also may be located beneath the clavicle, in the neck, or in the left trapezius (scapula) region. Pain or discomfort usually remains fairly constant, but it may worsen with deep inspiration and when lying down or turning. The most characteristic clinical manifestation of pericarditis is a creaky or scratchy friction rub heard most clearly at the left lower sternal border. Other signs may include a mild fever, increased WBC count, anemia, and an elevated ESR or C-reactive protein level. Patients may have a nonproductive cough or hiccup. Dyspnea, as well as respiratory splinting because of pain upon inspiration, and other signs and symptoms of heart failure may occur as a result of pericardial compression due to constrictive pericarditis or cardiac tamponade. The heart rate may increase to maintain cardiac output.

Chart 24-7

Causes of Pericarditis

- Idiopathic or nonspecific causes
- Infection:
  - Viral: most commonly infectious cause (e.g., enteroviruses, herpes viruses, adenoviruses, parvoviruses)
  - Bacterial: rare (but if bacterial cause, most commonly *Mycobacterium tuberculosis* is implicated)
  - Fungal: rare (e.g., *Histoplasma, Aspergillus, Candida*)
  - Parasitic: rare (e.g., *Echinococcus, Toxoplasma*)
- Autoimmune disorders (e.g., systemic lupus erythematosus, rheumatic fever, rheumatoid arthritis, polyarteritis, sarcoidosis, scleroderma)
- Immune-mediated drug reactions:
  - Lupuslike reaction
  - Antineoplastic drugs
  - Hypersensitivity eosinophilia
- Disorders of adjacent structures (e.g., myocardial infarction, dissecting aneurysm, pneumonia)
- Neoplastic disease:
  - Metastasis from lung or breast cancer
  - Primary neoplasms (e.g., mesothelioma)
- Radiation therapy of chest and upper torso (peak occurrence 5–9 mo after treatment)
- Intentional or unintentional chest trauma (e.g., chest injury, cardiac surgery, cardiac catheterization, implantation of pacemaker, or implantation of a cardiac implantable electronic device)
- Metabolic:
  - Uremia
  - Anorexia
  - Myxedema

Adapted from Miranda, W. R., Imazio, M., Greason, K. L., et al. (2017). Pericardial diseases. In V. Fuster, R. A. Harrington, J. Narula, et al. (Eds.). *Hurst's the heart* (14th ed.). New York: McGraw-Hill.

Assessment and Diagnostic Findings

The diagnosis most often is made on the basis of history, signs, and symptoms. An echocardiogram may detect inflammation, pericardial effusion or tamponade, and heart failure. It may help confirm the diagnosis and may be used to guide pericardiocentesis (needle or catheter drainage of the pericardium). TEE may be useful in diagnosis but may underestimate the extent of pericardial effusions. CT imaging may be the best diagnostic tool for determining size, shape, and location of pericardial effusions and may be used

to guide pericardiocentesis. Cardiac MRI may assist with detection of inflammation and adhesions. Occasionally, a video-assisted pericardioscope-guided biopsy of the pericardium or epicardium is performed to obtain tissue samples for culture and microscopic examination. Because the pericardial sac surrounds the heart, a 12-lead ECG may show concave ST elevations in many, if not all, leads (with no reciprocal changes) and may show depressed PR segments or atrial arrhythmias (Imazio & Gaita, 2015).

Medical Management

Objectives of pericarditis management are to determine the cause, administer therapy for treatment and symptom relief, and detect signs and symptoms of cardiac tamponade. When cardiac output is impaired, the patient is placed on bed rest until fever, chest pain, and friction rub have subsided.

Analgesic medications and NSAIDs such as aspirin, indomethacin, or ibuprofen may be prescribed for pain relief during the acute phase. Corticosteroids (e.g., prednisone) can be used as an alternative when NSAIDs are contraindicated (e.g., kidney disease). Colchicine may be prescribed if the pericarditis is severe as an additive therapy to NSAIDs (Adler et al., 2015).

Pericardiocentesis, a procedure in which some pericardial fluid is removed, rarely is necessary. It may be performed to assist in identification of the cause or relieve symptoms, especially if there are signs and symptoms of heart failure or tamponade. Pericardial fluid is cultured if bacterial, tubercular, or fungal disease is suspected; a sample is sent for cytology if neoplastic disease is suspected. A pericardial window, a small opening made in the pericardium, may be performed to allow continuous drainage into the chest cavity. Surgical removal of tough encasing pericardium (pericardiectomy) may be necessary to release both ventricles from constrictive and restrictive inflammation and scarring.

Nursing Management

Patients with acute pericarditis require pain management with antispasmodic agents, assistance with positioning, and psychological support. Patients with chest pain often benefit from education and reassurance that the pain is not due to a heart attack. Pain may be relieved with a forward-leaning or sitting position. To minimize complications, the nurse helps the patient with activity restrictions until pain and fever subside. As the patient's condition improves, the nurse encourages gradual increases of activity. However, if pain, fever, or friction rub recurs, activity restrictions must be resumed. The nurse educates the patient and family about a healthy lifestyle to enhance the patient's immune system.

Nurses caring for patients with pericarditis must be alert to signs and symptoms of cardiac tamponade (see Chapter 25). The nurse monitors the patient for heart failure. Patients with hemodynamic instability or pulmonary congestion are treated as if they had heart failure (see Chapter 25).

NURSING PROCESS

The Patient with Pericarditis

Assessment

The primary symptom of pericarditis is pain, which is assessed by evaluating the patient in various positions. The nurse tries to identify whether pain is influenced by respiratory movements, while holding an inhaled breath or holding an exhaled breath; by flexion, extension, or rotation of the spine, including the neck; by movements of shoulders and arms; by coughing; or by swallowing. Recognizing events that precipitate or intensify pain may help establish a diagnosis and differentiate pain of pericarditis from pain of myocardial infarction.

When pericardial surfaces lose their lubricating fluid because of inflammation, a pericardial friction rub occurs. The rub is audible on auscultation and is synchronous with the heartbeat. However, it may be elusive and difficult to detect.

Quality and Safety Nursing Alert

A pericardial friction rub is diagnostic of pericarditis. It is a creaky or scratchy sound and is louder at the end of exhalation. Nurses should monitor for pericardial friction rub by placing the diaphragm of the stethoscope tightly against the patient's thorax and auscultating the left sternal edge in the fourth intercostal space, which is the site where the pericardium comes into closest contact with the left chest wall. The rub may be heard best when a patient is sitting and leaning forward.

If there is difficulty in distinguishing a pericardial friction rub from a pleural friction rub, the patient is asked to hold their breath; a pericardial friction rub will continue to be heard.

The patient's temperature is monitored frequently. Pericarditis may cause an abrupt onset of fever in a patient who has been afebrile.

Diagnosis

NURSING DIAGNOSES

Based on the assessment data, the major nursing diagnoses may be:

- Acute pain associated with inflammation of the pericardium
- Lack of knowledge of diagnosis and therapeutic self-care management

COLLABORATIVE PROBLEMS/POTENTIAL COMPLICATIONS

Potential complications may include the following:

- Pericardial effusion
- Cardiac tamponade

Planning and Goals

The patient's major goals may include relief of pain and absence of complications.

Nursing Interventions

Relieving Pain

Relief of pain is achieved by rest. Because sitting upright and leaning forward is the posture that tends to relieve pain, chair rest may be more comfortable. The nurse instructs the patient to restrict activity until pain subsides. As chest pain and friction rub abate, activities of daily living may be resumed gradually. If the patient is taking antispasmodic agents, antibiotics, or corticosteroids for pericarditis, responses to these medications are monitored and recorded. Patients taking NSAIDs or colchicine are assessed for gastrointestinal adverse effects. If chest pain and friction rub recur, bed rest or chair rest is resumed.

Enhancing Knowledge About Pericarditis and Self-Care Management

There are a multitude of possible causes for pericarditis (see Chart 24-7). Some of these are life-threatening (e.g., metastatic cancers) while others are not; regardless, the patient is likely to be fearful and anxious because they are experiencing chest pain. Educating the patient about the cause of the pericarditis, and medications prescribed to treat it (e.g., NSAIDs), and methods to improve breathing patterns and alleviate pain (e.g., sitting up and leaning forward upon a pillow) can allay anxieties. The patient should verbalize when it is appropriate to follow up with the primary provider (i.e., for routine follow ups, with relapse of symptoms, with symptoms suggestive of cardiac tamponade, including lightheadedness, orthostasis and tachycardia [see following]).

Monitoring and Managing Potential Complications

Abnormal accumulation of fluid between the pericardial linings (i.e., in the pericardial sac) is called *pericardial effusion*. Most patients have no effects or symptoms. However, enough fluid can accumulate to constrict the myocardium, impairing ventricular filling and the myocardium's ability to pump, a condition known as *cardiac tamponade* (discussed below) (Imazio et al., 2015). Failure to identify and treat this problem can lead to death.

Signs and symptoms of cardiac tamponade may begin with the patient reporting shortness of breath, chest tightness, or dizziness. The nurse may observe that the patient is becoming progressively more restless. Assessment of blood pressure may reveal a decrease of 10 mm Hg or more

in systolic blood pressure during inspiration (pulsus paradoxus). Usually, the systolic pressure decreases and the diastolic pressure remains stable; hence, the pulse pressure narrows. The patient usually has tachycardia, and ECG voltage may be decreased or QRS complexes may alternate in height (electrical alternans). Heart sounds may progress from distant to imperceptible. Blood continues to return to the heart from the periphery but cannot flow into the heart to be pumped back into the circulation. The patient develops jugular vein distention and other signs of rising central venous pressure. The Beck triad (hypotension, muffled heart sounds, and an elevated jugular venous pressure) is a useful diagnostic parameter of severe tamponade.

In such situations, the nurse notifies the primary provider immediately and prepares to assist with diagnostic echocardiography and pericardiocentesis (see Chapter 25). The nurse stays with the patient and continues to assess and record signs and symptoms while intervening to decrease patient anxiety.

PROMOTING HOME, COMMUNITY-BASED, AND TRANSITIONAL CARE

Because patients, their family members, and health care providers tend to focus on the most obvious needs and issues related to pericarditis, the nurse reminds them about the importance of continuing health promotion and screening practices. The nurse educates patients who have not been involved in these practices in the past about their importance and refers them to appropriate health care providers.

Evaluation

Expected patient outcomes may include:

1. Freedom from pain
   a. Performs activities of daily living without pain, fatigue, or shortness of breath
   b. Temperature returns to normal range
   c. Exhibits no pericardial friction rub
2. Effectively manages self-care
   a. Identifies cause(s) of pericarditis and rationale for prescribed therapeutic regimen
   b. Follows-up with primary provider for ongoing appointments and as needed
3. Absence of complications
   a. Sustains blood pressure in normal range
   b. Heart sounds strong and can be auscultated
   c. Absence of jugular vein distention

CRITICAL THINKING EXERCISES

1 ebp A 67-year-old woman presents to the emergency department (ED) where you work as a staff nurse with reports of fevers, malaise, and painful nodules on the pads of her fingers. Upon review of her medical history, the patient reports an aortic valve replacement (prosthetic) as a child, but no other significant medical or surgical history. Based on the history and physical examination findings, the primary provider thinks that the patient may have infective endocarditis and prescribes antibiotics. What should you ensure happens before the antibiotics are given? What are the care priorities for this patient?

2 ipc A 57-year-old man presents to the cardiology clinic where you work with a complaint of ankle swelling and trouble breathing when he walks more than 20 feet. The cardiologist does an echocardiogram and diagnoses the patient with cardiomyopathy. The patient expresses anxiety about what this means. Based on what you know about cardiomyopathy, what would you focus on when educating this patient? What are the key roles of other members of the health care team in appropriately assisting the patient in managing a new diagnosis of cardiomyopathy?

3 pq A 47-year-old woman with HCM presents to the ED where you work after fainting. It is the middle of summer and the primary provider thinks the patient was dehydrated. Explain the pathophysiology of why dehydration in a patient with HCM might precipitate a syncopal episode. Describe your prioritized focused assessment of this patient in the ED.

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

American Heart Association, National Center, www.heart.org
Cardiomyopathy UK, www.cardiomyopathy.org
MyLVAD, www.mylvad.com

25 Management of Patients with Complications from Heart Disease

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Recognize the etiology, pathophysiology, and clinical manifestations of the different classifications of heart failure.
2. Describe the medical management, including recommended pharmacologic treatments, for patients with heart failure.
3. Use the nursing process as a framework for care of the patient with heart failure.
4. Identify additional heart disease disorders and medical and nursing management of patients with complications from heart disease.

NURSING CONCEPT

Perfusion

GLOSSARY

anuria: urine output of less than 50 mL/24 h

ascites: an accumulation of serous fluid in the peritoneal cavity

cardiac resynchronization therapy (CRT): a treatment for heart failure in which a device paces both ventricles to synchronize contractions

congestive heart failure (CHF): a fluid overload condition (congestion) associated with heart failure

diastolic heart failure: the inability of the left ventricle of the heart to fill and pump sufficiently; term used to define a type of heart failure (*synonym:* Heart Failure with preserved Ejection Fraction [HFpEF])

ejection fraction (EF): percentage of blood volume in the ventricles at the end of diastole that is ejected during systole; a measurement of contractility

heart failure (HF): a clinical syndrome resulting from structural or functional cardiac disorders that impair the ability of a ventricle to fill or eject blood

Heart Failure with midrange Ejection Fraction (HFmrEF): clinical heart failure syndrome with left ventricular ejection fraction that is 40% to 49%

Heart Failure with preserved Ejection Fraction (HFpEF): clinical heart failure syndrome with left ventricular ejection fraction greater than or equal to 50% (*synonym:* diastolic heart failure)

Heart Failure with reduced Ejection Fraction (HFrEF): clinical heart failure syndrome with left ventricular ejection fraction less than or equal to 40% (*synonym:* systolic heart failure)

left-sided heart failure: inability of the left ventricle to fill or eject sufficient blood into the systemic circulation (*synonym:* left ventricular failure)

oliguria: diminished urine output; less than 0.5 mL/kg/h over at least 6 hours, or less than 400 mL in 24 hours

orthopnea: shortness of breath when lying flat

paroxysmal nocturnal dyspnea (PND): shortness of breath that occurs suddenly during sleep

pericardiocentesis: procedure that involves aspiration of fluid from the pericardial sac

pericardiotomy: surgically created opening of the pericardium

pulmonary edema: pathologic accumulation of fluid in the interstitial spaces and alveoli of the lungs causing severe respiratory distress

pulseless electrical activity (PEA): condition in which electrical activity is present on an electrocardiogram, but there is not a physiologically adequate pulse or blood pressure

pulsus paradoxus: systolic blood pressure that is more than 10 mm Hg lower during inhalation than during exhalation; difference is normally less than 10 mm Hg

right-sided heart failure: inability of the right ventricle to fill or eject sufficient blood into the pulmonary circulation (*synonym:* right ventricular failure)

systolic heart failure: inability of the heart to pump sufficiently because of an alteration in the ability of the heart to contract; term used to describe a type of heart failure (*synonym:* Heart Failure with reduced Ejection Fraction [HFrEF])

Cardiovascular disease is the leading cause of death in the United States (Centers for Disease Control and Prevention [CDC], 2017). Because of advancements in diagnostic and screening procedures, greater recognition of the importance of diligent self-care practices, and new discoveries in pharmacotherapies, it is now possible for a person diagnosed with heart disease to continue to live with a high quality of life years after being diagnosed. Despite this progress, heart disease remains a chronic and often progressive condition, associated with serious comorbidities, such as heart failure (Benjamin, Muntner, Alonso, et al., 2019). This chapter presents the complications most often associated with heart disease, including the medical management and nursing processes for managing patients with complications of cardiovascular disease.

HEART FAILURE

Heart failure (HF) is a clinical syndrome resulting from structural or functional cardiac disorders so that the heart is unable to pump enough blood to meet the body's metabolic demands or needs (American Heart Association [AHA], 2019a). The term *heart failure* indicates myocardial disease in which impaired contraction of the heart (systolic dysfunction) or filling of the heart (diastolic dysfunction) may cause pulmonary or systemic congestion. Some cases of HF are reversible, depending on the cause. Most often, HF is a chronic, progressive condition that is managed with lifestyle changes and medications to prevent episodes of acute decompensated heart failure. These episodes are characterized by increased symptoms of respiratory distress, decreased cardiac output (CO), and poor perfusion. These episodes are also associated with increased hospitalizations, increased health care costs, and decreased quality of life (Benjamin et al., 2019).

Approximately six million people in the United States have HF, and 870,000 new cases are diagnosed each year (AHA, 2019a). As more people

live longer with chronic heart diseases, HF has become an epidemic that challenges the country's health care resources. HF is the most common reason for hospitalization of people older than 65 years and is the second most common reason for visits to a provider's office. Emergency department (ED) visits and hospital readmissions for this disorder are very common, despite efforts to prevent rehospitalizations. Over 20% of patients discharged after treatment for HF are readmitted to the hospital within 30 days, and nearly 50% are readmitted to the hospital within 6 months (O'Connor, 2017). The estimated economic burden caused by HF in the United States is more than $30 billion annually in direct and indirect costs and is expected to continue to increase over time (CDC, 2017).

HF is more prevalent among African Americans and Hispanics than among Caucasians. The risk for having HF increases with advancing age. For adults over 60 years of age, HF is more prevalent among men than women (Benjamin et al., 2019). As typical for other major cardiovascular diseases and disorders, cigarette smoking, obesity, poorly managed diabetes, and metabolic syndrome are all risks for HF (Benjamin et al., 2019). The onset of HF is typically a morbid consequence of another disease or disorder, including coronary artery disease (CAD), hypertension, cardiomyopathy, valvular disorders, and renal dysfunction with volume overload (McCance, Huether, Brashers, et al., 2019).

Atherosclerosis of the coronary arteries is a primary cause of HF, and CAD is found in the majority of patients with HF. Ischemia causes myocardial dysfunction because it deprives heart cells of oxygen and causes cellular damage. Myocardial infarction (MI) causes focal heart muscle necrosis, the death of myocardial cells, and a loss of contractility; the extent of the infarction correlates with the severity of HF. Revascularization of the coronary artery by a percutaneous coronary intervention (PCI) or by coronary artery bypass surgery (coronary artery bypass graft [CABG]) may improve myocardial oxygenation and ventricular function and prevent more extensive myocardial necrosis that can lead to HF (see Chapter 23).

Systemic or pulmonary hypertension increases afterload (resistance to ejection), increasing the cardiac workload and leading to the hypertrophy of myocardial muscle fibers. This can be considered a compensatory mechanism because it initially increases contractility. However, sustained hypertension eventually leads to changes that impair the heart's ability to fill properly during diastole, and the hypertrophied ventricles may dilate and fail (Norris, 2019; Yancy, Jessup, Bozkurt, et al., 2017).

Cardiomyopathy is a disease of the myocardium. The various types of cardiomyopathy lead to HF and arrhythmias. Dilated cardiomyopathy (DCM), the most common type of cardiomyopathy, causes diffuse myocyte necrosis and fibrosis, and commonly leads to progressive HF (Norris, 2019). DCM can be idiopathic (unknown cause), or it can result from an inflammatory process, such as myocarditis, or from a cytotoxic agent, such as alcohol or certain

antineoplastic drugs. Usually, HF due to cardiomyopathy is chronic and progressive. However, cardiomyopathy and HF may resolve following removal of the causative agent. Genetic testing may be recommended for idiopathic cardiomyopathy (van der Meer, Gaggin, & Dec, 2019) (see Chapter 24).

Valvular heart disease is also a cause of HF. The valves ensure that blood flows in one direction. With valvular dysfunction, it becomes increasingly difficult for blood to move forward, increasing pressure within the heart and increasing cardiac workload, leading to HF (see Chapter 24).

Several systemic conditions, including progressive kidney failure, contribute to the development and severity of HF. Nearly 30% of patients with chronic HF also have chronic kidney disease (Benjamin et al., 2019). In addition, cardiac arrhythmias such as atrial fibrillation may either cause or result from HF; in both instances, the altered electrical stimulation impairs myocardial contraction and decreases the overall efficiency of myocardial function. Other factors, such as hypoxia, acidosis, and electrolyte abnormalities, can worsen myocardial function (Yancy et al., 2017).

Pathophysiology

Regardless of the etiology, the pathophysiology of HF results in similar changes and clinical manifestations. Significant myocardial dysfunction usually occurs before the patient experiences signs and symptoms of HF such as shortness of breath, edema, or fatigue.

As HF develops, the body activates neurohormonal compensatory mechanisms. These mechanisms represent the body's attempt to cope with the HF and are responsible for the signs and symptoms that develop (Norris, 2019). Understanding these mechanisms is important because the treatment for HF is aimed at correcting them and relieving symptoms.

The most common type of HF is systolic HF, also called Heart Failure with reduced Ejection Fraction (HFrEF; see later discussion in Assessment and Diagnostic Findings). **Systolic heart failure** results in decreased blood ejected from the ventricle. The decreased blood flow is sensed by baroreceptors in the aortic and carotid bodies, and the sympathetic nervous system is then stimulated to release epinephrine and norepinephrine (Fig. 25-1). The purpose of this initial response is to increase heart rate and contractility and support the failing myocardium, but the continued response has multiple negative effects. Sympathetic stimulation causes vasoconstriction in the skin, gastrointestinal tract, and kidneys. A decrease in renal perfusion due to low CO and vasoconstriction then causes the release of renin by the kidneys. Renin converts the plasma protein angiotensinogen to angiotensin I, which then circulates to the lungs. Angiotensin-converting enzyme (ACE) in the lumen of pulmonary blood vessels converts angiotensin I to angiotensin II, a potent vasoconstrictor, which then increases the blood pressure and afterload.

Angiotensin II also stimulates the release of aldosterone from the adrenal cortex, resulting in sodium and fluid retention by the renal tubules and an increase in blood volume. These mechanisms lead to the fluid volume overload commonly seen in HF. Angiotensin, aldosterone, and other neurohormones (e.g., endothelin) lead to an increase in preload and afterload, which increases stress on the ventricular wall, causing an increase in cardiac workload. A counterregulatory mechanism is attempted through the release of natriuretic peptides. Atrial natriuretic peptide (ANP) and B-type natriuretic peptide (BNP; brain type) are released from the overdistended cardiac chambers. These substances promote vasodilation and diuresis. However, their effect is usually not strong enough to overcome the negative effects of the other mechanisms (Norris, 2019).

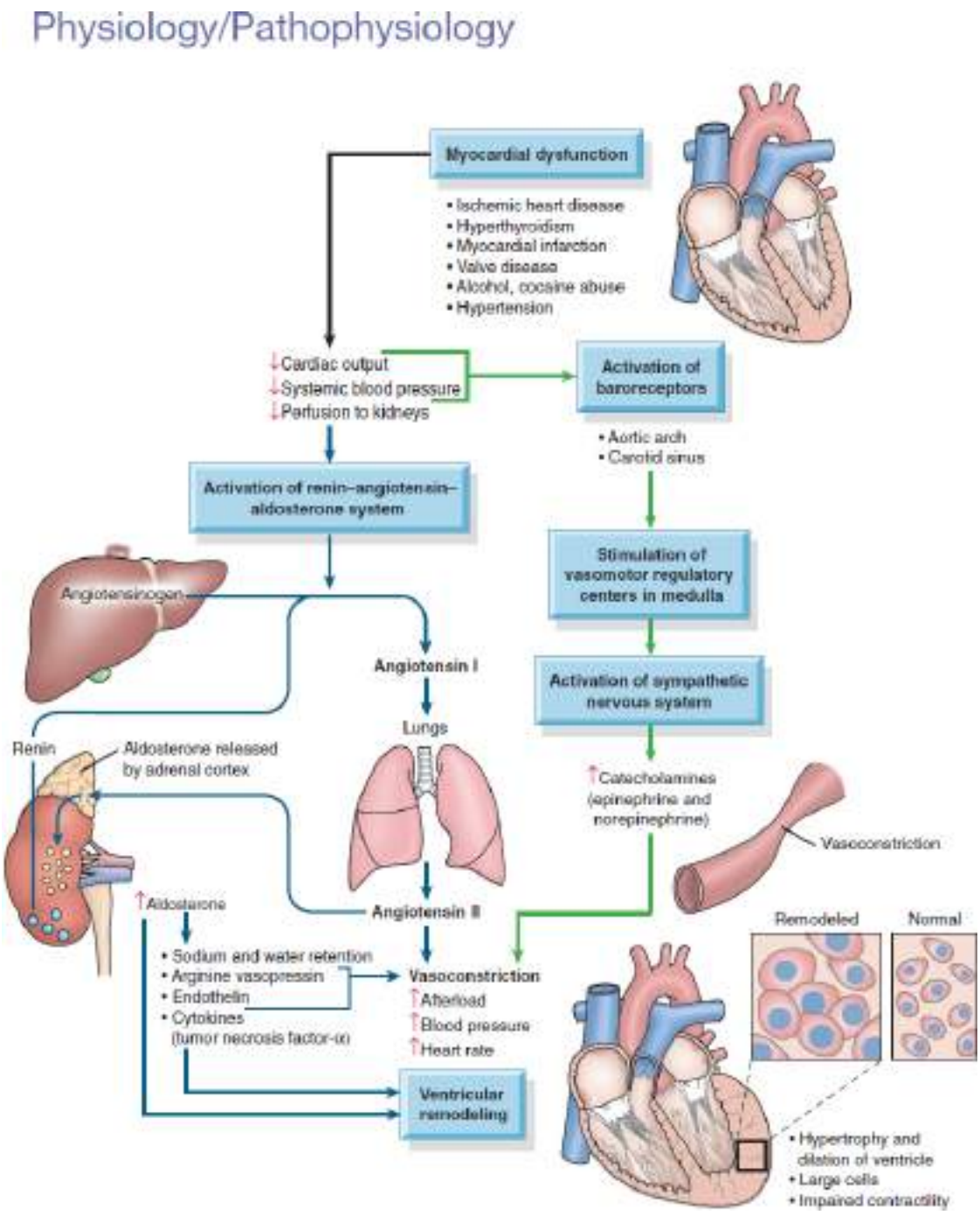

Figure 25-1 • The pathophysiology of heart failure. A decrease in cardiac output activates multiple neurohormonal mechanisms that ultimately result in the signs and symptoms of heart failure.

As the heart's workload increases, contractility of the myocardial muscle fibers decreases. Decreased contractility results in an increase in end-diastolic blood volume in the ventricle, stretching the myocardial muscle fibers and increasing the size of the ventricle (ventricular dilation). The heart compensates for the increased workload by increasing the thickness of the heart muscle (ventricular hypertrophy). Hypertrophy results in abnormal

changes in the structure and function of myocardial cells, a process known as ventricular remodeling. Under the influence of neurohormones (e.g., angiotensin II), enlarged myocardial cells become dysfunctional and die early (a process called *apoptosis*), leaving the other, functional myocardial cells struggling to maintain CO.

As cardiac cells die and the heart muscle becomes fibrotic, **diastolic heart failure**, also called Heart Failure with preserved Ejection Fraction (HFpEF) (see later discussion in Assessment and Diagnostic Findings), can develop, leading to further dysfunction. A stiff ventricle resists filling, and less blood in the ventricles causes a further decrease in CO. All of these compensatory mechanisms of HF have been referred to as the "vicious cycle of heart failure" because low CO leads to multiple mechanisms that make the heart work harder, worsening the HF.

Clinical Manifestations

Many clinical manifestations are associated with HF (Chart 25-1). However, the cardinal manifestations of HF are dyspnea; fatigue, which may limit exercise tolerance; and fluid retention, which may lead to congestion, evidenced by pulmonary and peripheral edema (Yancy, Jessup, Bozkurt, et al., 2013). The signs and symptoms of HF are related to the ventricle that is most affected. **Left-sided heart failure**, also referred to as left ventricular failure because of the inability of the left ventricle to fill or eject sufficient blood into the systemic circulation, causes different manifestations than **right-sided heart failure**, also referred to as right ventricular failure because of the inability of the right ventricle to fill or eject sufficient blood into the pulmonary circulation. In chronic HF, particularly congestive heart failure, patients may have signs and symptoms of both left- and right-sided heart failure. The patient with pulmonary edema manifests signs and symptoms of acute decompensation, warranting expeditious treatment.

Left-Sided Heart Failure

Pulmonary congestion occurs when the left ventricle cannot effectively pump blood out of the ventricle into the aorta and the systemic circulation. The increased left ventricular end-diastolic blood volume increases the left ventricular end-diastolic pressure, which decreases blood flow from the left atrium into the left ventricle during diastole. The blood volume and pressure build up in the left atrium, decreasing flow through the pulmonary veins into the left atrium. Pulmonary venous blood volume and pressure increase in the lungs, forcing fluid from the pulmonary capillaries into the pulmonary tissues and alveoli, causing pulmonary interstitial edema and impaired gas exchange.

The clinical manifestations of pulmonary congestion include dyspnea, cough, pulmonary crackles, and low oxygen saturation levels. An extra heart sound, the S_3, or "ventricular gallop," may be detected on auscultation. It is caused by abnormal ventricular filling (Colucci & Dunlay, 2017; Dumitru, 2018).

Chart 25-1 ASSESSMENT

Heart Failure

Be alert for the following signs and symptoms:

Congestion

- Dyspnea
- Orthopnea
- Paroxysmal nocturnal dyspnea
- Cough (recumbent or exertional)
- Pulmonary crackles that do not clear with cough
- Weight gain (rapid)
- Dependent edema
- Abdominal bloating or discomfort
- Ascites
- Jugular venous distention
- Sleep disturbance (anxiety or air hunger)
- Fatigue

Poor Perfusion/Low Cardiac Output

- Decreased exercise tolerance
- Muscle wasting or weakness
- Anorexia or nausea
- Unexplained weight loss
- Lightheadedness or dizziness
- Unexplained confusion or altered mental status
- Resting tachycardia
- Daytime oliguria with recumbent nocturia
- Cool or vasoconstricted extremities
- Pallor or cyanosis

Adapted from Colucci, W. S., & Dunlay, S. M. (2017). Clinical manifestations and diagnosis of advanced heart failure. *UpToDate*. Retrieved on 12/6/2019 at: www.uptodate.com/contents/clinical-manifestations-and-diagnosis-of-advanced-heart-failure; Dumitru, I. (2018). Heart failure. *Medscape.* Retrieved on 12/6/2019 at: www.emedicine.medscape.com/article/163062-overview

Dyspnea, or shortness of breath, may be precipitated by minimal to moderate activity (dyspnea on exertion [DOE]), yet dyspnea may also occur at rest. The patient may report **orthopnea**, difficulty breathing when lying flat. Patients with orthopnea may use multiple pillows to prop themselves up in bed, or they may sleep sitting up or in a high, reclined position. Some patients have sudden attacks of dyspnea at night, a condition known as **paroxysmal nocturnal dyspnea (PND)**. Fluid accumulating in the dependent extremities during the day may be reabsorbed into the circulating blood volume when the patient lies down. Because the impaired left ventricle cannot eject the increased circulating blood volume, the pressure in the pulmonary circulation increases, shifting fluid into the alveoli. The fluid-filled alveoli cannot exchange oxygen and carbon dioxide. Without sufficient oxygen, the patient experiences dyspnea and has difficulty sleeping (Colucci & Dunlay, 2017; Dumitru, 2018).

The cough associated with left ventricular failure is initially dry and nonproductive. Most often, patients complain of a dry hacking cough that may be mislabeled as asthma or chronic obstructive pulmonary disease (COPD). Over time, the cough may begin to accumulate secretions. Large quantities of frothy sputum, sometimes pink or tan, may be produced, indicating acute decompensated HF and pulmonary edema (Colucci & Dunlay, 2017; Dumitru, 2018).

Adventitious breath sounds may be heard in various areas of the lungs. Usually, bibasilar crackles that do not clear with coughing are detected in the early phase of left ventricular failure. As the failure worsens and pulmonary congestion increases, crackles may be auscultated throughout the lung fields. At this point, oxygen saturation may decrease.

In addition to pulmonary manifestations, the decreased amount of blood ejected from the left ventricle can lead to inadequate tissue perfusion. The diminished CO has widespread manifestations because not enough blood reaches all of the tissues and organs (low perfusion) to provide the necessary oxygen. The decrease in stroke volume (SV) can also stimulate the sympathetic nervous system to release catecholamines, which further impedes perfusion to many organs, including the kidneys.

As reduced CO and catecholamines decrease blood flow to the kidneys, urine output drops. Renal perfusion pressure falls, and the renin–angiotensin–aldosterone system is stimulated to increase blood pressure and intravascular volume. While the patient sleeps, the cardiac workload decreases, improving renal perfusion. This may cause **nocturia** (i.e., frequent urination at night) (Colucci & Dunlay, 2017; Dumitru, 2018).

As HF progresses, decreased output from the left ventricle may cause other symptoms. Decreased gastrointestinal perfusion causes altered digestion. Decreased brain perfusion causes dizziness, lightheadedness, confusion, restlessness, and anxiety due to decreased oxygenation and blood flow. As

anxiety increases, so does dyspnea, increasing anxiety and creating a vicious cycle. Stimulation of the sympathetic system also causes the peripheral blood vessels to constrict, so the skin appears pale or ashen and feels cool and clammy.

A decrease in SV causes the sympathetic nervous system to increase the heart rate (tachycardia), often causing the patient to complain of palpitations. The peripheral pulses become weak. Without adequate CO, the body cannot respond to increased energy demands, and the patient becomes easily fatigued and has decreased activity tolerance. Fatigue also results from the increased energy expended in breathing and the insomnia that results from respiratory distress, coughing, and nocturia (Colucci & Dunlay, 2017; Dumitru, 2018).

Right-Sided Heart Failure

When the right ventricle fails, congestion in the peripheral tissues and the viscera predominates. This occurs because the right side of the heart cannot eject blood effectively and cannot accommodate all of the blood that normally returns to it from the venous circulation. Increased venous pressure leads to jugular venous distention (JVD) and increased capillary hydrostatic pressure throughout the venous system. Systemic clinical manifestations include dependent edema (edema of the lower extremities), **hepatomegaly** (enlargement of the liver), **ascites** (accumulation of fluid in the peritoneal cavity), and weight gain due to retention of fluid. Edema usually affects the feet and ankles and worsens when the patient stands or sits for a long period. The edema may decrease when the patient elevates the legs. Edema can gradually progress up the legs and thighs and eventually into the external genitalia and lower trunk. Ascites is evidenced by increased abdominal girth and may accompany lower body edema or may be the only edema present. Sacral edema is common in patients who are on bed rest, because the sacral area is dependent. Pitting edema, in which indentations in the skin remain after even slight compression with the fingertips (Fig. 25-2), is generally obvious after retention of at least 4.5 kg (10 lb) of fluid (4.5 L).

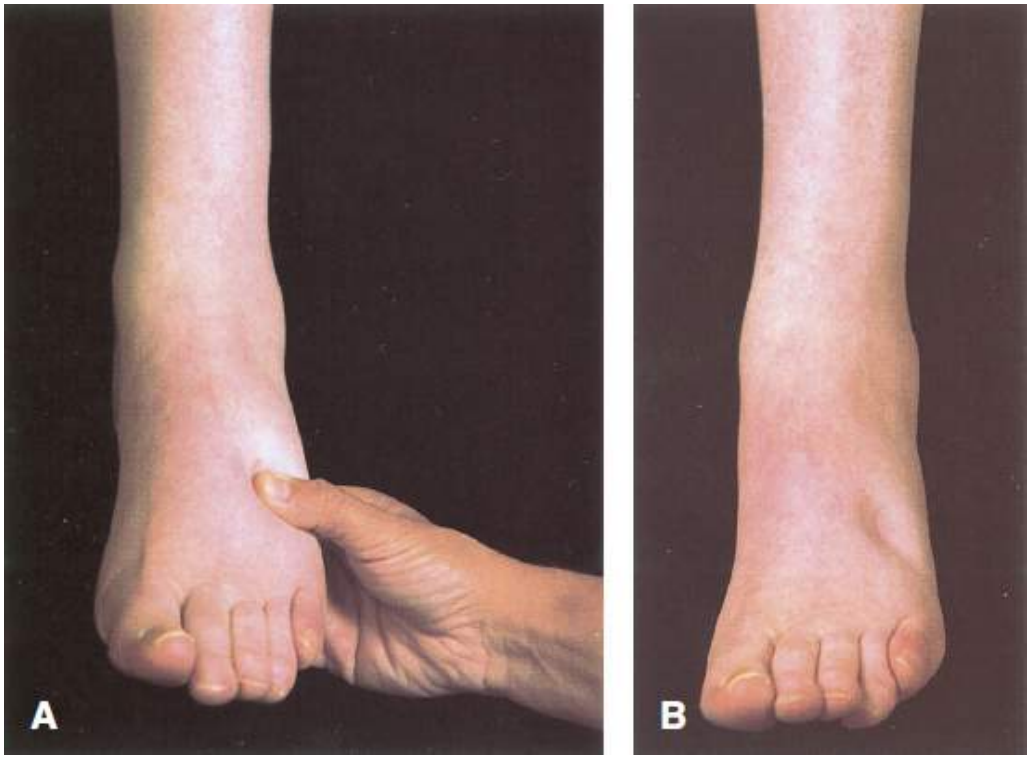

Figure 25-2 • Example of pitting edema. **A.** The nurse applies pressure to an area near the ankle. **B.** When the pressure is released, an indentation remains in the edematous tissue. Reprinted with permission from Bickley, L. S. (2017). *Bates' guide to physical examination and history taking* (12th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Hepatomegaly and tenderness in the right upper quadrant of the abdomen result from venous engorgement of the liver. The increased pressure may interfere with the liver's ability to function (secondary liver dysfunction). As hepatic dysfunction progresses, increased pressure within the portal vessels may force fluid into the abdominal cavity, causing ascites. Ascites may increase pressure on the stomach and intestines and cause gastrointestinal distress. Hepatomegaly may also increase pressure on the diaphragm, causing respiratory distress.

Anorexia (loss of appetite), nausea, or abdominal pain may result from the venous engorgement and venous stasis within the abdominal organs. The generalized weakness that accompanies right-sided HF results from reduced CO and impaired circulation (Colucci & Dunlay, 2017; Dumitru, 2018).

Congestive Heart Failure

Right-sided heart failure can sometimes occur as a result of left-sided failure. The failure of these dual mechanisms is sometimes referred to as **congestive heart failure**. When the left ventricle fails, increased fluid pressure is transferred back through the lungs, leading to damage of the right side of the

heart. When the right side loses pumping power, the blood backs up in the body's venous system. This may cause swelling or congestion in the legs, ankles, and swelling within the abdomen such as the GI tract and liver. Increased venous pressure may also lead to JVD and increased capillary hydrostatic pressure throughout the venous system. Edema may be present in the periphery as well as within the pulmonary vascular bed. Without appropriate treatment, this may progress to pulmonary edema.

Pulmonary Edema

Pulmonary edema is an acute event, reflecting a breakdown of physiologic compensatory mechanisms; hence, it is sometimes referred to as acute decompensated heart failure. It can occur following acute MI or as an exacerbation of chronic HF. When the left ventricle begins to fail, blood backs up into the pulmonary circulation, causing pulmonary interstitial edema. This may occur quickly in some patients, a condition sometimes called *flash pulmonary edema.* Pulmonary edema can also develop slowly, especially when it is caused by noncardiac disorders such as kidney injury and other conditions that cause fluid overload. The left ventricle cannot handle the volume overload, and blood volume and pressure build up in the left atrium. The rapid increase in atrial pressure results in an acute increase in pulmonary venous pressure, which produces an increase in hydrostatic pressure that forces fluid out of the pulmonary capillaries and into the interstitial spaces and alveoli (Norris, 2019).

As a result of decreased cerebral oxygenation, the patient may become increasingly restless and anxious. Along with a sudden onset of breathlessness and a sense of suffocation, the patient may be tachypneic with low oxygen saturation levels. The skin and mucous membranes may be pale to cyanotic, and the hands may be cool and clammy. Tachycardia and JVD may be present. Incessant coughing may occur, producing increasing quantities of foamy sputum. The patient may become progressively confused. The situation demands emergent action before oxygenation and perfusion levels become critical.

Assessment and Diagnostic Findings

For many years, the severity of HF was classified solely according to the patient's symptoms, using the New York Heart Association (NYHA) classification of HF. This classification system, which is still in widespread use, is described in Table 25-1. The American College of Cardiology and the American Heart Association (ACC/AHA) have developed another HF classification system (Yancy et al., 2013). This system, described in Table 25-2, takes into consideration the natural history and progressive nature of HF.

The ACC/AHA periodically issues evidence-based guidelines for patients with HF or at high-risk of having HF, using this classification system as a framework for treatment (Yancy et al., 2013; Yancy, Jessup, Bozkurt, et al., 2016; Yancy et al., 2017).

HF may go undetected until the patient presents with signs and symptoms of pulmonary and peripheral edema. Some of the physical signs that suggest HF may also occur with other diseases, such as kidney injury and COPD; therefore, diagnostic testing is essential to confirm a diagnosis of HF.

Assessment of ventricular function is an essential part of the initial diagnostic workup. An echocardiogram is performed to determine the ejection fraction (EF), identify anatomic features such as structural abnormalities and valve malfunction, and confirm the diagnosis of HF. The **ejection fraction** is a measure of ventricular contractility; it is the percentage of the end-diastolic blood volume that is ejected with each heartbeat. An expected EF is 55% to 65% of the ventricular volume; the ventricle does not completely empty between contractions (Wiegand, 2017).

TABLE 25-1 New York Heart Association (NYHA) Classification of Heart Failure

Classification	Signs and Symptoms
I	No limitation of physical activity Ordinary activity does not cause undue fatigue, palpitation, or dyspnea.
II	Slight limitation of physical activity Comfortable at rest, but ordinary physical activity causes fatigue, palpitation, or dyspnea.
III	Marked limitation of physical activity Comfortable at rest, but less than ordinary activity causes fatigue, palpitation, or dyspnea.
IV	Unable to carry out any physical activity without discomfort Symptoms of cardiac insufficiency at rest If any physical activity is undertaken, discomfort is increased.

Adapted from Yancy, C. W., Jessup, M., Bozkurt, B., et al. (2013). 2013 ACCF/AHA Guideline for the management of heart failure. A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation*, *128*(16), e240–e327.

There are two recognized main types of left-sided HF, with a third, emerging category. In **heart failure with reduced ejection fraction (HFrEF)**, or systolic heart failure, the left ventricle loses the ability to contract effectively, manifesting as EFs of less than 40%, reflecting decreased CO and pump failure (Yancy et al., 2017).

Heart failure with preserved ejection fraction (HFpEF), or diastolic heart failure, is diagnosed when the left ventricular function measures greater

than or equal to 50%, yet the ventricle loses its ability to relax due to myocardial stiffness. Because of the noncompliance of the ventricular wall, the chamber is unable to fill at normal capacity during the relaxation phase of diastole (Yancy et al., 2017).

Heart failure with midrange ejection fraction (HFmrEF) is a third and emerging classification category, with EFs typically between 40% and 49% (van der Meer et al., 2019).

Diagnosing a patient with HFpEF is more challenging than diagnosing a patient with HFrEF, because the diagnosis of HFpEF is a *diagnosis of exclusion.* That is, it is made by excluding other potential noncardiac causes suggestive of HF. The incidence of HFpEF is increasing and is becoming more commonplace among older adult women with a history of hypertension; indeed, hypertension is the most common underlying cause of HFpEF. Comorbid conditions such as obesity, CAD, diabetes, atrial fibrillation, and hyperlipidemia are also common in patients with HFpEF (Yancy et al., 2013).

In addition to the echocardiogram, a chest x-ray and a 12-lead electrocardiogram (ECG) are obtained to assist in the diagnosis. Laboratory studies usually performed during the initial workup include serum electrolytes, blood urea nitrogen (BUN), creatinine, liver function tests, thyroid-stimulating hormone, complete blood count (CBC), BNP, and routine urinalysis. The results of these laboratory studies assist in determining the underlying cause and can also be used to establish a baseline to assess effects of treatment. The BNP level is a key diagnostic indicator of HF; high levels are a sign of high cardiac filling pressure and can aid in both the diagnosis and management of HF; in particular, rising levels may suggest an acute exacerbation of HF (Yancy et al., 2013). BNP levels are best used for diagnostic purposes when there is a baseline measurement and a measurement obtained at the time of treatment (e.g., hospital discharge) to help in determining a posttreatment prognosis (Yancy et al., 2017).

TABLE 25-2 American College of Cardiology and American Heart Association (ACC/AHA) Classification of Heart Failure

Classification	Criteria	Patient Characteristics	Treatment Recommendations for Appropriate Patients
Stage A	Patients at high risk for developing left ventricular dysfunction but without structural heart disease or symptoms of HF	Hypertension Atherosclerotic disease Diabetes Metabolic syndrome	Heart healthy lifestyle Risk factor control of hypertension, lipids, diabetes, obesity
Stage B	Patients with left ventricular dysfunction or structural heart disease who have not developed symptoms of HF	History of myocardial infarction Left ventricular hypertrophy Low ejection fraction	Implement stage A recommendations, plus: • ACE inhibitor, or ARB, or ARNI for low EF or history of MI • Beta-blocker • Statin
Stage C	Patients with left ventricular dysfunction or structural heart disease with current or prior symptoms of heart disease	Shortness of breath Fatigue Decreased exercise tolerance	Implement stage A and B recommendations, plus: • Diuretics • Aldosterone antagonist • Sodium restriction • Implantable defibrillator • Cardiac resynchronization therapy
Stage D	Patients with refractory end-stage HF requiring specialized interventions	Symptoms despite maximal medical therapy Recurrent hospitalizations	Implement stage A, B, and C recommendations, plus: • Fluid restriction • End-of-life care • Extraordinary measures: • Inotropes • Cardiac transplantation • Mechanical support

ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; ARNI, angiotensin receptor-neprilysin inhibitor, EF, ejection fraction; HF, heart failure; MI, myocardial infarction.
Adapted from Yancy, C. W., Jessup, M., Bozkurt, B., et al. (2013). 2013 ACCF/AHA guideline for the diagnosis and management of heart failure: A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation*, *128*(16), e240–e327; Yancy, C. W., Jessup, M., Bozkurt, B., et al. (2016). ACC/AHA/HFSA focused update on new pharmacological therapy for heart failure: An update of the 2013 ACCF/AHA guideline for the management of heart failure: A report of the American College of Cardiology Foundation/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Failure Society of America. *Circulation*, *134*(13), e282–e293.

Medical Management

The prognosis for patients with HF has improved with the use of evidence-based protocols for patient management. Specific interventions are based on the stage of HF (Yancy et al., 2013; Yancy et al., 2016; Yancy et al., 2017). The management goals of HF include the following (Cyrille & Patel, 2017):

- Improvement of cardiac function with optimal pharmacologic management
- Reduction of symptoms and improvement of functional status
- Stabilization of patient condition and lowering of the risk of hospitalization
- Delay of the progression of HF and extension of life expectancy
- Promotion of a lifestyle conducive to cardiac health

Treatment options vary according to the severity of the patient's condition, comorbidities, and cause of the HF, and may include oral and intravenous (IV) medications, lifestyle modifications, supplemental oxygen, and surgical interventions, including implantation of cardiac devices, and cardiac transplantation (see Chapter 24).

Managing the patient with HF begins with providing comprehensive education and counseling to the patient and family. The patient and family must understand the nature of HF and the importance of their participation in the treatment regimen, including side and adverse effects of pharmacologic therapies. Lifestyle recommendations include restriction of dietary sodium; avoidance of smoking, including secondhand smoke; avoidance of excessive fluid and alcohol intake; weight reduction when indicated; and regular exercise. The patient must also know how to recognize signs and symptoms that need to be reported to the primary provider.

Pharmacologic Therapy

Several types of medications are routinely prescribed for patients with HF. The cornerstone of therapy for patients with HFrEF (systolic HF), which is the most common type of HF, includes a diuretic, an angiotensin system blocker,

and a beta-blocker (Table 25-3). Many of these medications, particularly angiotensin system blockers and beta-blockers, improve symptoms and extend survival. Others, such as diuretics, improve symptoms but may not affect survival (Meyer, 2019b). The patient with HFpEF (diastolic HF) may be prescribed a diuretic, most commonly an aldosterone antagonist (see Table 25-3), and may also be prescribed an angiotensin system blocker and/or a beta-blocker and find symptomatic relief; however, these drugs are not necessarily associated with improved survival in those patients (Borlaug & Colucci, 2019). Target doses for these medications and alternative medications for treating heart failure are identified in the ACC/AHA guidelines. Nurses, primary providers, and pharmacists work collaboratively toward achieving effective dosing of these medications (Yancy et al., 2013; Yancy et al., 2016; Yancy et al., 2017).

TABLE 25-3 Select Medications Used to Treat Heart Failure

Medication	Therapeutic Effects	Key Nursing Considerations
Diuretics		
Loop diuretics: furosemide *Thiazide diuretics:* metolazone hydrochlorothiazide	↓ Fluid volume overload ↓ Signs and symptoms of HF	Observe for electrolyte abnormalities, renal dysfunction, diuretic resistance, and ↓ BP. Carefully monitor I&O and daily weight (see Chart 25-2).
Aldosterone antagonists: spironolactone	Improves HF symptoms in advanced HF	Observe for ↑ serum K^+, ↓ serum Na^+.
Angiotensin System Blockers		
ACE Inhibitors: lisinopril enalapril	↓ BP and ↓ afterload Relieves signs and symptoms of HF Prevents progression of HF	Observe for symptomatic ↓ BP, ↑ serum K^+, cough, and worsening renal function.
ARBs: valsartan losartan	↓ BP and ↓ afterload Relieves signs and symptoms of HF Prevents progression of HF	Observe for symptomatic ↓ BP, ↑ serum K^+, and worsening renal function.
ARNI: sacubitril-valsartan	↓ BP and ↓ afterload ↓ Fluid volume overload ↓ Signs and symptoms of HF Prevents progression of HF	Observe for symptomatic ↓ BP, ↑ serum K^+, cough, dizziness, and renal failure.
Beta-Adrenergic–Blocking Agents (Beta-Blockers)		
carvedilol bisoprolol metoprolol	Dilates blood vessels and ↓ afterload ↓ Signs and symptoms of HF Improves exercise capacity	Observe for ↓ heart rate, symptomatic ↓ BP, dizziness, and fatigue.
Ivabradine	Decreases rate of conduction through the SA node	Observe for ↓ heart rate, symptomatic ↓ BP, dizziness, and fatigue.
Hydralazine-isosorbide dinitrate	Dilates blood vessels ↓ BP and ↓ afterload	Observe for symptomatic ↓ BP.
Digitalis		
digoxin	Improves cardiac contractility ↓ Signs and symptoms of HF	Observe for ↓ heart rate and digitalis toxicity.

ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; ARNI, angiotensin receptor-neprilysin inhibitor; BP, blood pressure; ↓, decreases; HF, heart failure; ↑, increases; I&O, input and output; K^+, potassium; Na^+, sodium; SA, sinoatrial.

Adapted from Burchum, J. R., & Rosenthal, L. D. (2019). *Lehne's pharmacology for nursing care* (9th ed.). St. Louis, MO: Elsevier.

Diuretics

Diuretics are prescribed to remove excess extracellular fluid by increasing diuresis in patients with signs and symptoms of fluid overload. ACC/AHA guidelines advocate using the smallest dose of diuretic necessary to control fluid volume (Yancy et al., 2013). The type and dose of diuretic prescribed depend on clinical signs and symptoms and renal function. Careful patient monitoring and dose adjustments are necessary to balance the effectiveness of these medications with the side effects (Chart 25-2). Loop, thiazide, and aldosterone-blocking diuretics may be prescribed; these medications differ in their site of action in the kidney and their effects on renal electrolyte excretion and reabsorption.

Loop diuretics, such as furosemide, inhibit sodium and chloride reabsorption mainly in the ascending loop of Henle. Patients with HF and with severe volume overload are generally treated with a loop diuretic first (Burchum & Rosenthal, 2019). *Thiazide diuretics,* such as metolazone, inhibit sodium and chloride reabsorption in the early distal tubules. Both of these classes of diuretics increase potassium excretion; therefore, patients treated with these medications must have their serum potassium levels closely monitored. Diuretics can also lead to orthostatic hypotension and kidney injury. Both a loop and a thiazide diuretic may be used in patients with severe HF who are unresponsive to a single diuretic. The need for diuretics can be decreased if the patient avoids excessive fluid intake (e.g., more than 2000 mL/day) and adheres to a low sodium diet (e.g., no more than 2 g/day).

Aldosterone antagonists, such as spironolactone, are potassium-sparing diuretics that block the effects of aldosterone in the distal tubule and collecting duct (Yancy et al., 2016). As noted previously, they are frequently prescribed for patients with HFpEF. Serum creatinine and potassium levels are monitored frequently (e.g., within the first week and then every 4 weeks) when spironolactone is first given. These drugs are not prescribed for patients with an elevated serum creatinine.

Chart 25-2 **PHARMACOLOGY**

Administering and Monitoring Diuretic Therapy

When nursing care involves diuretic therapy for conditions such as heart failure, the nurse needs to administer the medication and monitor the patient's response carefully, as follows:

- Prior to administration of the diuretic, check laboratory results for electrolyte depletion, especially potassium, sodium, and magnesium.
- Prior to administration of the diuretic, check for signs and symptoms of volume depletion, such as orthostatic hypotension, lightheadedness, and dizziness.
- Administer the diuretic at a time conducive to the patient's lifestyle—for example, early in the day to avoid nocturia.
- Monitor urine output during the hours after administration, and analyze intake, output, and daily weights to assess response.
- Monitor blood pressure for orthostatic changes.
- Continue to monitor serum electrolytes for depletion. Replace potassium with increased oral intake of food rich in potassium or potassium supplements. Replace magnesium as needed.
- Monitor for hyperkalemia in patients receiving potassium-sparing diuretics.
- Continue to assess for signs of volume depletion.
- Monitor creatinine for increased levels indicative of diuretic-induced renal dysfunction.
- Monitor for elevated uric acid level and signs and symptoms of gout.
- Assess lungs sounds and edema to evaluate response to therapy.
- Monitor for adverse reactions such as arrhythmias.
- Assist patients to manage urinary frequency and urgency associated with diuretic therapy.

Adapted from Burchum, J. R., & Rosenthal, L. D. (2019). *Lehne's pharmacology for nursing care* (10th ed.). St. Louis, MO: Elsevier.

Loop diuretics are administered IV for exacerbations of HF when rapid diuresis is necessary, as when pulmonary edema is present (see later discussion). Diuretics improve the patient's symptoms, provided that renal function is adequate. As HF progresses, cardiorenal syndrome may develop or worsen. Cardiorenal syndrome is a type of prerenal acute kidney injury characterized by a disruption in adequate blood flow to the kidneys. Patients

with this syndrome are resistant to diuretics and may require other interventions to deal with congestive signs and symptoms.

Angiotensin System Blockers

Angiotensin system blockers include classes of medications such as the ACE inhibitors, angiotensin receptor blockers (ARBs), and angiotensin receptor-neprilysin inhibitors (ARNIs).

Angiotensin-Converting Enzyme Inhibitors

ACE inhibitors, such as lisinopril, have been found to relieve clinical manifestations of HF and significantly decrease mortality and morbidity in patients with HFrEF. Specifically, they slow the progression of HF, improve exercise tolerance, and decrease the number of hospitalizations in patients with HFrEF (Yancy et al., 2013; Yancy et al., 2017). ACE inhibitors are also appropriate for hypertension management in patients with HFpEF (Yancy et al., 2017). Available as oral and IV medications, ACE inhibitors promote vasodilation and diuresis, ultimately decreasing both afterload and preload. Vasodilation reduces resistance to left ventricular ejection of blood, diminishing the heart's workload and improving ventricular emptying. ACE inhibitors decrease the secretion of aldosterone, a hormone that causes the kidneys to retain sodium and water. ACE inhibitors also promote renal excretion of sodium and fluid (while retaining potassium), thereby reducing left ventricular filling pressure and decreasing pulmonary congestion. These agents are also recommended for prevention of HF in patients at risk due to vascular disease and diabetes (Yancy et al., 2013; Yancy et al., 2017).

Patients receiving ACE inhibitors are monitored for hypotension, hyperkalemia (increased potassium in the blood), and alterations in renal function, especially if they are also receiving diuretics. Because ACE inhibitors cause the kidneys to retain potassium, the patient who is also receiving a loop diuretic or a thiazide diuretic may not need to take oral potassium supplements. However, the patient receiving a potassium-sparing diuretic, such as an aldosterone antagonist, which does not cause potassium loss with diuresis, must be carefully monitored for hyperkalemia. ACE inhibitors may be discontinued if the potassium level remains greater than 5.5 mEq/L or if the serum creatinine rises.

An adverse effect of ACE inhibitors includes a dry, persistent cough that may not respond to cough suppressants due to the inhibition of the enzyme kininase, which inactivates bradykinin. The nurse should carefully assess any cough in a patient taking an ACE inhibitor, as this symptom can also indicate a worsening of ventricular function and failure. In less than 1% of patients, ACE inhibitors may cause an allergic reaction accompanied by angioedema. This reaction tends to occur more frequently in African Americans and women (Yancy et al., 2016; Yancy et al., 2017). If angioedema affects the

oropharyngeal area and impairs breathing, the ACE inhibitor must be stopped immediately and appropriate emergency care must be provided.

If the patient cannot continue taking an ACE inhibitor because of development of cough, an elevated creatinine level, or hyperkalemia, an ARB, an ARNI, or a combination of hydralazine and isosorbide dinitrate is prescribed (see Table 25-3).

Angiotensin Receptor Blockers

Whereas ACE inhibitors block the conversion of angiotensin I to angiotensin II, ARBs, such as valsartan, block the vasoconstricting effects of angiotensin II at the angiotensin II receptors. ARBs are commonly prescribed as an alternative to ACE inhibitors, as they are associated with reduced morbidity and mortality in patients with HFrEF and can provide symptomatic relief in patients with HFpEF who are intolerant of ACE inhibitors (Yancy et al., 2013; Yancy et al., 2017). ARBs do not inhibit kininase; therefore, ARBs are not associated with the bothersome cough that occurs with some patients prescribed an ACE inhibitor.

Angiotensin Receptor-Neprilysin Inhibitors

An ARNI combines an ARB with a neprilysin inhibitor. Neprilysin is an enzyme that breaks down natriuretic peptides. Participants with HFrEF enrolled in clinical trials who were prescribed an ARNI demonstrated a significant reduction in cardiovascular death or hospitalization as compared with participants prescribed an ACE inhibitor (Meyer, 2019b). Based on these findings, updated ACC/AHA guidelines advocate prescribing an ARNI as first-line angiotensin system blocker therapy for most patients with symptomatic HFrEF. However, an ARNI is reportedly a costlier option than most ACE inhibitors and ARBs, which may preclude its practical use. For patients unable to take an ARNI, an ACE inhibitor or ARB is a good alternative. An ARNI should not be administered concurrently or within 36 hours of an ACE inhibitor as concomitant dosing with both agents is associated with angioedema (Yancy et al., 2016; Yancy et al., 2017). Adverse effects associated with use of an ARNI are similar to those associated with ACE inhibitor or ARB use; therefore, the nurse should assess for hypotension, renal insufficiency, and angioedema in patients taking an ARNI (Yancy et al., 2016; Yancy et al., 2017). The first U.S. Food and Drug Administration (FDA) approved ARNI for use in patients with HF is sacubitril-valsartan.

Beta-Blockers

Beta-blockers block the adverse effects of the sympathetic nervous system. They relax blood vessels, lower blood pressure, decrease afterload, and decrease cardiac workload. Beta-blockers, such as carvedilol, have been found to improve functional status and reduce mortality and morbidity in patients with HF (Burchum & Rosenthal, 2019). In addition, beta-blockers have been

recommended for patients with asymptomatic HFrEF to prevent progression and the onset of symptoms of HF, even if patients do not have a history of MI. The therapeutic effects of these drugs may not be seen for several weeks or even months (Yancy et al., 2013, Yancy et al., 2017).

Beta-blockers can produce a number of side effects, including dizziness, hypotension, bradycardia, fatigue, and depression. Side effects are most common in the initial few weeks of treatment. Because of the potential for side effects, beta-blockers are started at a low dose. The dose is titrated up slowly (every few weeks), with close monitoring after each dosage increase. Nurses educate patients about potential symptoms during the early phase of treatment and stress that adjustment to the drug may take several weeks. Nurses must also provide support to patients going through this symptom-provoking phase of treatment. Because beta-blockade can cause bronchiole constriction, these drugs are used with caution in patients with a history of bronchospastic diseases such as asthma.

Ivabradine

Ivabradine is a new agent that is a hyperpolarization-activated cyclic nucleotide channel blocker. It is a medication with unique electrophysiologic effects, characterized by its negative chronotropic effect on the sinoatrial node, thereby decreasing the heart rate without targeting the neurohormonal system. It is indicated as an adjunct agent to beta-blockers in patients with symptomatic HFrEF and with high resting heart rates of at least 70 bpm (Koruth, Lala, Pinney, et al., 2017). It may also be beneficial for patients with HFrEF who cannot tolerate beta-blockers (Yancy et al., 2017). Adverse effects of ivabradine include bradycardia resulting in dizziness and fatigue; it is also associated with an increased risk of atrial fibrillation (Koruth et al., 2017).

Hydralazine and Isosorbide Dinitrate

A combination of hydralazine and isosorbide dinitrate may be an alternative medication for patients who cannot take any of the three angiotensin system blockers (i.e., ACE inhibitor, ARB, and ARNI), so long as the patient's systolic BP is at least 90 mm Hg. Nitrates (e.g., isosorbide dinitrate) cause venous dilation, which reduces the amount of blood return to the heart and lowers preload. Hydralazine lowers systemic vascular resistance and left ventricular afterload. Hydralazine-isosorbide dinitrate is associated with decreased hospitalizations and improved survival in patients with HFrEF; however, these improvements are not as robust as those associated with angiotensin system blockers (Meyer, 2019b; Yancy et al., 2017). Adverse effects may include hypotension, and rarely, a lupus-type reaction (Meyer, 2019b).

Digitalis

For many years, digitalis (i.e., digoxin) was considered an essential agent for the treatment of HF. With the introduction of newer medications, it is not prescribed as often. Digoxin increases the force of myocardial contraction and slows conduction through the atrioventricular node. It improves contractility, increasing left ventricular output. Although the use of digoxin does not result in decreased mortality rates among patients with HFrEF, it can be effective in decreasing the symptoms of HF and may help prevent hospitalization (Yancy et al., 2013). Patients with renal dysfunction and older patients should receive smaller doses of digoxin, as it is excreted through the kidneys.

A key concern associated with digoxin therapy is digitalis toxicity. Clinical manifestations of toxicity include anorexia, nausea, visual disturbances, confusion, and bradycardia. The serum potassium level is monitored because the effect of digoxin is enhanced in the presence of hypokalemia and digoxin toxicity may occur. A serum digoxin level is obtained if the patient's renal function changes or there are symptoms of toxicity.

Intravenous Infusions

IV inotropes (e.g., dopamine, dobutamine, milrinone) increase the force of myocardial contraction; as such, they may be indicated for hospitalized patients with pulmonary edema (i.e., acute decompensated HF). These agents are used for patients who do not respond to routine pharmacologic therapy and are reserved for patients with severe ventricular dysfunction, low blood pressure, or impaired perfusion and evidence of significantly depressed CO, with or without congestion. They are used with caution, as some studies have associated their use with increased mortality (Malotte, Saguros, & Groninger, 2018; Yancy et al., 2013). Patients usually require admission to the intensive care unit (ICU) and may also have hemodynamic monitoring with a pulmonary artery catheter or alternative technology (see Chapter 21). Hemodynamic data are used to assess cardiac function and volume status and to guide therapy with inotropes, vasodilators, and diuretics (Urden, Stacy, & Lough, 2018). Patients with end-stage HF who cannot be weaned from IV inotropes may be candidates for continuous therapy at home (Malotte et al., 2018).

Dopamine

Dopamine is a vasopressor given to increase BP and myocardial contractility. Given at low doses, a dopamine infusion may be helpful as an adjunct therapy along with loop diuretics in improving diuresis, preserving renal function, and improving renal blood flow (Yancy et al., 2013).

Dobutamine

Dobutamine is given to patients with significant left ventricular dysfunction and hypoperfusion. A catecholamine, dobutamine stimulates the beta-1 adrenergic receptors. Its major action is to increase cardiac contractility and

renal perfusion to enhance urine output. However, it also increases the heart rate and can precipitate ectopic beats and tachyarrhythmias (Burchum & Rosenthal, 2019).

Milrinone

Milrinone is a phosphodiesterase inhibitor that leads to an increase in intracellular calcium within myocardial cells, increasing their contractility (Ayres & Maani, 2019). This agent also promotes vasodilation, resulting in decreased preload and afterload and reduced cardiac workload. Milrinone is administered IV to patients with severe HF, including patients who are waiting for heart transplantation (see Chapter 24). Because the drug causes vasodilation, the patient's blood pressure is monitored prior to administration; if the patient is hypovolemic, the blood pressure could drop quickly. The major side effects are hypotension and increased ventricular arrhythmias. Blood pressure and ECG are monitored closely during and following infusions of milrinone.

Vasodilators

Intravenous vasodilators such as IV nitroglycerin, nitroprusside, or nesiritide may enhance symptom relief for acutely decompensated HF (Yancy et al., 2013). Their use is contraindicated in patients who are hypotensive. Blood pressure is continually assessed in patients receiving IV vasodilator infusions.

Adjunct Medications for Heart Failure

The importance of ensuring that patients with hypertension take prescribed antihypertensive agents as prescribed is of paramount importance (see Chapter 27 for further discussion of antihypertensive medications). Target blood pressures should be less than 130/80 mm Hg. Maintaining BPs at these levels is associated with reduced likelihood of morbid progression to symptomatic HF in patients who are asymptomatic. It is also associated with improved morbidity in patients who are symptomatic with both HFrEF and HFpEF (Yancy et al., 2017).

Anemia is independently associated with HF disease severity, and iron deficiency appears to be uniquely associated with reduced exercise capacity. IV iron repletion in patients with HF may improve functional capacity and quality of life; however, there is mixed evidence to support the use of oral iron supplementation. Erythropoietin-stimulating agents, such as darbepoetin alfa, are not recommended in patients with both HF and anemia as a risk of thromboembolic events associated with their use has been observed during clinical trials (Yancy et al., 2017).

Anticoagulants may be prescribed, especially if the patient has a history of atrial fibrillation or a thromboembolic event. Antiarrhythmic drugs such as amiodarone may be prescribed for patients with arrhythmias, along with an evaluation for device therapy with an implantable cardioverter defibrillator

(ICD) (see Chapter 22). Medications to manage hyperlipidemia (e.g., statins) are also routinely prescribed, in tandem with guidance on nutritional therapy (see following section). It is recommended that patients with HF avoid nonsteroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen because the risk of decreased renal perfusion is higher, especially in older adults (Schwartz, Schmader, Hanlon, et al., 2018).

Adjunct Therapies for Heart Failure

Additional therapies that may be indicated in the treatment of patients with HF include nutritional therapy, supplemental oxygen, management of sleep disorders, and procedural or surgical interventions.

Nutritional Therapy

Following a low sodium (no more than 2 g/day) diet and avoiding excessive fluid intake are usually recommended, although studies differ regarding the effectiveness of sodium restriction (Yancy et al., 2013). Decreasing dietary sodium reduces fluid retention and the symptoms of peripheral and pulmonary congestion. The purpose of sodium restriction is to decrease the amount of circulating blood volume, which decreases myocardial work. A balance should be achieved between the patient's ability to adhere to the diet and the recommended guidelines.

Nutritional supplements, such as vitamins and antioxidants, are not recommended for patients with HF as no benefits are associated with their use. Omega-3 polyunsaturated fatty acid (PUFA) supplementation is associated with decreased fatal cardiovascular events and is recommended for patients with either HFrEF or HFpEF, unless contraindicated (Yancy et al., 2013).

Any change in eating patterns should consider good nutrition as well as the patient's likes, dislikes, and cultural food patterns. Patient adherence is important because dietary indiscretions may result in exacerbations of HF symptoms. However, behavioral changes in eating patterns are difficult for many patients to achieve.

Supplemental Oxygen

Oxygen therapy may become necessary as HF progresses based on the degree of pulmonary congestion and resulting hypoxia. Some patients require supplemental oxygen only during periods of activity (see Chapter 20 for further discussion of oxygen delivery systems).

Management of Sleep Disorders

Sleep disorders, including sleep apnea, are common in patients with HF. It is estimated that 61% of patients with HF have either central or obstructive sleep apnea (OSA). A formal sleep study should be performed. Continuous positive

airway pressure (CPAP) might be recommended if results from the sleep study suggest OSA (see Chapter 18). CPAP has been shown to improve sleep quality, reduce apneic episodes and excessive daytime sleepiness, and improve nocturnal oxygenation in patients with OSA and HF (Yancy et al., 2017).

Procedural and Surgical Interventions

A number of procedures and surgical approaches may benefit patients with HF. If the patient has underlying CAD, coronary artery revascularization with PCI or coronary artery bypass surgery (see Chapter 23) may be considered. Ventricular function may improve in some patients when coronary flow is increased.

Patients with HF are at high risk for arrhythmias, and sudden cardiac death is common among patients with advanced HF. In patients with severe left ventricular dysfunction and the possibility of life-threatening arrhythmias, placement of an ICD can prevent sudden cardiac death and extend survival (see Chapter 22). Candidates for an ICD include those with an EF less than 35%, including those with and without a history of ventricular arrhythmias (Yancy et al., 2013).

Patients with HF who do not improve with standard therapy may benefit from **cardiac resynchronization therapy (CRT)**. CRT involves the use of a biventricular pacemaker to treat electrical conduction defects and to synchronize ventricular contractions. A prolonged QRS duration on ECG indicates left bundle branch block, which is a type of delayed conduction that is frequently seen in patients with HF. This problem results in asynchronous conduction and contraction of the right and left ventricles, which can further decrease EF (Yancy et al., 2013). The use of a pacing device with leads placed in the right atrium, right ventricle, and left ventricular cardiac vein can synchronize the contractions of the right and left ventricles (Fig. 25-3). This intervention improves CO, optimizes myocardial energy consumption, reduces mitral regurgitation, and slows the ventricular remodeling process. For patients with a CRT, improvement of left ventricular EF is associated with reduced rates of ventricular arrhythmias. There are combination devices available for patients who require CRT and an ICD (Gulati & Udelson, 2018). See Chapter 22 for further discussion of care of patients with pacemakers, CRT, and ICDs.

Ultrafiltration is an alternative intervention for patients with severe fluid overload. It is reserved for patients with advanced HF who are resistant to diuretic therapy (Yancy et al., 2013). A dual-lumen central IV catheter is placed, and the patient's blood is circulated through a small bedside filtration machine. Liters of excess fluid and plasma are removed slowly from the patient's intravascular circulating volume over a number of hours. The patient's output of filtration fluid, blood pressure, and hemoglobin (analyzed for hemoconcentration) are monitored as indicators of volume status. Research

on ultrafiltration is ongoing, and targets comparisons of its efficacy to diuretics and the optimal fluid removal target (Costanzo, 2019).

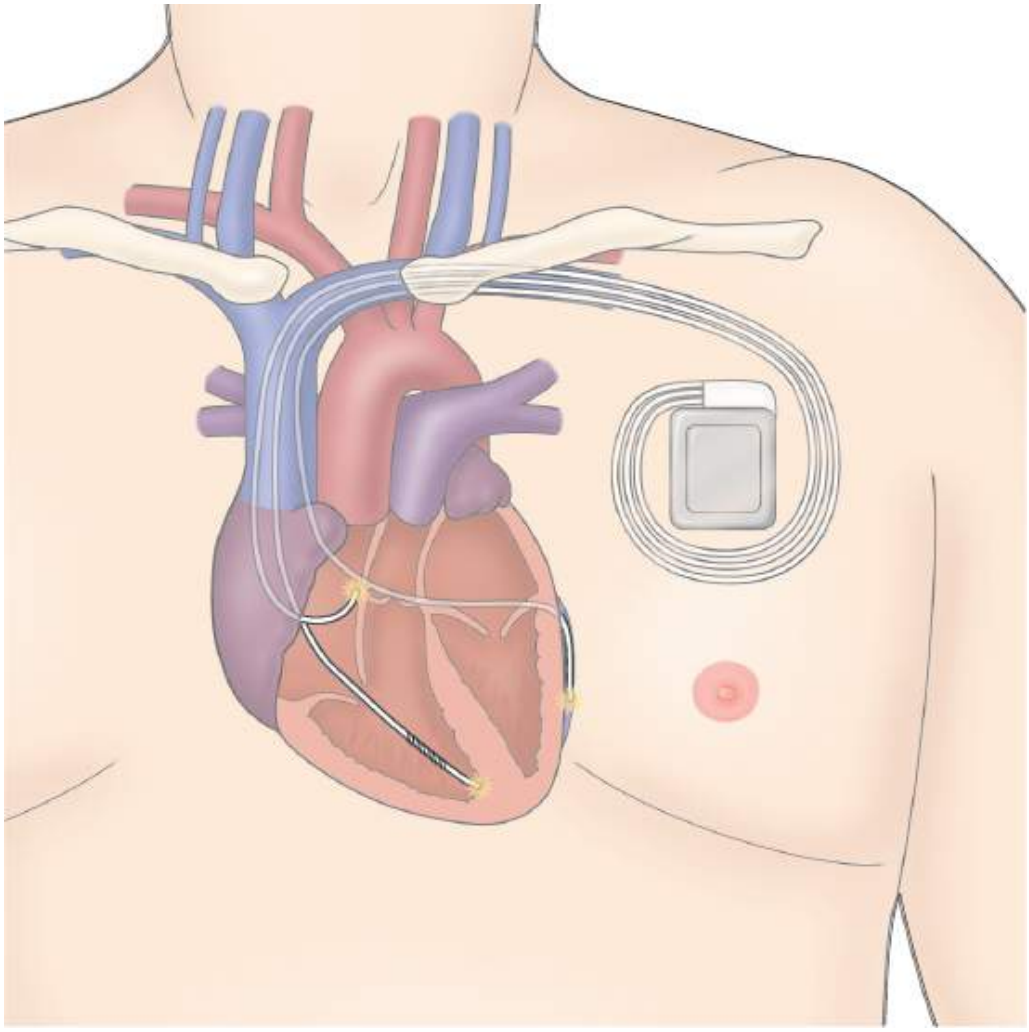

Figure 25-3 • Cardiac resynchronization therapy. To pace both ventricles, pacemaker leads are placed in the right atrium and right ventricle; a third lead is threaded through the coronary sinus into a lateral vein on the wall of the left ventricle.

For some patients with end-stage HF, cardiac transplantation is one of the few options for long-term survival. Patients with ACC/AHA stage D HF who may be eligible are referred for consideration of transplantation. Some of these patients require mechanical circulatory assistance with an implanted ventricular assist device as a bridge therapy to cardiac transplantation. A left ventricular assist device may also be implanted as *destination therapy* (permanent therapy) for select patients (Yancy et al., 2013).

Gerontologic Considerations

Several normal age-related changes increase the frequency of HF: increased systolic blood pressure, increased ventricular wall thickness, and increased myocardial fibrosis. There are a number of reasons that older adults may need to be hospitalized with HF (Albert, Barnason, Deswal, et al., 2015). Older adults may not always detect or accurately interpret common symptoms of HF such as shortness of breath, or they may have atypical symptoms such as weakness and somnolence. Decreased renal function can make the older patient resistant to diuretics and more sensitive to changes in volume. The administration of diuretics to older men requires nursing surveillance for bladder distention caused by urethral obstruction from an enlarged prostate gland. The bladder may be assessed with an ultrasound scanner or the suprapubic area palpated for an oval mass and percussed for dullness, indicative of bladder fullness. Urinary frequency and urgency may be particularly stressful to older patients, as many have arthritis and limited mobility.

NURSING PROCESS

The Patient with Heart Failure

Despite advances in treatment of HF, morbidity and mortality remain high. Nurses have a major impact on outcomes for patients with HF, especially in the areas of patient education and monitoring.

Assessment

Nursing assessment for the patient with HF focuses on observing for effectiveness of therapy and for the patient's ability to understand and implement self-care management strategies. Signs and symptoms of worsening HF are analyzed and reported to the patient's provider so that therapy can be adjusted. The nurse also explores the patient's emotional response to the diagnosis of HF, because it is a chronic and often progressive condition that is commonly associated with depression and other psychosocial issues (Jiang, Shorey, Seah, et al., 2018).

Health History

The health history focuses on the signs and symptoms of HF, such as dyspnea, fatigue, and edema. Sleep disturbances, particularly sleep suddenly interrupted by shortness of breath, may be reported. Patients are asked about the number of pillows needed for sleep, edema, abdominal symptoms, altered mental status, activities of daily living, and the activities that cause fatigue. Nurses need to be aware of the variety of clinical manifestations that may indicate worsening HF and assess the patient accordingly. While obtaining the patient's history, the nurse assesses the patient's understanding of HF, self-care management strategies, and the patient's ability and willingness to adhere to those strategies.

Physical Examination

The patient is observed for restlessness and anxiety that might suggest hypoxia from pulmonary congestion. The patient's level of consciousness is also evaluated for any changes, as low CO can decrease the flow of oxygen to the brain.

The rate and depth of respirations are assessed along with the effort required for breathing. The lungs are auscultated to detect crackles and wheezes (Meyer, 2019a). Crackles are produced by the sudden opening of edematous narrowed airways and alveoli. They may be heard at the end of inspiration and are not cleared with coughing. Wheezing may also be heard in some patients who have bronchospasm along with pulmonary congestion.

The blood pressure is carefully evaluated, because patients with HF may present with hypotension or hypertension. Patients may be assessed for

orthostatic hypotension, especially if they report lightheadedness, dizziness, or syncope. The heart is auscultated for an S_3 heart sound, which is an early sign that increased blood volume fills the ventricle with each beat. Heart rate and rhythm are also documented, and patients are often placed on continuous ECG monitoring in the hospital setting. When the heart rate is rapid or very slow, the CO decreases and potentially worsens the HF. JVD is assessed with the patient sitting at a 45-degree angle; distention greater than 4 cm above the sternal angle is considered abnormal and indicative of right ventricular failure (Bickley, 2017). This is an estimate, not a precise measurement, of high central venous pressure.

The nurse assesses peripheral pulses and rates their volume on a scale from 0 (not palpable) to 3+ (bounding). The skin is also assessed for color and temperature. With significant decreases in SV, there is a decrease in perfusion to the periphery, decreasing the volume of pulses and causing the skin to feel cool and appear pale or cyanotic. The feet and lower legs are examined for edema; if the patient is supine in bed, the sacrum and back are also assessed for edema. The upper extremities may also become edematous in some patients. Edema is typically rated on a scale from 0 (no edema) to 4+ (severe pitting edema).

The abdomen is examined for tenderness and hepatomegaly. The presence of firmness, distention, and possible ascites is noted. The liver may be assessed for hepatojugular reflux. The patient is asked to breathe normally while manual pressure is applied over the right upper quadrant of the abdomen for 30–60 s. If neck vein distention increases more than 1 cm, the finding is positive for increased venous pressure.

If the patient is hospitalized, the nurse measures urinary output and evaluates it in terms of diuretic use. Intake and output records are rigorously maintained and analyzed. It is important to track whether the patient has excreted excessive volume (i.e., negative fluid balance is generally the goal). The intake and output is then compared with changes in weight. Although diuresis is expected, the patient with HF must also be monitored for **oliguria** (diminished urine output, less than 0.5 mL/kg/h for at least 6 h or <400 mL/24 h) or **anuria** (urine output of less than 50 mL/24 h) because of the risk of renal dysfunction.

The patient is weighed daily in the hospital or at home, at the same time of day, with the same type of clothing, and on the same scale. If there is a significant change in weight (i.e., 2–3-lb increase in a day or 5-lb increase in a wk), the primary provider is notified and medications are adjusted (e.g., the diuretic dose is increased).

Diagnosis

Nursing Diagnoses

Based on the assessment data, major nursing diagnoses may include the following:

- Activity intolerance associated with decreased CO
- Hypervolaemia associated with the HF syndrome
- Anxiety associated with clinical manifestations of HF
- Powerlessness associated with chronic illness and hospitalizations
- Impaired family ability to manage regime

Collaborative Problems/Potential Complications

Potential complications may include the following:

- Pulmonary edema
- Hypotension, poor perfusion, and cardiogenic shock (see Chapter 11)
- Arrhythmias (see Chapter 22)
- Thromboembolism (see Chapter 26)
- Pericardial effusion (see later discussion in this chapter)

Planning and Goals

Major goals for the patient may include promoting activity and reducing fatigue, relieving fluid overload symptoms, decreasing anxiety or increasing the patient's ability to manage anxiety, encouraging the patient to verbalize their ability to make decisions and influence outcomes, and educating the patient and family about health management.

Nursing Interventions

Nursing interventions revolve around promoting the patient's activity tolerance, managing the patient's fluid volume status, assisting the patient so that anxiety is relieved, helping to minimize any feelings of powerlessness that the patient might experience, and assisting the patient and family members to effectively manage the patient's health. In addition, nursing interventions must be attuned to prevent and manage acute complications that can be experienced by patients with HF.

Promoting Activity Tolerance

Reduced physical activity caused by HF symptoms leads to physical deconditioning that worsens the patient's symptoms and exercise tolerance. Prolonged inactivity, which may be self-imposed, should be avoided because of its deconditioning effects and risks, such as pressure injuries (especially in edematous patients) and venous thromboembolism. An acute illness that exacerbates HF symptoms or requires hospitalization may be an indication for temporary bed rest. Otherwise, some type of physical activity every day should be encouraged. A typical program for a patient with HF might include a daily walking regimen, with the duration increased over a 6-wk period. The primary provider, nurse, and patient collaborate to

develop a schedule that promotes pacing and prioritization of activities. The schedule should alternate activities with periods of rest and avoid having two significant energy-consuming activities occur on the same day or in immediate succession. Before undertaking physical activity, the patient should be given guidelines similar to those noted in Chart 25-3. Because some patients may be severely debilitated, they may need to limit physical activities to only 3–5 min at a time, one to four times per day. The patient should increase the duration of the activity, then the frequency, before increasing the intensity of the activity (Piña, 2019).

Chart 25-3 HEALTH PROMOTION

An Exercise Program for Patients with Heart Failure

Before undertaking physical activity, the patient should be given the following guidelines:

- Talk with your primary provider for specific exercise program recommendations.
- Begin with low-impact activities such as walking.
- Start with warm-up activity followed by sessions that gradually build up to about 30 min.
- Follow your exercise period with cool-down activities.
- Avoid performing physical activities outside in extreme hot, cold, or humid weather.
- Wait 2 h after eating a meal before performing the physical activity.
- Ensure that you are able to talk during the physical activity; if you cannot do so, decrease the intensity of activity.
- Stop the activity if severe shortness of breath, pain, or dizziness develops.

Adapted from Piña, I. L. (2019). Cardiac rehabilitation in patients with heart failure. *UpToDate*. Retrieved on 9/11/2019 at: www.uptodate.com/contents/cardiac-rehabilitation-in-patients-with-heart-failure

Barriers to performing activities are identified, and methods of adjusting an activity are discussed. For example, vegetables can be chopped or peeled while sitting at the kitchen table rather than standing at the kitchen counter. Small, frequent meals decrease the amount of energy needed for digestion while providing adequate nutrition. The nurse helps the patient identify peak and low periods of energy, planning energy-consuming activities for peak periods. For example, the patient may prepare the meals for the entire day in the morning. Pacing and prioritizing activities help maintain the patient's energy to promote participation in regular physical activity.

The patient's response to activities needs to be monitored. If the patient is hospitalized, vital signs and oxygen saturation levels are monitored before, during, and immediately after an activity to identify whether they are within the desired range. Heart rate should return to baseline within 3 min following the activity. If the patient is at home, the degree of fatigue felt after the activity can be used to assess the response. If the patient tolerates the activity, short- and long-term goals can be developed to gradually increase the intensity, duration, and frequency of activity.

Adherence to exercise training is essential if the patient is to benefit from it, but it may be difficult for patients with other comorbid conditions (e.g., arthritis, anemia, cardiomyopathy, obesity, chronic kidney disease, chronic obstructive pulmonary disease) and those who have had HF for a longer time (Cattadori, Segurini, Picozzi, et al., 2018). Referral to a cardiac rehabilitation program may be indicated, especially for patients newly diagnosed with HF (Piña, 2019). A supervised program may also benefit those who need a structured environment, significant educational support, regular encouragement, and interpersonal contact.

Managing Fluid Volume

Patients with severe HF may receive IV diuretic therapy; however, patients with less severe symptoms are typically prescribed oral diuretics. Oral diuretics should be given early in the morning so that diuresis does not interfere with the patient's nighttime rest. Discussing the timing of medication administration is especially important for older patients who may have urinary urgency or incontinence. A single dose of a diuretic may cause the patient to excrete a large volume of fluid shortly after its administration.

The patient's fluid status is monitored closely by auscultating the lungs, monitoring daily body weight, and assisting the patient to adhere to a low sodium diet by reading food labels and avoiding high sodium foods such as canned, processed, and convenience foods (Chart 25-4). Weight gain in a patient with HF almost always reflects fluid retention. If the diet includes fluid restriction, the nurse can assist the patient to plan fluid intake throughout the day while respecting the patient's dietary preferences. If the patient is receiving IV fluids and medications, the amount of fluid needs to be monitored closely, and the primary provider or pharmacist can be consulted about the possibility of maximizing the amount of medication in the same volume of IV fluid (e.g., double concentrating to decrease the fluid volume given).

The patient is positioned or taught how to assume a position that facilitates breathing. The number of pillows may be increased, the head of the bed may be elevated, or the patient may sit in a recliner. In these positions, the venous return to the heart (preload) is reduced, pulmonary congestion is reduced, and pressure on the diaphragm is minimized. The

lower arms can be supported with pillows to eliminate the fatigue caused by the pull of the patient's weight on the shoulder muscles. If the patient is experiencing acute decompensation, positioning them upright, preferably with the legs dangling over the side of the bed, has the immediate effect of decreasing venous return, decreasing right ventricular stroke volume, and decreasing lung congestion.

Chart 25-4 HEALTH PROMOTION

Facts About Dietary Sodium

Although the major source of sodium in the average American diet is salt, many types of natural foods contain varying amounts of sodium. Even if no salt is added in cooking and if salty foods are avoided, the daily diet will still contain about 2000 mg of sodium. Fresh fruits and vegetables are low in sodium and should be encouraged.

Additives in Food

In general, food prepared at home is lower in sodium than restaurant or processed foods. Added food substances (additives), such as sodium alginate, which improves food texture, sodium benzoate, which acts as a preservative, and disodium phosphate, which improves cooking quality in certain foods, increase the sodium intake when included in the daily diet. Therefore, patients on low sodium diets should be advised to check labels carefully for words such as “salt” or “sodium,” especially on canned foods. For example, without looking at the sodium content per serving found on the nutrition labels, when given a choice between a serving of potato chips and a cup of canned cream of mushroom soup, most would think that soup is lower in sodium. However, when the labels are examined, the lower sodium choice is found to be the chips. Although potato chips are *not* recommended in a low sodium diet, this example illustrates that it is important to read food labels to determine both sodium content and serving size.

Nonfood Sodium Sources

Sodium is contained in municipal water. Water softeners also increase the sodium content of drinking water. Patients on sodium-restricted diets should be cautioned against using nonprescription medications such as antacids, cough syrups, and laxatives. Salt substitutes may be allowed, but it is recognized that they are high in potassium. Over-the-counter medications should not be used without first consulting the patient’s primary provider.

Promoting Dietary Adherence

If patients find food unpalatable because of the dietary sodium restrictions and/or the taste disturbances caused by the medications, they may refuse to eat or to follow the dietary regimen. For this reason, severe sodium restrictions should be avoided, and diuretic medication should be balanced with the patient’s ability to restrict dietary sodium. A variety of flavorings, such as lemon juice, vinegar, and herbs, may be used to improve the taste of the food and facilitate acceptance of the diet. It is important to consider the patient’s food preferences. Diet counseling and educational handouts can be geared toward a patient–family-centered approach and with cultural practices considered.

Adapted from American Heart Association (AHA). (2016). Shaking the salt habit. Retrieved on 10/24/2019 at: www.heart.org/HEARTORG/Conditions/HighBloodPressure/PreventionTreatmentofHighBloodPressure/Shaking-the-Salt-Habit_UCM_303241_Article.jsp#.Vzy9eNe3BK8

Because decreased circulation in edematous areas increases the risk of pressure injuries, the nurse assesses for skin breakdown and institutes preventive measures. Positioning to avoid pressure and frequent changes of position help prevent pressure injuries.

Controlling Anxiety

Patients with HF may exhibit signs and symptoms of anxiety. In addition to psychosocial sources of anxiety, the physiologic compensatory mechanisms include activation of neurohormones including catecholamines. Complex medical interventions, such as implantation of an ICD can provoke anxiety in patients and families. These sources of anxiety include living with the threat of shocks, role changes, and concerns about the patient's ability to carry out activities of daily living. The patient's anxiety may intensify at night and interfere with sleep. Emotional stress further stimulates the sympathetic nervous system, causing vasoconstriction, elevated arterial pressure, and increased heart rate. This sympathetic response increases cardiac workload.

When the patient exhibits anxiety, the nurse takes steps to promote physical comfort and provide psychological support. As mentioned previously, the patient may be more comfortable sitting in a recliner. Oxygen may be given during an acute event to diminish the work of breathing and increase the patient's comfort. In many cases, a family member's presence provides reassurance. Patients with HF rely on their families for many aspects of care; therefore, nurses should assess the needs of family caregivers and provide support to them (Hodson, Peacock, & Holtslander, 2019).

Along with reassurance, the nurse can begin educating the patient and family about techniques for controlling anxiety and avoiding anxiety-provoking situations. This includes how to identify factors that contribute to anxiety and how to use relaxation techniques to control anxious feelings. As the patient's anxiety decreases, cardiac function may improve and symptoms of HF may decrease.

Quality and Safety Nursing Alert

When patients with HF are delirious, confused, or anxious, restraints should be avoided. Restraints are likely to be resisted, and resistance inevitably increases the cardiac workload.

Minimizing Powerlessness

Patients with HF may feel overwhelmed with their diagnosis and treatment regimen, leading to feelings of powerlessness. Contributing factors may include lack of knowledge and lack of opportunity to make decisions, particularly if health care providers or family members do not encourage the patient to participate in the treatment decision-making process.

Nurses should help patients recognize their choices, and that they can positively influence the outcomes of their diagnosis and treatment. Taking time to listen actively to patients encourages them to express their concerns and ask questions. Other strategies include providing the patient with decision making opportunities, such as when activities are to occur, or encouraging food and fluid choices consistent with the dietary restrictions. Encouragement is provided, progress is identified, and the patient is assisted to differentiate between factors that can and cannot be controlled.

In addition to feelings of powerlessness, patients with HF have a high incidence of depressive symptoms, which are associated with increased morbidity and mortality (Jiang et al., 2018). Because depressive symptoms are known to increase as the disease worsens, patients with HF need to be screened for depression so that it can be treated, hopefully maintaining the patient's functional status and quality of life.

Assisting Patients and Families to Effectively Manage Health

Therapeutic regimens for HF are complex and require the patient and family to make significant lifestyle changes. An inability or unwillingness to adhere to dietary and pharmacologic recommendations can lead to episodes of acute decompensated HF and hospitalization. Nonadherence with prescribed diet and fluid restrictions and medications cause many hospital readmissions. Nursing research findings suggest that for some patients with HF who are taking more than one medication daily, the decision to not take HF medications as prescribed may actually reflect their efforts to best manage their personal health, and, therefore, may be a self-care strategy (see the Nursing Research Profile in Chart 25-5) (Meraz, 2020).

Nurses have a key role in managing episodes of acute decompensated HF and in developing a comprehensive education and discharge plan to prevent hospital readmissions and increase the patient's quality of life. Because of the high cost of hospitalization for HF, the Centers for Medicare & Medicaid Services (CMS) initiated a program that reduces reimbursement to hospitals with a high 30-d readmission rate (U.S. Department of Health and Human Services [HHS], 2019). Research continues to identify the most effective interventions that may decrease these rates. A number of evidence-based components are known to increase the effectiveness of a discharge plan for patients with HF, including providing them with comprehensive, patient-centered instructions,

scheduling follow-up visits with their primary providers within 7 d of discharge, and following up by telephone within 3 d of discharge (Yancy et al., 2013; Yancy et al., 2016; Yancy et al., 2017).

Monitoring and Managing Potential Complications

Because HF is a complex and progressive condition, patients are at risk for many complications, including acute decompensated HF and pulmonary edema; hypotension and cardiogenic shock (see Chapter 11); arrhythmias (see Chapter 22); thromboembolism formation (see Chapter 26); and pericardial effusion (see later discussion).

Pulmonary Edema. As described previously, pulmonary edema is associated with acute decompensated HF that can lead to acute respiratory failure and death. If it is recognized early, pulmonary edema may be alleviated by increasing dosages of diuretics and by implementing other interventions to decrease preload. For instance, placing the patient in an upright position with the feet and legs dependent reduces left ventricular workload. The treatment regimen and the patient's understanding of and adherence to it are assessed. The long-range approach for preventing pulmonary edema must be directed at identifying and managing its precipitating factors.

Chart 25-5 **NURSING RESEARCH PROFILE**

Medication Nonadherence or Self-Care?

Meraz, R. (2020). Medication nonadherence or self-care? Understanding the medication decision-making process and experiences of older adults with heart failure. *Journal of Cardiovascular Nursing, 35*(1), 26–34.

Purpose

It is estimated that over half of patients with heart failure do not take their medications as prescribed. The reasons why many patients with heart failure do not adhere to their prescribed medication regimen are elusive, particularly since nonadherence is associated with hospitalization and emergency department visits. Therefore, the purpose of this study was to discover why patients with heart failure might not take their heart failure medications as prescribed.

Design

This was a qualitative study that used narrative inquiry and storytelling to discover why community dwelling patients with heart failure might not adhere to their medication regimen. Eleven participants, all 65 y of age or older, volunteered to be interviewed. Each of these participants had to live independently in the community setting, had to take at least two medications daily to treat heart failure, and had to self-administer these medications in order to be eligible to participate in this study.

Findings

Results from participant interviews found that patients' nonadherence with the prescribed medication regimen was deliberate, and not because of forgetfulness. In all reported instances, it was not contingent upon financial constraints, either. Some participants stopped taking a medication while others adjusted the dosages. Participants' deliberate decisions to adjust their medication regimen tended to be made based on the belief that they knew their own bodies and needs best, and felt that they were best equipped to take care of their own needs. Others noted that at times it was too difficult to get in contact with their primary providers or nurses, and that their primary providers or nurses were too busy to discuss their medication regimen with them. Most noted that they researched online their medications' effects and felt competent to manage their medication dosage without necessarily consulting their providers. Paradoxically, participants did not view their decisions to self-adjust their prescribed medication regimens as consonant with nonadherence.

Nursing Implications

Patients with heart failure who are prescribed multiple medications to treat their heart failure may not view self-adjustment of their prescriptions as tantamount to nonadherence. It seems likely that these self-

care/nonadherent practices place these patients at risk for hospitalization and morbid complications. Participants in this study noted that one key reason that they self-adjusted their medications was because their primary providers and nurses were “too busy” to talk to them about their medications. Nurses are in an ideal position to talk to patients with heart failure about their prescriptions, discover their concerns about their medications, help them find ways to problem-solve and manage side effects, and help them proactively engage in self-care so that they avoid hospitalization.

Clinical management of a patient with acute pulmonary edema due to left ventricular failure is directed toward reducing volume overload, improving ventricular function, and increasing oxygenation. These goals are accomplished through a combination of oxygen and ventilatory support, IV medication, and nursing assessment and interventions.

The patient’s airway and breathing are assessed to determine the severity of respiratory distress, along with vital signs. The patient is placed on pulse oximetry, a cardiac monitor, and IV access is confirmed or established for administration of medications. Laboratory tests are obtained, including arterial blood gases, electrolytes, BUN, and creatinine; other laboratory tests that may be indicated include a complete blood cell count (CBC), BNP, or a serum troponin-I. A chest x-ray or an ultrasound of the lungs may be obtained to confirm the extent of pulmonary edema (Meyer, 2019a).

Oxygen is given in concentrations adequate to relieve hypoxemia and dyspnea; a non-rebreathing mask may be used initially. If respiratory failure is severe or persists, noninvasive positive-pressure ventilation is the preferred mode of assisted ventilation (Colucci, 2019). For some patients, endotracheal (ET) intubation and mechanical ventilation are required. The ventilator can provide positive end-expiratory pressure (PEEP), which is effective in reducing venous return, decreasing fluid movement from the pulmonary capillaries to the alveoli, and improving oxygenation (see Chapter 19). Oxygenation is monitored by pulse oximetry and by measurement of arterial blood gases.

The patient who is experiencing pulmonary edema is likely going to be highly anxious, as are the patient’s family members. As the ability to breathe decreases, the patient’s fear and anxiety rise proportionately, making the condition more severe. Reassuring the patient and family and providing skillful anticipatory nursing care are integral parts of the therapy. Because the patient is in an unstable condition, the nurse must remain with the patient. The nurse gives the patient simple, concise information in a reassuring voice about what is being done to treat the condition and the expected results.

Vasodilators such as IV nitroglycerin or nitroprusside may enhance symptom relief in pulmonary edema, as previously described (Meyer,

2019a). Blood pressure is continually assessed in patients receiving IV vasodilator infusions.

Furosemide or another loop diuretic is given by IV push or as a continuous infusion to produce a rapid diuretic effect. The blood pressure is closely monitored as the urine output increases, because it is possible for the patient to become hypotensive as intravascular volume decreases. The patient receiving diuretic therapy may excrete a large volume of urine within minutes after a potent diuretic is given. A bedside commode may be used to decrease the energy required by the patient and to reduce the resultant increase in cardiac workload induced by getting on and off a bedpan. If necessary, in order to carefully monitor urine output, an indwelling urinary catheter may be inserted.

Once the patient is stable, they may transition to oral diuretics; intake and output, daily weights, serum electrolytes, and creatinine are carefully monitored.

Many potential problems associated with HF therapy relate to the use of diuretics. These problems require ongoing nursing assessment and collaborative intervention:

Excessive and repeated diuresis can lead to hypokalemia (i.e., potassium depletion). Signs include ventricular arrhythmias, hypotension, muscle weakness, and generalized weakness. In patients receiving digoxin, hypokalemia can lead to digitalis toxicity, which increases the likelihood of dangerous arrhythmias. Patients with HF may also develop low levels of magnesium, which can add to the risk of arrhythmias. Hyperkalemia may occur, especially with the use of ACE inhibitors, ARBs, or spironolactone. Hyperkalemia can also lead to profound bradycardia and other arrhythmias. Prolonged diuretic therapy may produce hyponatremia (deficiency of sodium in the blood), which can result in disorientation, weakness, muscle cramps, and anorexia. Volume depletion from excessive fluid loss may lead to dehydration and hypotension. ACE inhibitors and beta-blockers may contribute to the hypotension. Other problems associated with diuretics include increased serum creatinine (indicative of renal dysfunction) and hyperuricemia (excessive uric acid in the blood), which leads to gout.

Promoting Home, Community-Based, and Transitional Care

Facilitating an easy and smooth transition back into the community is of paramount importance for the patient living with HF. Community-based nursing interventions for patients with HF can improve health outcomes and health care value as evidenced by reduced hospital readmissions for up to 6 mo. Important nursing interventions that keep the patient with HF out of the hospital incorporate a multidisciplinary care planning approach (Jones, Bowles, Richard, et al., 2017).

Educating Patients About Self-Care. The nurse provides patient education and involves the patient and family in the therapeutic regimen to promote understanding and adherence to the plan. When the patient recognizes that the diagnosis of HF can be successfully managed with lifestyle changes and medications, recurrences of acute HF lessen, unnecessary hospitalizations decrease, and life expectancy increases. Nurses play a key role in educating patients and their families about medication management, a low sodium diet, moderate alcohol consumption, activity and exercise recommendations, smoking cessation, how to recognize the signs and symptoms of worsening HF, and when to contact the primary provider (Jones et al., 2017). Use of the teach-back technique to assess the patient's comprehension of the instructions can increase education effectiveness and prevent rehospitalization (Esquivel, White, Carroll, et al., 2018) (see Chapter 3 for further discussion of teach-back methods). In order for teach-back to be effective, the nurse must ensure adequate time is dedicated to ensuring that patient learning occurs (Esquivel et al., 2018). A basic home education plan for the patient with HF is presented in Chart 25-6. The patient should receive a written copy of the instructions.

The patient's readiness to learn and potential barriers to learning are assessed. Patients with HF may have temporary or ongoing cognitive impairment due to their illness or other factors, increasing the need to rely on an identified caretaker (Hodson et al., 2019). An effective treatment plan incorporates both the patient's goals and those of the health care providers. The nurse must consider cultural factors and adapt the education plan accordingly. Patients and families need to understand that effective HF management is influenced by choices made about treatment options and their ability to follow the treatment plan. They also need to be informed that health care providers are available to assist them in reaching their health care goals.

Chart 25-6 **HOME CARE CHECKLIST**

The Patient with Heart Failure

At the completion of education, the patient and/or caregiver will be able to:

- Identify heart failure as a chronic disease that can be managed with medications and specific self-management behaviors.
- State the impact of heart failure on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- State the name, dose, side effects, frequency, and schedule for all medications.
- Take or administer medications daily, exactly as prescribed.
- Monitor effects of medication such as changes in breathing and edema.
- Know signs and symptoms of orthostatic hypotension and how to prevent it.
- Weigh self daily at the same time, with same clothes.
- Restrict sodium intake to no more than 2 g/day:
  - Adapt diet by examining nutrition labels to check sodium content per serving.
  - Avoid canned or processed foods, eating fresh or frozen foods.
  - Consult the written diet plan and the list of permitted and restricted foods.
  - Avoid salt use.
  - Avoid excesses in eating and drinking.
- Participate in prescribed activity program:
  - Participate in a daily exercise program.
  - Increase walking and other activities gradually, provided they do not cause unusual fatigue or dyspnea.
  - Conserve energy by balancing activity with rest periods.
  - Avoid activity in extremes of heat and cold, which increase the work of the heart.
  - Recognize that air-conditioning may be essential in a hot, humid environment.
- Develop methods to manage and prevent stress:
  - Avoid tobacco.
  - Avoid alcohol.
  - Engage in social and diversional activities.
- Identify community resources for peer and caregiver/family support:
  - Identify sources of support (e.g., friends, relatives, faith community).
  - Identify the contact details for support services for patients and their caregivers/families.

- Report immediately to the primary provider or clinic any of the following:
  - Gain in weight of 2–3 lb (0.9–1.4 kg) in 1 d, or 5 lb (2.3 kg) in 1 wk
  - Unusual shortness of breath with activity or at rest
  - Increased swelling of ankles, feet, or abdomen
  - Persistent cough
  - Loss of appetite
  - Development of restless sleep; increase in number of pillows needed to sleep
  - Profound fatigue
- State how to reach primary provider with questions or complications:
  - State time and date of follow-up appointments and diagnostic tests.
- Identify the need for health promotion, disease prevention, and screening activities.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Continuing and Transitional Care. Successful management of HF requires adherence to a complex medical regimen that includes multiple lifestyle changes for most patients. Assistance may be provided through a number of options that optimize evidence-based recommendations for effective management of HF. Depending on the patient's physical status and the availability of family assistance, a home care referral or another type of disease management program may be indicated for a patient who has been hospitalized. Transitional care programs (hospital to home) that include telephone contact along with home visits have been shown to decrease rehospitalizations and increase patient quality of life (Cyrille & Patel, 2017; Jones et al., 2017). Home visits by nurses who are specially trained in managing patients with HF provide assessment and management tailored to specific individualized patient needs. Older patients and those who have long-standing heart disease with compromised physical stamina often require assistance with the transition to home after hospitalization for an acute episode of HF. The home health nurse assesses the physical environment of the home and makes suggestions for adapting the home environment to meet the patient's activity limitations. If stairs are a concern, the patient can plan the day's activities so that stair-climbing is minimized; for some patients, a temporary bedroom may be set up on the main level of the home. The home health nurse works with the patient and family to maximize the benefits of these changes.

The home health nurse also reinforces and clarifies information about dietary changes and fluid restrictions, the need to monitor symptoms and

daily body weight, and the importance of obtaining follow-up care with the primary provider's office or clinic. Assistance may be given in scheduling and keeping appointments as well. The patient is encouraged to gradually increase their self-care and responsibility for carrying out the therapeutic regimen.

Evidence-based HF guidelines also recommend patient referral to HF clinics, which provide intensive nursing management along with medical care in a collaborative model. Many of these clinics are managed by advanced practice nurses. Referral to an HF clinic gives the patient ready access to continuing education, professional nursing and medical staff, and timely adjustments to treatment regimens. HF clinics can also provide outpatient treatment (e.g., IV diuretics, laboratory monitoring) as an alternative to hospitalization. Because of the additional support and coordination of care, patients managed through HF clinics have fewer exacerbations of HF, fewer hospitalizations, decreased costs of medical care, and increased quality of life (Yancy, 2013).

Other disease management programs are carried out through telehealth, using telephones or computers to maintain contact with patients and to obtain patient data. This enables nurses and others to assess and manage patients on a frequent basis, without requiring patients to make frequent visits to health care providers. A variety of techniques ranging from simple telephone monitoring to sophisticated computer and video connections that monitor symptoms, daily weight, vital signs, heart sounds, and breath sounds may be used. Patient data may also include hemodynamics and other parameters transmitted from implantable devices. Studies have shown that telehealth management can decrease costs and hospitalizations for acute exacerbations of HF (Koehler, Koehler, Deckwart, et al., 2018).

End-of-Life Considerations. Because HF is a chronic and often progressive condition, patients and families need to consider issues related to the end-of-life and when palliative or hospice care should be considered (Cross, Kamal, Taylor, et al., 2019). Although the prognosis in patients with HF may be uncertain, issues often arise sooner or later related to the patient's thoughts and possible concerns about the use of complex treatment options (e.g., implantation of an ICD or a ventricular assist device [VAD]). VADs are an option for some patients with HF who have failed medical therapy and who are not candidates for cardiac transplantation. Discussions concerning the use of technology, preferences for end-of-life care, and advance directives should take place while the patient is able to participate and express preferences. For example, with the expanded use of ICDs in the HF population, patients with ICDs, their families, and their primary providers should receive instructions for ICD inactivation at the end-of-life to prevent inappropriate discharges. See Chapter 13 for further discussion of end-of-life care.

Evaluation

Expected patient outcomes may include:

1. Demonstrates tolerance for desired activity
   a. Describes adaptive methods for usual activities
   b. Schedules activities to conserve energy and reduce fatigue and dyspnea
   c. Maintains heart rate, blood pressure, respiratory rate, and pulse oximetry within the targeted range
2. Maintains fluid balance
   a. Exhibits decreased peripheral edema
   b. Verbalizes understanding of fluid intake and diuretic use
3. Decreased anxiety
   a. Avoids situations that produce stress
   b. Sleeps comfortably at night
   c. Reports decreased stress and anxiety
   d. Denies symptoms of depression
4. Makes sound decisions regarding care and treatment
   a. Demonstrates ability to influence outcomes
5. Patients and family members adhere to healthy regimen
   a. Performs and records daily weights
   b. Limits dietary sodium intake to no more than 2 g/day
   c. Takes medications as prescribed
   d. Reports symptoms of worsening HF
   e. Makes and keeps appointments for follow-up care
6. Exhibits no evidence of acute decompensation and pulmonary edema
7. Denies dyspnea
8. No apparent delirium or acute anxiety
9. Maintains fluid balance as noted previously
10. No evidence of electrolyte disturbances from diuretic therapy

COMPLICATIONS FROM HEART DISEASE

Cardiogenic Shock

Cardiogenic shock occurs when decreased CO leads to inadequate tissue perfusion and initiation of the shock syndrome. Cardiogenic shock most commonly occurs following acute MI when a large area of myocardium

becomes ischemic and hypokinetic. It also can occur as a result of end-stage HF, cardiac tamponade, pulmonary embolism (PE), cardiomyopathy, and arrhythmias. Cardiogenic shock is a life-threatening condition with a high mortality rate. (See Chapter 11 for detailed information about the pathophysiology and management of cardiogenic shock.)

Thromboembolism

Patients with cardiovascular disorders are at risk for the development of arterial thromboemboli and venous thromboemboli (VTE). Intracardiac thrombi can form in patients with atrial fibrillation because the atria do not contract forcefully, resulting in slow and turbulent flow, and increasing the likelihood of thrombus formation. Mural thrombi can also form on ventricular walls when contractility is poor. Intracardiac thrombi can break off and travel through the circulation to other structures, including the brain, where they cause a stroke. Clots within the cardiac chambers can be detected by an echocardiogram and treated with anticoagulant agents, such as heparin and warfarin (see Chapter 26 for further discussion of assessment and treatment of VTEs; Table 26-2 discusses specific anticoagulant medications).

Decreased mobility and other factors in patients with cardiac disease also can lead to clot formation in the deep veins of the legs. Although signs and symptoms of deep vein thrombosis (DVT) can vary, patients may report leg pain and swelling and the leg may appear erythematous and feel warm. These clots can break off and travel through the inferior vena cava and through the right side of the heart into the pulmonary artery, where they can cause a pulmonary embolus (PE) (see Chapter 26 for further discussion of assessment and treatment of PE).

Pericardial Effusion and Cardiac Tamponade

Pericardial effusion (accumulation of fluid in the pericardial sac) may accompany advanced HF, pericarditis, metastatic carcinoma, cardiac surgery, or trauma. Normally, the pericardial sac contains about 20 mL of fluid, which is needed to decrease friction for the beating heart. An increase in pericardial fluid raises the pressure within the pericardial sac and compresses the heart. This has the following effects:

- Elevated pressure in all cardiac chambers
- Decreased venous return due to atrial compression
- Inability of the ventricles to distend and fill adequately

Pericardial fluid may build up slowly without causing noticeable symptoms until a large amount (1 to 2 L) accumulates (Hoit, 2019). However, a rapidly

developing effusion (e.g., hemorrhage into the pericardial sac from chest trauma) can quickly stretch the pericardium to its maximum size and cause an acute problem. As pericardial fluid increases, pericardial pressure increases, reducing venous return to the heart and decreasing CO. This can result in cardiac tamponade, which causes low CO and obstructive shock.

Clinical Manifestations

The signs and symptoms of pericardial effusion can vary according to whether the problem develops quickly or slowly. In acute cardiac tamponade, the patient suddenly develops chest pain, tachypnea, and dyspnea. JVD results from poor right atrial filling and increased venous pressure. Hypotension occurs from low CO, and heart sounds are often muted. The subacute presentation of a pericardial effusion is less dramatic. The patient may report chest discomfort or a feeling of fullness. The feeling of pressure in the chest may result from stretching of the pericardial sac. These patients also develop dyspnea, JVD, and hypotension over time (Hoit, 2019). Patients with cardiac tamponade typically have tachycardia in response to low CO. In addition to hypotension, patients with cardiac tamponade may develop **pulsus paradoxus**, a systolic blood pressure that is markedly lower during inhalation. Also known as paradoxical pulse, this finding is characterized by an abnormal difference of at least 10 mm Hg in systolic pressure between the point that it is heard during exhalation and the point that it is heard during inhalation. This difference is caused by the variation in cardiac filling that occurs with changes in intrathoracic pressure during breathing. The cardinal signs of cardiac tamponade are illustrated in Figure 25-4.

Assessment and Diagnostic Findings

An echocardiogram is performed to confirm the diagnosis and quantify the amount of pericardial fluid. A chest x-ray may show an enlarged cardiac silhouette due to pericardial effusion. The ECG shows tachycardia and may also show low voltage (Hoit, 2019). See Chapter 22 for discussion of the significance of ECG abnormalities.

Medical Management

Acute management of cardiac tamponade may include a pericardiocentesis; whereas, recurrent effusions may be managed with a pericardiotomy.

Pericardiocentesis

If cardiac function becomes seriously impaired, **pericardiocentesis** (puncture of the pericardial sac to aspirate pericardial fluid) is performed. During this

procedure, the patient is monitored by continuous ECG and frequent vital signs. Catheter pericardiocentesis is performed using echocardiography to guide placement of the drainage catheter (Hoit, 2019).

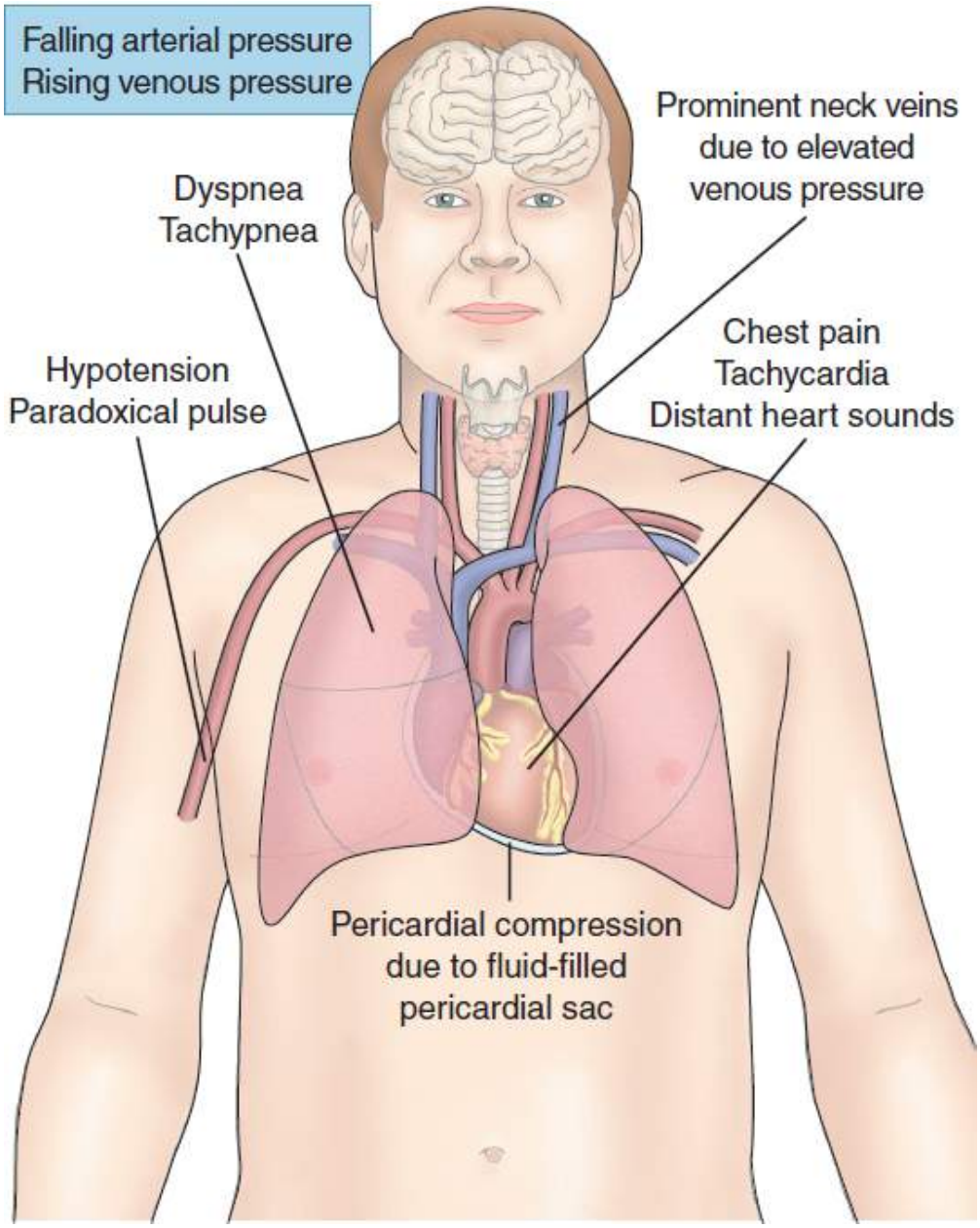

Figure 25-4 • Assessment findings in cardiac tamponade resulting from pericardial effusion include chest pain or fullness, dyspnea, tachypnea, jugular vein distention, hypotension, paradoxical pulse, tachycardia, and distant heart sounds.

A resulting decrease in central venous pressure and an associated increase in blood pressure after withdrawal of pericardial fluid indicate that the cardiac tamponade has been relieved. The patient almost always feels immediate relief. If there is a substantial amount of pericardial fluid aspirated, a small

catheter may be left in place to drain recurrent accumulation of blood or fluid. Pericardial fluid is sent to the laboratory for examination for tumor cells, bacterial culture, chemical and serologic analysis, and differential blood cell count.

Complications of pericardiocentesis include coronary artery puncture, myocardial trauma, arrhythmias, pleural laceration, and gastric puncture. After pericardiocentesis, the patient's heart rhythm, blood pressure, venous pressure, and heart sounds are monitored frequently to detect possible recurrence of cardiac tamponade. A follow-up echocardiogram is also performed. If the effusion recurs, repeat aspiration is necessary. Cardiac tamponade may require treatment by open surgical drainage (pericardiotomy) (Hoit, 2019).

Pericardiotomy

Recurrent pericardial effusions, usually associated with neoplastic disease, may be treated by a **pericardiotomy** (pericardial window). Under general anesthesia, a portion of the pericardium is excised to permit the exudative pericardial fluid to drain into the lymphatic system. The nursing care following the procedure includes routine postsurgical care (see Chapter 16) in addition to observation for recurrent tamponade.

Cardiac Arrest

In cardiac arrest, the heart is unable to pump and circulate blood to the body's organs and tissues. It is often caused by an arrhythmia such as ventricular fibrillation, progressive bradycardia, or asystole (i.e., absence of cardiac electrical activity and heart muscle contraction). Cardiac arrest can also occur when electrical activity is present on the ECG but cardiac contractions are ineffective, a condition called **pulseless electrical activity (PEA)**. PEA may be caused by a variety of problems such as profound hypovolemia (e.g., hemorrhage). Diagnoses that are commonly associated with cardiac arrest include MI, massive pulmonary emboli, hyperkalemia, hypothermia, severe hypoxia, and medication overdose. Rapid identification of these problems and prompt intervention can restore circulation in some patients.

Clinical Manifestations

In cardiac arrest, consciousness, pulse, and blood pressure are lost immediately. Breathing usually ceases, but ineffective respiratory gasping may occur. The pupils of the eyes begin dilating in less than a minute, and seizures may occur. Pallor and cyanosis are seen in the skin and mucous membranes. The risk of organ damage, including irreversible brain damage, and of death increases with every minute that passes. A patient's age and overall health

determine their vulnerability to irreversible damage. As soon as possible, the diagnosis of cardiac arrest must be made and action taken immediately to restore circulation.

Emergency Assessment and Management: Cardiopulmonary Resuscitation

Cardiopulmonary resuscitation (CPR) provides blood flow to vital organs until effective circulation can be reestablished. Following the recognition of unresponsiveness, a protocol for basic life support is initiated. The AHA Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care direct the current protocols for CPR, medical emergency teams, postcardiac arrest care, and acute respiratory compromise. The primary goal of resuscitation protocols is to save lives by preventing in-hospital cardiac arrest and optimizing outcomes (AHA, 2017).

The resuscitation process begins with the immediate assessment of the patient for breathing and consciousness, then a call for assistance, as CPR can be performed most effectively with the addition of more health care providers and equipment (e.g., defibrillator). The current resuscitation protocol recommends the following practices for CPR:

1. *Quick recognition of sudden cardiac arrest*. The patient is assessed for responsiveness and breathing.
2. *Activation of the Emergency Response System*. Within a medical facility, a call is made to alert the emergency response team. Outside of a medical facility, 911 is called to activate the Emergency Medical Service (EMS).
3. *Performance of high-quality CPR*. If there is no carotid pulse detected, chest compressions are initiated at a rate of 100 bpm.
4. *Rapid cardiac rhythm analysis and defibrillation* within 2 minutes for patients in ventricular fibrillation or pulseless ventricular tachycardia, followed by continuous chest compressions.

Rescue breathing is no longer recommended unless health care providers are present; if that is the case, it is then started after chest compressions. The airway is opened using a head-tilt/chin-lift maneuver, and any obvious material in the mouth or throat is removed. An oropharyngeal airway may be inserted if available to help maintain patency of the airway. Rescue ventilations are provided using a bag-valve mask or mouth-mask device. Oxygen is given at 100% during resuscitation to correct hypoxemia and improve tissue oxygenation.

Compressions are performed with the patient on a firm surface such as the floor or a cardiac board. The provider, facing the patient's side, places one hand in the center of the chest on the lower half of the sternum and positions the other hand on top of the first hand (Fig. 25-5). The chest is compressed 2

inches (approximately 5 cm) at a rate of 100 compressions/min. Complete recoil of the chest must be allowed between compressions to allow for cardiac filling. Interruptions in CPR to switch providers or check for a pulse are minimized (Panchal, Berg, Hirsch, et al., 2019). It is recommended providers switch every 2 minutes due to the exertion of delivering effective compressions.

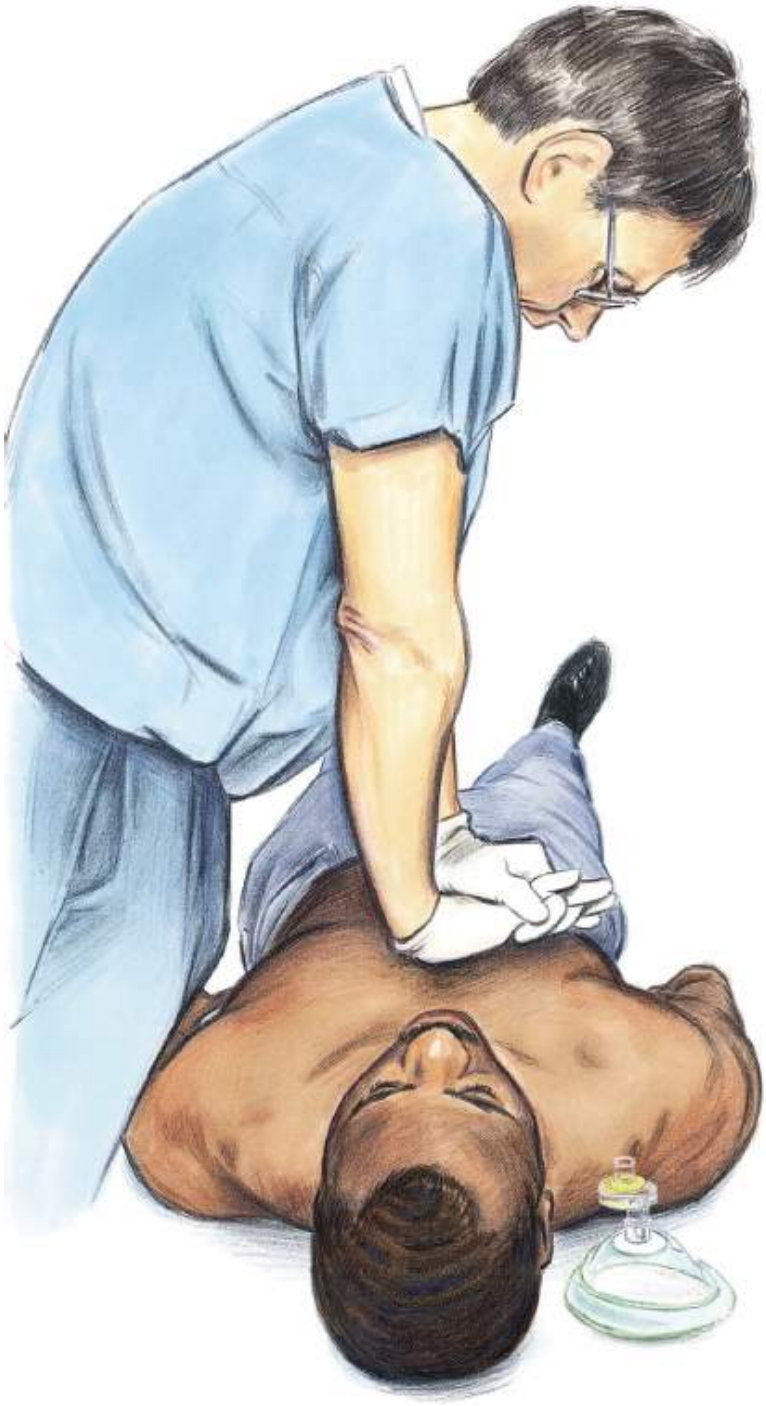

Figure 25-5 • Chest compressions in cardiopulmonary resuscitation are performed by placing the heel of one hand in the center of the chest over the sternum and the other hand on top of the first hand. Elbows are kept straight and body weight is used to apply forceful compressions to the lower sternum. The patient should be on a hard surface such as a cardiac board. Reprinted with permission from Field, J. M., Kudenchuk, P. J., O'Connor, R. E., et al. (2009). *The textbook of emergency cardiovascular care and CPR*. Philadelphia, PA: Lippincott Williams & Wilkins.

Defibrillation

As soon as a monitor/defibrillator is available, monitor electrodes are applied to the patient's chest and the heart rhythm is analyzed. When an automated external defibrillator (AED) is used, the device is turned on, the pads are applied to the patient's chest, and the rhythm is analyzed by the defibrillator to determine whether a shock is indicated. When the ECG shows ventricular fibrillation or pulseless ventricular tachycardia, immediate defibrillation is the treatment of choice.

The AHA (2017) recommends the first defibrillation to occur within 2 minutes of the first documented, pulseless rhythm. Survival time decreases for every minute that defibrillation is delayed. Following defibrillation, high-quality chest compressions are resumed immediately. Survival after cardiac arrest has been improved by extensive education of health care providers and by the use of AEDs.

Advanced Cardiovascular Life Support

During a resuscitation, an advanced airway (e.g., endotracheal tube, tracheal tube) may be placed by a primary provider, nurse anesthetist, or respiratory therapist to ensure a patent airway and adequate ventilation. Following confirmation of the placement of airway (auscultation of breath sounds, observation of equal chest expansion, or a carbon dioxide detector), positive-pressure ventilation should be delivered without pausing chest compressions at a rate of one breath every 6 seconds, or 10 breaths/min (Kleinman, Goldberger, Rea, et al., 2017; Panchal et al., 2019).

Specific subsequent advanced support interventions depend on the assessment of the patient's condition and response to therapy. For example, if asystole is detected on the monitor, CPR is continued while IV or intraosseous (IO) epinephrine is given. Additional medications (Table 25-4) may be indicated for the patient during and after resuscitation.

Each person on an effective Advanced Cardiac Life Support (ACLS) team, called a *CPR team* or sometimes a *code team,* has delineated roles. An efficient code team is characterized by individual members who are knowledgeable about their position and responsibilities. This ensures direct and clear lines of communication, effective team work, and a safe environment for the health care team and the patient (Panchal et al., 2019).

It is recommended practice to support family members of all patients who have had cardiac arrest and are undergoing resuscitation. In addition, there is clear support to have them present at the bedside if that is consonant with the patient's wishes. Written policies and procedures to support family presence during this time ought to be readily available for nurses and staff to easily access. Studies demonstrate family presence does not disrupt patient care, has no negative outcomes during the resuscitation event, and results in no adverse

psychological effects (American Association of Critical-Care Nurses [AACN], 2016).

CPR is stopped when vital signs are detected or the patient responds. If the patient does not respond to interventions, the resuscitation effort may be stopped by the code team leader or other provider in charge of the resuscitation after options have been exhausted. Many factors are considered in the decision, such as the initiating arrhythmia, potential etiology, length of time for initiation of life support, the patient's response to treatment, and the patient's overall clinical status.

TABLE 25-4 Medications Used in Cardiopulmonary Resuscitation

Agent and Action	Indications	Nursing Considerations
Epinephrine—vasopressor used to optimize BP and cardiac output; improves perfusion and myocardial contractility	Given to patients in cardiac arrest caused by asystole, pulseless electrical activity, pulseless VT or VF	Administer 1 mg every 3–5 min by IV push or IO push. Follow peripheral IV administration with 20-mL saline flush and elevate extremity for 10–20 s.
Norepinephrine—vasopressor given to increase BP	Given for hypotension and shock	Administer 0.1–0.5 mcg/kg/min as IV infusion, preferably through a central line.
Dopamine—vasopressor given to increase BP and contractility	Given for hypotension and shock	Administer 5–10 mcg/kg/min as IV infusion, preferably through a central line.
Atropine—blocks parasympathetic action; increases SA node automaticity and AV conduction	Given to patients with symptomatic bradycardia (i.e., hemodynamically unstable with hypotension)	Administer 0.5-mg IV push; may repeat to dose of 3 mg, follow with saline flush.
Amiodarone—acts on sodium–potassium and calcium channels to prolong action potential and refractory period	Used to treat pulseless VT and VF unresponsive to shock delivery	Administer 300 mg IV; may give second dose of 150 mg in 3–5 min.
Sodium bicarbonate ($NaHCO_3$)—corrects metabolic acidosis	Given to correct metabolic acidosis that is refractory to standard advanced cardiac life support interventions (cardiopulmonary resuscitation, intubation, and respiratory management)	Administer initial dose of 1 mEq/kg IV/IO; then administer dose based on base deficit. Recognize that to prevent development of rebound metabolic alkalosis, complete correction of acidosis is not indicated.
Magnesium sulfate—promotes adequate functioning of cellular sodium–potassium pump	Given to patients with torsade de pointes, a type of VT	May administer 1–2 g diluted in 10 mL D_5W over 5–20 min.

AV, atrioventricular; BP, blood pressure; D_5W, dextrose 5% in water; IO, intraosseous; IV, intravenous; SA, sinoatrial; VF, ventricular fibrillation; VT, ventricular tachycardia.

Adapted from American Heart Association. (2019b). Part 7: Adult advanced cardiovascular life support. Resuscitation science: CPR and ECC guidelines. Retrieved on 12/9/2019 at: www.eccguidelines.heart.org/circulation/cpr-ecc-guidelines/part-7-adult-advanced-cardiovascular-life-support

Follow-Up Monitoring and Care

The care provided to the patient following resuscitation is another determinant of survival (AHA, 2017). A 12-lead ECG is performed to detect any new ST segment elevation or myocardial ischemia (see Chapter 23). Continuous ECG monitoring and frequent blood pressure assessments are essential until hemodynamic stability is established and blood pressure is kept in a range to support adequate perfusion. Factors that precipitated the arrest such as arrhythmias or electrolyte or metabolic imbalances are identified and treated.

Following resuscitation and the return of spontaneous circulation, patients who are comatose may benefit from targeted temperature management (TTM). With TTM, core body temperature is decreased to 32° and 36°C (89.6° to 96.8°F) for at least 24 hours. This induced hypothermia decreases the cerebral metabolic rate and need for oxygen. Similarly, hyperthermic conditions, such as fever, are avoided to reduce oxygen demands (Callaway, Donnino, Fink, et al., 2015).

Advances in cardiac care, such as new techniques for effective resuscitation and postresuscitation hypothermia, have improved outcomes for patients. Research studies demonstrate better neurologic recovery and overall survival for patients when the correct algorithms and team dynamics are used after cardiac arrest; there is hope for even better outcomes in the future.

CRITICAL THINKING EXERCISES

1 ipc After recently being discharged from the hospital with an episode of acute decompensated HFrEF, a 62-year-old man presents to the cardiology clinic where you work. You note that this was the third hospitalization for this patient within the past 6 months. The patient is a widower, lives alone in a two-story home without a bathroom or bedroom on the first floor, and has been receiving disability benefits for several years. Identify how you intend to further assess the patient. What questions will you ask him? Which community-based resources and health care team members could be mobilized to facilitate his transition from the hospital-based setting to the community setting so that he avoids continued rehospitalization?

2 ebp You are a nurse educator working in a home health agency. You are tasked with presenting an educational session on HF self-care strategies. Using knowledge of evidence-based practice guidelines, list the most important topics to cover. Consider gender differences, medications, dietary recommendations, and suggestions for exercise.

3 pq A 75-year-old woman with an acute MI is admitted to the unit where you work as a staff nurse. You assess the patient and find that she is developing a cough, an increasing respiratory rate (32 breaths/min), and pink-tinged sputum. The patient seems agitated and becomes disoriented; she asks you why she is in the hospital. You call the rapid response team, and the following are prescribed: chest x-ray, arterial blood gases and basic metabolic panel, furosemide 40 mg IV, oxygen per nasal cannula to maintain a saturation greater than 94%. Place your planned interventions in priority order and explain your rationale.

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

American Association of Heart Failure Nurses (AAHFN), www.aahfn.org
American College of Cardiology (ACC), www.acc.org
American Heart Association (AHA), www.heart.org
Heart Failure Society of America (HFSA), www.hfsa.org
National Heart, Lung, and Blood Institute, www.nhlbi.nih.gov

26 Assessment and Management of Patients with Vascular Disorders and Problems of Peripheral Circulation

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Identify anatomic and physiologic factors that affect peripheral blood flow and tissue oxygenation.
2. Apply assessment parameters appropriate for determining the status of peripheral circulation.
3. Use the nursing process as a framework for care of the patient with arterial and venous disorders.
4. Compare the pathophysiology, clinical manifestations, management, and prevention of diseases of the arteries.
5. Describe the pathophysiology, clinical manifestations, management, and prevention of venous thromboembolism, venous insufficiency, leg ulcers, and varicose veins.
6. Describe the pathophysiology, clinical manifestations, and management of lymphatic disorders and cellulitis.

NURSING CONCEPTS

Assessment
Clotting
Functional Ability
Perfusion

GLOSSARY

anastomosis: junction of two vessels

aneurysm: a localized sac or dilation of an artery formed at a weak point in the vessel wall

angioplasty: an invasive procedure that uses a balloon-tipped catheter to dilate a stenotic area of a blood vessel

ankle-brachial index (ABI): ratio of the ankle systolic pressure to the brachial systolic pressure; an objective measurement of arterial disease that provides quantification of the degree of stenosis

arteriosclerosis: diffuse process whereby the muscle fibers and the endothelial lining of the walls of small arteries and arterioles thicken

atherectomy: an invasive procedure that uses a cutting device or laser to remove or reduce plaque in an artery

atherosclerosis: inflammatory process involving the accumulation of lipids, calcium, blood components, carbohydrates, and fibrous tissue on the intimal layer of a large- or medium-sized artery

bruit: sound produced by turbulent blood flow through an irregular, tortuous, stenotic, or dilated vessel

cyanosis: a bluish tint of the skin manifested when the amount of oxygenated hemoglobin contained in the blood is reduced

deep vein thrombosis (DVT): a blood clot or thrombus located within a deep vein that causes obstruction or occlusion

dissection: separation of the weakened elastic and fibromuscular elements in the medial layer of an artery

duplex ultrasonography: combines B-mode grayscale imaging of tissue, organs, and blood vessels with capabilities of estimating velocity changes by the use of a pulsed Doppler

embolus: a blood clot, fatty deposit, or air that travels through the blood, lodges in an artery or vein, and blocks flow

endovascular: a type of procedure that uses a puncture or small incision to place catheters inside a blood vessel to repair it or insert a device

intermittent claudication: a muscular, cramplike pain or fatigue in the extremities consistently reproduced with the same degree of exercise or activity and relieved by rest

ischemia: deficient blood supply

pulmonary embolism (PE): a blood clot or thrombus within a pulmonary artery that blocks or obstructs blood flow to the lungs

rest pain: persistent pain in the foot or digits when the patient is resting, indicating a severe degree of arterial insufficiency

rubor: reddish-blue discoloration of the extremities; indicative of severe peripheral arterial damage in vessels that remain dilated and unable to constrict

stenosis: narrowing or constriction of a blood vessel

thromboembolus: a blood clot that may become dislodged from the vessel where it originally formed

thrombus: a blood clot within an artery or a vein

venous thromboembolism (VTE): a blood clot that forms in the venous vasculature that may manifest as a DVT or a PE

Conditions of the vascular system include arterial disorders, venous disorders, lymphatic disorders, and cellulitis. These disorders may be seen in patients in both the inpatient and the outpatient setting. Nursing assessment and management depends on an understanding of the vascular system.

Anatomic and Physiologic Overview

Adequate perfusion ensures oxygenation and nourishment of body tissues, and it depends in part on a properly functioning cardiovascular system. Adequate blood flow depends on the efficiency of the heart as a pump, the patency and responsiveness of the blood vessels, and the adequacy of circulating blood volume. Nervous system activity, blood viscosity, and the metabolic needs of tissues influence the rate and adequacy of blood flow.

The vascular system consists of two interdependent systems. The right side of the heart pumps blood through the lungs to the pulmonary circulation, and the left side of the heart pumps blood to all other body tissues through the systemic circulation. The blood vessels in both systems channel the blood from the heart to the tissues and back to the heart (see Fig. 26-1). Contraction of the ventricles is the driving force that moves blood through the vascular system.

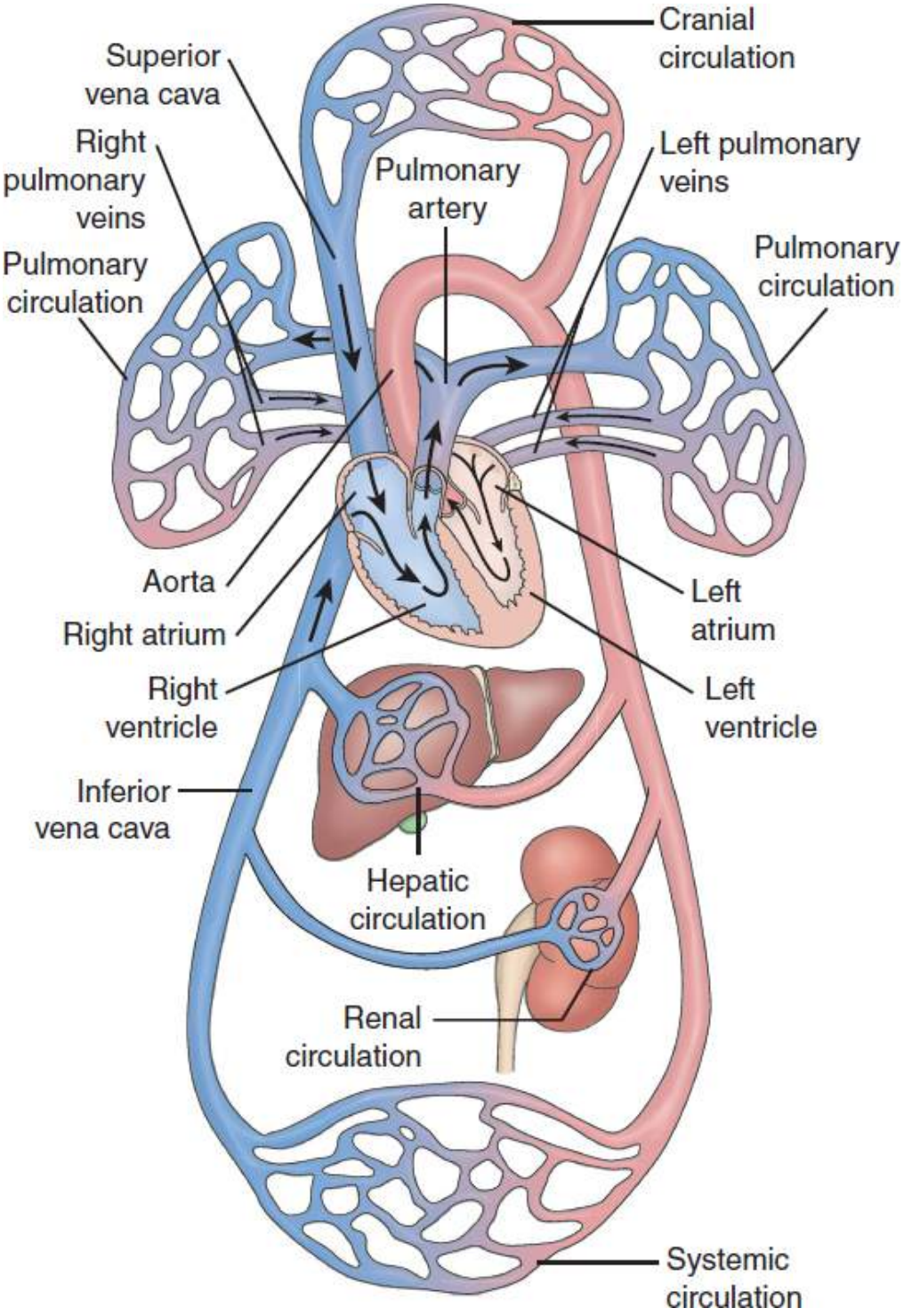

Figure 26-1 • Systemic and pulmonary circulation. Oxygen-rich blood from the pulmonary circulation is pumped from the left heart into the aorta and the systemic arteries to the capillaries, where the exchange of nutrients and waste products takes place. The deoxygenated blood returns to the right heart by way of the systemic veins and is pumped into the pulmonary circulation.

Arteries distribute oxygenated blood from the left side of the heart to the tissues, whereas the veins carry deoxygenated blood from the tissues to the right side of the heart. Capillary vessels located within the tissues connect the arterial and venous systems. These vessels permit the exchange of nutrients and metabolic wastes between the circulatory system and the tissues. Arterioles and venules immediately adjacent to the capillaries, together with the capillaries, make up the microcirculation.

The lymphatic system complements the function of the circulatory system. Lymphatic vessels transport lymph (a fluid similar to plasma) and tissue fluids (containing proteins, cells, and cellular debris) from the interstitial space to systemic veins. Lymphatic fluid empties into the subclavian and internal jugular veins.

Anatomy of the Vascular System

Arteries, arterioles, capillaries, veins, venules, and lymphatic vessels are the main structures that comprise the vascular system.

Arteries and Arterioles

Arteries are thick-walled structures that carry blood from the heart to the tissues. The aorta, which has a diameter of approximately 2.5 cm (1 inch) in the average-sized adult, gives rise to numerous branches, which continue to divide into progressively smaller arteries that are 4 mm (0.16 inches) in diameter. The vessels divide further, diminishing in size to approximately 30 mcm in diameter. These smallest arteries, called *arterioles,* are generally embedded within the tissues (Norris, 2019).

The walls of the arteries and arterioles are composed of three layers: the intima, an inner endothelial cell layer; the media, a middle layer of smooth muscle and elastic tissue; and the adventitia, an outer layer of connective tissue. The intima, a very thin layer, provides a smooth surface for contact with the flowing blood. The media makes up most of the vessel wall in the aorta and other large arteries of the body. This layer is composed chiefly of elastic and connective tissue fibers that give the vessels considerable strength and allow them to constrict and dilate to accommodate the blood ejected from the heart during each cardiac cycle (stroke volume) and maintain an even, steady flow of blood. The adventitia is a layer of connective tissue that anchors the vessel to its surroundings. There is much less elastic tissue in the smaller arteries and arterioles, and the media in these vessels is composed primarily of smooth muscle (Norris, 2019). Smooth muscle controls the diameter of the vessels by contracting and relaxing. Chemical, hormonal, and neuronal factors influence the activity of smooth muscle. Arterioles offer resistance to blood flow by altering their diameter and are often referred to as resistance vessels. Arterioles regulate the volume and pressure in the arterial system and the rate

of blood flow to the capillaries. There is a large amount of smooth muscle in the media, and the walls of the arteries are relatively thick, accounting for approximately 25% of the total diameter of the artery.

The intima and the inner third of the smooth muscle layer of the media are in such close contact with the blood that the blood vessels receive their nourishment by direct diffusion. The adventitia and the outer media layers require their own blood supply to meet metabolic needs. The vasa vasorum is a network of small blood vessels that supplies blood and nutrients to the larger arteries.

Capillaries

The walls of the capillaries, which lack smooth muscle and adventitia, are composed of a single layer of endothelial cells. This thin-walled structure permits rapid and efficient transport of nutrients to the cells and removal of metabolic wastes. The diameter of capillaries ranges from 5 to 10 mcm; this means that red blood cells must alter their shape to pass through these vessels. Changes in a capillary's diameter are passive and are influenced by contractile changes in the blood vessels that carry blood to and from a capillary. The capillary's diameter also changes in response to chemical stimuli. In some tissues, a cuff of smooth muscle, called the *precapillary sphincter,* is located at the arteriolar end of the capillary and is responsible, along with the arteriole, for controlling capillary blood flow (Norris, 2019).

Some capillary beds, such as those in the fingertips, contain arteriovenous anastomoses, through which blood passes directly from the arterial to the venous system. These vessels are believed to regulate heat exchange between the body and the external environment.

The distribution of capillaries varies with the type of tissue. For example, skeletal tissue, which has high metabolic requirements, has a denser capillary network than cartilage, which has low metabolic needs.

Veins and Venules

Capillaries join to form larger vessels called *venules,* which join to form veins. The venous system is therefore structurally analogous to the arterial system; venules correspond to arterioles, veins to arteries, and the vena cava to the aorta. Analogous types of vessels in the arterial and venous systems have approximately the same diameters (see Fig. 26-1).

The walls of the veins, in contrast to those of the arteries, are thinner and considerably less muscular. In most veins, the wall makes up only 10% of the diameter, in contrast to 25% in most arteries. In veins, the walls are composed of three layers, like those of arteries; however, in veins, these layers are not as well defined.

The thin, less muscular structure of the vein wall allows these vessels to distend more than arteries. Greater distensibility and compliance permit large volumes of blood to remain in the veins under low pressure. For this reason, veins are referred to as capacitance vessels. Approximately 75% of total blood volume is contained in the veins. The sympathetic nervous system, which innervates the vein musculature, can stimulate venoconstriction (constriction of the veins), thereby reducing venous volume and increasing the volume of blood in the general circulation. Contraction of skeletal muscles in the extremities creates the primary pumping action to facilitate venous blood flow back to the heart (Norris, 2019).

Some veins, unlike arteries, are equipped with valves. In general, veins that transport blood against the force of gravity, as in the lower extremities, have one-way bicuspid valves that prevent blood from retrograde flow as it is propelled toward the heart. Valves are composed of endothelial leaflets, the competency of which depends on the integrity of the vein wall.

Lymphatic Vessels

The lymphatic vessels are a complex network of thin-walled vessels similar to the capillaries. This network collects lymphatic fluid from tissues and organs, and transports the fluid to the venous circulation. The lymphatic vessels converge into two main structures: the thoracic duct and the right lymphatic duct. These ducts empty into the junction of the subclavian and internal jugular veins. The right lymphatic duct conveys lymph primarily from the right side of the head, neck, thorax, and upper arms. The thoracic duct conveys lymph from the remainder of the body. Peripheral lymphatic vessels join larger lymph vessels and pass through regional lymph nodes before entering the venous circulation. The lymph nodes play an important role in filtering foreign particles.

The lymphatic vessels are permeable to large molecules and provide the only means by which interstitial proteins can return to the venous system. With muscular contraction, lymph vessels become distorted to create spaces between the endothelial cells, allowing protein and particles to enter. Muscular contraction of the lymphatic walls and surrounding tissues aids in propelling the lymph toward the venous drainage points (Norris, 2019).

Function of the Vascular System

Important functions of the vascular system include supplying the circulatory needs of tissue, maintaining blood flow and blood pressure, and providing capillary filtration and reabsorption, hemodynamic resistance, and other peripheral vascular regulating mechanisms.

Circulatory Needs of Tissues

The amount of blood flow needed by the body's tissues constantly changes. The percentage of blood flow received by individual organs or tissues is determined by the rate of tissue metabolism, the availability of oxygen, and the function of the tissue. When metabolic requirements increase, blood vessels dilate to increase the flow of oxygen and nutrients to the tissues. When metabolic needs decrease, vessels constrict and blood flow to the tissues decreases. Metabolic demands of tissues increase with physical activity or exercise, local heat application, fever, and infection. Reduced metabolic requirements of tissues accompany rest or decreased physical activity, local cold application, and cooling of the body. If the blood vessels fail to dilate in response to the need for increased blood flow, tissue **ischemia** (deficient blood supply to a body part) results. The mechanism by which blood vessels dilate and constrict to adjust for metabolic changes ensures that normal arterial pressure is maintained (Norris, 2019).

As blood passes through tissue capillaries, oxygen is removed and carbon dioxide is added. The amount of oxygen extracted by each type of tissue differs. For example, the myocardium tends to extract about 50% of the oxygen from arterial blood in one pass through its capillary bed, whereas the kidneys extract only about 7% of the oxygen from the blood that passes through them. The average amount of oxygen removed collectively by all of the body tissues is about 25%. This means that the blood in the vena cava contains about 25% less oxygen than aortic blood. This is known as the systemic arteriovenous oxygen difference (Norris, 2019). This difference becomes greater when less oxygen is delivered to the tissues than they need.

Blood Flow

Blood flow through the cardiovascular system always proceeds in the same direction: left side of the heart to the aorta, arteries, arterioles, capillaries, venules, veins, vena cava, and right side of the heart. This unidirectional flow is caused by a pressure difference that exists between the arterial and venous systems. Because arterial pressure (approximately 100 mm Hg) is greater than venous pressure (approximately 40 mm Hg) and fluid flows from an area of higher pressure to an area of lower pressure, blood flows from the arterial system to the venous system.

The pressure difference (ΔP) between the two ends of the vessel propels the blood. Impediments to blood flow exert an opposing force, which is known as resistance (R). The rate of blood flow is determined by dividing the pressure difference by the resistance:

$$\text{Flow rate} = \Delta P/R$$

This equation shows that when resistance increases, a greater pressure is required to maintain the same degree of flow (Norris, 2019). In the body, an

increase in pressure is accomplished by an increase in the force of contraction of the heart. If arterial resistance is chronically elevated, the myocardium hypertrophies (enlarges) to sustain a greater contractile force.

In most long, smooth blood vessels, flow is laminar or streamlined, with blood in the center of the vessel moving slightly faster than the blood near the vessel walls. Laminar flow becomes turbulent when the blood flow rate increases, when blood viscosity increases, when the diameter of the vessel becomes greater than normal, or when segments of the vessel are narrowed or constricted (Norris, 2019). Turbulent blood flow creates an abnormal sound, called a **bruit,** which can be heard with a stethoscope.

Blood Pressure

Chapter 27 provides more information on the physiology and measurement of blood pressure.

Capillary Filtration and Reabsorption

Fluid exchange across the capillary wall is continuous. This fluid, which has the same composition as plasma without the proteins, forms the interstitial fluid. The equilibrium between hydrostatic and osmotic forces of the blood and interstitium, as well as capillary permeability, determines the amount and direction of fluid movement across the capillary. Hydrostatic force is a driving pressure that is generated by the blood pressure. Osmotic pressure is the pulling force created by plasma proteins. Normally, the hydrostatic pressure at the arterial end of the capillary is relatively high compared with that at the venous end. This high pressure at the arterial end of the capillaries tends to drive fluid out of the capillary and into the tissue space. Osmotic pressure tends to pull fluid back into the capillary from the tissue space, but this osmotic force cannot overcome the high hydrostatic pressure at the arterial end of the capillary. However, at the venous end of the capillary, the osmotic force predominates over the low hydrostatic pressure, and there is a net reabsorption of fluid from the tissue space back into the capillary (Norris, 2019).

Except for a very small amount, fluid that is filtered out at the arterial end of the capillary bed is reabsorbed at the venous end. The excess filtered fluid enters the lymphatic circulation. These processes of filtration, reabsorption, and lymph formation aid in maintaining tissue fluid volume and removing tissue waste and debris. Under normal conditions, capillary permeability remains constant.

Under certain abnormal conditions, the fluid filtered out of the capillaries may greatly exceed the amounts reabsorbed and carried away by the lymphatic vessels. This imbalance can result from damage to capillary walls and subsequent increased permeability, obstruction of lymphatic drainage, elevation of venous pressure, or a decrease in plasma protein osmotic force.

Accumulation of excess interstitial fluid that results from these processes is called *edema.*

Hemodynamic Resistance

The most important factor that determines resistance in the vascular system is the vessel radius. Small changes in vessel radius lead to large changes in resistance. The predominant sites of change in the caliber or width of blood vessels, and therefore in resistance, are the arterioles and the precapillary sphincter. Peripheral vascular resistance is the opposition to blood flow provided by the blood vessels. This resistance is proportional to the viscosity or thickness of the blood and the length of the vessel and is influenced by the diameter of the vessels. Under normal conditions, blood viscosity and vessel length do not change significantly, and these factors do not usually play an important role in blood flow. However, a large increase in hematocrit may increase blood viscosity and reduce capillary blood flow.

Peripheral Vascular Regulating Mechanisms

Even at rest, the metabolic needs of body tissues are continuously changing. Therefore, an integrated and coordinated regulatory system is necessary so that blood flow to individual tissues is maintained in proportion to the needs of those tissues. This regulatory mechanism is complex and consists of central nervous system influences, circulating hormones and chemicals, and independent activity of the arterial wall itself.

Sympathetic (adrenergic) nervous system activity, mediated by the hypothalamus, is the most important factor in regulating the caliber and therefore the blood flow of peripheral blood vessels. All vessels are innervated by the sympathetic nervous system except the capillary and precapillary sphincters. Stimulation of the sympathetic nervous system causes vasoconstriction. The neurotransmitter responsible for sympathetic vasoconstriction is norepinephrine (Norris, 2019). Sympathetic activation occurs in response to physiologic and psychological stressors. Diminution of sympathetic activity by medications or sympathectomy results in vasodilation.

Other hormones affect peripheral vascular resistance. Epinephrine, released from the adrenal medulla, acts like norepinephrine in constricting peripheral blood vessels in most tissue beds. However, in low concentrations, epinephrine causes vasodilation in skeletal muscles, the heart, and the brain. Angiotensin I, which is formed from the interaction of renin (synthesized by the kidney) and angiotensinogen, a circulating serum protein, is then converted to angiotensin II by an enzyme secreted by the pulmonary vasculature, called *angiotensin-converting enzyme* (ACE). Angiotensin II is a potent vasoconstrictor, particularly of the arterioles. Although the amount of angiotensin II concentrated in the blood is usually small, its profound vasoconstrictive effects

are important in certain abnormal states, such as heart failure and hypovolemia (Norris, 2019).

Alterations in local blood flow are influenced by various circulating substances that have vasoactive properties. Potent vasodilators include nitric oxide, prostacyclin, histamine, bradykinin, prostaglandin, and certain muscle metabolites. A reduction in available oxygen and nutrients and changes in local pH also affect local blood flow. Proinflammatory cytokines are substances liberated from platelets that aggregate at the site of damaged vessels, causing arteriolar vasoconstriction and continued platelet aggregation at the site of injury (Atherton, Sindone, De Pasquale, et al., 2018).

Pathophysiology of the Vascular System

Reduced blood flow through peripheral blood vessels characterizes all peripheral vascular diseases. The physiologic effects of altered blood flow depend on the extent to which tissue demands exceed the supply of oxygen and nutrients available. If tissue needs are high, even modestly reduced blood flow may be inadequate to maintain tissue integrity. Tissues become ischemic, malnourished, and ultimately die unless adequate blood flow is restored.

Pump Failure

Inadequate peripheral blood flow occurs when the heart's pumping action becomes inefficient. Heart failure with reduced left ventricular ejection fraction (HFrEF; also called systolic HF) causes an accumulation of blood in the lungs and a reduction in forward flow or cardiac output, which results in inadequate arterial blood flow to the tissues. Heart failure with preserved left ventricular ejection fraction (HFpEF; also called diastolic HF) causes systemic venous congestion and a reduction in forward flow (Atherton et al., 2018) (see Chapter 25).

Alterations in Blood and Lymphatic Vessels

Intact, patent, and responsive blood vessels are necessary to deliver adequate amounts of oxygen and nutrients to tissues and to remove metabolic wastes. Arteries can become damaged or obstructed as a result of atherosclerotic plaque, a **thromboembolus** (a blood clot that may become dislodged from the vessel from where it originally formed), chemical or mechanical trauma, infections or inflammatory processes, vasospastic disorders, and congenital malformations. A sudden arterial occlusion causes profound and often irreversible tissue ischemia and tissue death. When arterial occlusions develop gradually, there is less risk of sudden tissue death because collateral circulation may develop, giving that tissue the opportunity to adapt to gradually decreased blood flow.

Venous blood flow can be reduced by a thromboembolus obstructing the vein, by incompetent venous valves, or by a reduction in the effectiveness of the pumping action of surrounding muscles. Decreased venous blood flow results in increased venous pressure, a subsequent increase in capillary hydrostatic pressure, net filtration of fluid out of the capillaries into the interstitial space, and subsequent edema. Edematous tissues cannot receive adequate nutrition from the blood and consequently are more susceptible to breakdown, injury, and infection. Obstruction of lymphatic vessels also results in edema. Lymphatic vessels can become obstructed by a tumor or by damage from mechanical trauma or inflammatory processes.

Circulatory Insufficiency of the Extremities

Although many types of peripheral vascular diseases exist, most result in ischemia and produce some of the same symptoms: pain, skin changes, diminished pulses, and possible edema. The type and severity of symptoms depend in part on the type, stage, and extent of the disease process and on the speed with which the disorder develops. Table 26-1 highlights the distinguishing features of arterial and venous insufficiency. In this chapter, peripheral vascular disease is categorized as arterial, venous, or lymphatic.

Gerontologic Considerations

Aging produces changes in the walls of the blood vessels that affect the transport of oxygen and nutrients to the tissues. The intima thickens as a result of cellular proliferation and fibrosis. Elastin fibers of the media become calcified, thin, and fragmented, and collagen accumulates in the intima and the media. These changes cause the vessels to stiffen, which results in increased peripheral resistance, impaired blood flow, and increased left ventricular workload causing hypertrophy, ischemia and HFrEF, and thrombosis along with hemorrhage in the microvessels in the brain and kidney (Atherton et al., 2018).

TABLE 26-1 Characteristics of Arterial and Venous Insufficiency and Resulting Ulcers

Characteristic	Arterial	Venous
General Characteristics		
Pain	Intermittent claudication to sharp, unrelenting, constant	Aching, throbbing, cramping
Pulses	Diminished or absent	Present, but may be difficult to palpate through edema
Skin characteristics	Dependent rubor—with elevation pallor of foot; dry, shiny skin; cool-to-cold temperature; loss of hair over toes and dorsum of foot; nails thickened and ridged	Pigmentation in gaiter area (area of medial and lateral malleolus), skin thickened and tough, may be reddish blue, frequently with associated dermatitis
Ulcer Characteristics		
Location	Tip of toes, web spaces, heel or other pressure points if patient is immobile	Medial malleolus, lateral malleolus, or anterior tibial area
Pain	Very painful	Minimal pain to very painful
Depth of ulcer	Deep, often involving joint space	Superficial
Shape	Circular	Irregular border
Ulcer base	Pale to black and wet to dry gangrene	Granulation tissue—beefy red to yellow fibrinous in chronic long-term ulcer
Leg edema	Minimal unless extremity kept in dependent position constantly to relieve pain	Moderate to severe

Adapted from Ermer-Selton, J. (2016). Lower extremity assessment. In R. Bryant & D. Nix (Eds.). *Acute and chronic wounds: Current management* (5th ed.). St. Louis, MO: Elsevier.

Assessment of the Vascular System

The nurse should perform a focused health history and physical assessment to establish a patient's baseline and identify alterations in the vascular system.

Health History

The nurse obtains an in-depth description from the patient with peripheral vascular disorders of any pain and its precipitating factors. A muscular, cramp-type pain, discomfort, or fatigue in the extremities consistently reproduced with the same degree of activity or exercise and relieved by rest is experienced by patients with peripheral arterial insufficiency. Referred to as **intermittent**

claudication, this pain, discomfort, or fatigue is caused by the inability of the arterial system to provide adequate blood flow to the tissues in the face of increased demands for nutrients and oxygen during exercise. As the tissues are forced to complete the energy cycle without adequate nutrients and oxygen, muscle metabolites and lactic acid are produced. Pain is experienced as the metabolites aggravate the nerve endings of the surrounding tissue. Typically, about 50% of the arterial lumen or 75% of the cross-sectional area must be obstructed before intermittent claudication is experienced. When the patient rests and thereby decreases the metabolic needs of the muscles, the pain subsides. The progression of the arterial disease can be monitored by documenting the amount of exercise or the distance the patient can walk before the onset of pain. Distance is measured in blocks, feet, or meters. Persistent pain in the anterior portion of the foot (forefoot) when the patient is resting indicates a severe degree of arterial insufficiency and a critical state of ischemia. Known as **rest pain,** this discomfort is often worse at night and may interfere with sleep. This pain frequently requires that the extremity be lowered to a dependent position to improve perfusion to the distal tissues.

The site of arterial disease can be deduced from the location of claudication, because pain occurs in muscle groups distal to the diseased vessel. Calf pain may accompany reduced blood flow through the superficial femoral or popliteal artery, whereas pain in the hip or buttock may result from reduced blood flow in the abdominal aorta or the common iliac or hypogastric (also known as internal iliac) arteries.

Physical Assessment

A thorough assessment of the patient's skin color and temperature and the character or quality of the peripheral pulses is important in the diagnosis of arterial disorders.

Inspection of the Skin

Adequate blood flow warms the extremities and gives individuals with lighter skin tones a rosy coloring. Inadequate blood flow results in cool and pale extremities. In people with pigmented skin, the color changes are often more difficult to discriminate because of the darker skin tone. Further reduction of blood flow to these tissues, which occurs when the extremity is elevated, for example, results in pallor (a whiter or more blanched appearance). **Rubor,** a reddish-blue discoloration of the extremities, may be observed within 20 seconds to 2 minutes after the extremity is placed in the dependent position. Rubor suggests severe peripheral arterial damage in which vessels that cannot constrict remain dilated. Even with rubor, the extremity begins to turn pale with elevation. **Cyanosis,** a bluish tint of the skin, is manifested when the amount of oxygenated hemoglobin contained in the blood is reduced.

Additional changes resulting from a chronically reduced nutrient supply include loss of hair, brittle nails, dry or scaling skin, atrophy, and ulcerations. Edema may be apparent bilaterally or unilaterally and is related to the affected extremity's chronically dependent position because of rest pain. Gangrenous changes appear after prolonged, severe ischemia and represent tissue necrosis.

Palpation of Pulses

Determining the presence or absence, as well as the quality, of peripheral pulses is important in assessing the status of peripheral arterial circulation (see Fig. 26-2). Pulse assessment in an edematous extremity should be undertaken with caution. Palpation of pulses is subjective, and the nurse may mistake their own pulse for that of the patient. To prevent this, the nurse should use light touch and use more than just the index finger for palpation, because this finger has the strongest arterial pulsation of all the fingers. The thumb should not be used for the same reason. Absence of a pulse may indicate that the site of **stenosis** (narrowing or constriction) or occlusion is proximal to that level. Occlusive arterial disease impairs blood flow and can reduce or obliterate palpable pulsations in the extremities. Pulses should be palpated bilaterally and simultaneously, comparing both sides for symmetry in rate, rhythm, and quality.

Diagnostic Evaluation

The nurse should educate the patient on the purpose of the diagnostic studies, what to expect, and any possible side effects related to these examinations. Trends in results are noted because they provide information about disease progression as well as the patient's response to therapy. Various tests may be performed to identify and diagnose abnormalities that can affect the vascular structures (arteries, veins, and lymphatics).

Doppler Ultrasound Flow Studies

When pulses cannot be reliably palpated, a handheld continuous wave (CW) Doppler ultrasound device may be used to detect the blood flow. This handheld device emits a continuous signal through the patient's tissues. The signals are reflected by the moving blood cells and received by the device. The filtered-output Doppler signal is then transmitted to a loudspeaker or headphones, where it can be heard for interpretation as arterial or venous signals (Fischbach & Fischbach, 2018). The depth at which blood flow can be detected by Doppler is determined by the frequency (in megahertz [MHz]) it generates. The lower the frequency, the deeper the tissue penetration; a 5- to 10-MHz probe may be used to evaluate the peripheral arteries.

Figure 26-2 • Assessing peripheral pulses. **A.** Popliteal pulse. **B.** Dorsalis pedis pulse. **C.** Posterior tibial pulse. Reprinted with permission from Weber, J. R., & Kelley, J. H. (2018). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Wolters Kluwer.

To evaluate the lower extremities, the patient is placed in the supine position with the head of the bed elevated 20 to 30 degrees; the legs are externally rotated, if possible, to permit adequate access to the medial malleolus. Acoustic water soluble gel is applied to the patient's skin to permit uniform transmission of the ultrasound wave. The tip of the Doppler transducer is positioned at a 45- to 60-degree angle over the expected location of the artery and angled slowly to identify arterial blood flow. Excessive pressure is avoided because severely diseased arteries can collapse with even minimal pressure.

The transducer can detect blood flow in advanced arterial disease states, especially if collateral circulation has developed; thus, identifying a signal indicates only the presence of blood flow. The patient's provider must be notified of the absence of a signal if one had been detected previously.

CW Doppler is more useful as a clinical tool when combined with ankle blood pressures, which are used to determine the **ankle-brachial index (ABI)** (see Fig. 26-3). The ABI is the ratio of the systolic blood pressure in the ankle to the systolic blood pressure in the arm (Zierler & Dawson, 2016). It is an objective indicator of arterial disease that allows the examiner to quantify the degree of stenosis. With increasing degrees of arterial narrowing, there is a progressive decrease in systolic pressure distal to the involved sites.

Figure 26-3 • Continuous wave Doppler ultrasound detects blood flow in peripheral vessels. Combined with computation of ankle or arm pressures, this diagnostic technique helps health care providers characterize the nature of peripheral vascular disease. Photograph courtesy of Kim Cantwell-Gab, MN, ACNP, ANP.

The first step in determining the ABI is to have the patient rest in a supine position (not seated) for approximately 5 minutes. An appropriate-sized blood pressure cuff (typically, a 10-cm cuff for an average-sized adult) is applied to the patient's ankle above the malleolus. After identifying an arterial signal of the posterior tibial (see Fig. 26-4) and dorsalis pedis arteries, the systolic pressures, are obtained in both ankles, while listening to the Doppler signal of each artery. Diastolic pressures in the ankles cannot be measured with Doppler. If pressure in these arteries cannot be obtained, pressure can be measured in the peroneal artery, which can also be assessed at the ankle.

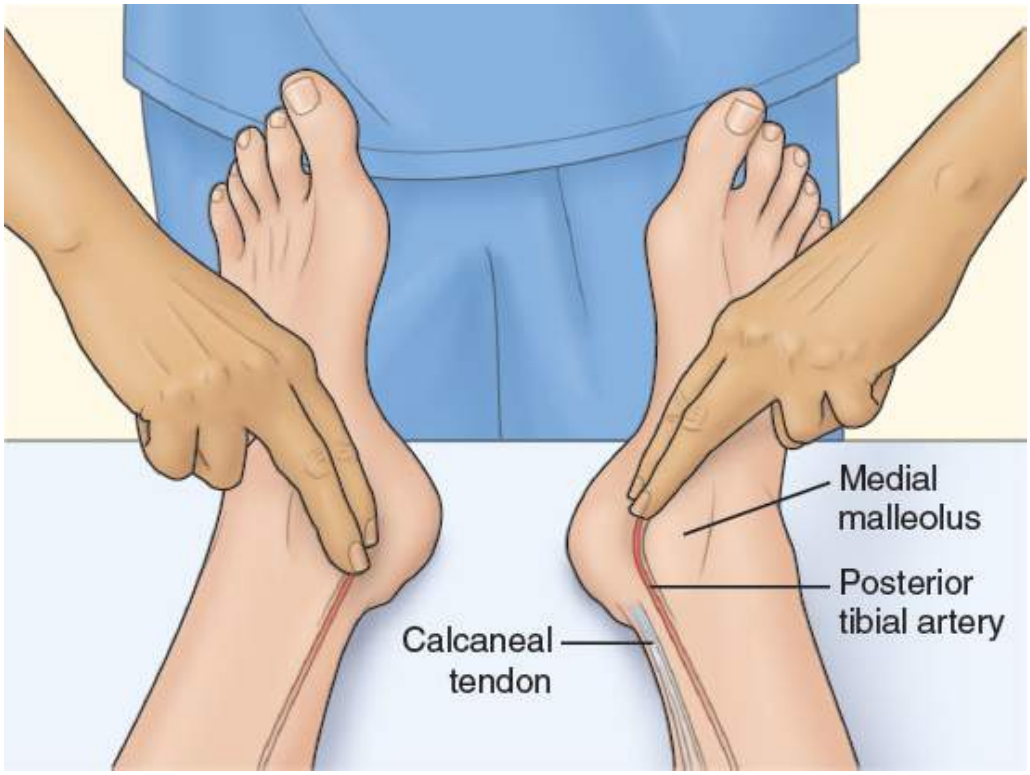

Figure 26-4 • Palpation of posterior tibial artery.

Doppler ultrasonography is used to measure brachial pressures in both arms. Both arms are evaluated because the patient may have an asymptomatic stenosis in the subclavian artery, causing brachial pressure on the affected side to be 15 to 20 mm Hg or more lower than systemic pressure. The abnormally low pressure should not be used for assessment.

To calculate the ABI, the highest systolic pressure for each ankle is divided by the higher of the two brachial systolic pressures (see Chart 26-1). The ABI can be computed for a patient with the following systolic pressures:

Right brachial: 160 mm Hg
Left brachial: 120 mm Hg
Right posterior tibial: 80 mm Hg
Right dorsalis pedis: 60 mm Hg
Left posterior tibial: 100 mm Hg
Left dorsalis pedis: 120 mm Hg

The highest systolic pressure for each ankle (80 mm Hg for the right, 120 mm Hg for the left) would be divided by the highest brachial pressure (160 mm Hg):

Right: 80/160 mm Hg = 0.50 ABI
Left: 120/160 mm Hg = 0.75 ABI

In general, systolic pressure in the ankle of a healthy person is the same or slightly higher than the brachial systolic pressure, resulting in an ABI of about 1.0 (no arterial insufficiency) (see Chart 26-2 for ABI pressure ranges).

Nursing Implications

Nurses should perform a baseline ABI on any patient with decreased pulses or any patient 65 years or older, especially patients with a history of diabetes or nicotine use (Gerhard-Herman, Gornik, Barrett, et al., 2016). Patients who undergo an arterial intervention or surgery should have ABIs performed per their institution's protocols. In addition, if there is a change in the clinical status of a patient, such as a sudden cold or painful limb, an ABI should be performed.

Prior to the procedure, nurses should educate patients about the indications for ABI and what to expect. Patients should be instructed to avoid use of nicotine products or drinking caffeinated beverages for at least 2 hours prior to testing (if it is done on a nonurgent basis). There may be some discomfort involved when the cuffs are inflated.

Chart 26-1

Avoiding Common Errors in Obtaining the Ankle-Brachial Index

Take the following precautions to ensure an accurate ankle-brachial index (ABI) calculation:

- *Use correctly sized blood pressure (BP) cuffs.* To obtain accurate BP measurements, use a cuff with a bladder width at least 40% and length at least 80% of the limb circumference.
- *On the nursing plan of care, document the cuff sizes used* (e.g., "12-cm adult cuff used for brachial pressures; 10-cm pediatric cuff used for ankle pressures"). This minimizes the risk of shift-to-shift discrepancies in ABIs.
- *Use sufficient cuff inflation.* To ensure complete closure of the artery and the most accurate measurements, inflate cuff 20 to 30 mm Hg beyond the point at which the last arterial signal is detected.
- *Do not deflate cuff too rapidly.* Try to maintain a deflation rate of 2 to 4 mm Hg/s for patients without arrhythmias and 2 mm Hg/s or slower for patients with arrhythmias. Deflating the cuff more rapidly may miss the patient's highest pressure and result in recording an erroneous (low) BP measurement.
- *Suspect medial calcific sclerosis any time an ABI is 1.20 or greater or ankle pressure is more than 250 mm Hg.* Medial calcific sclerosis is associated with diabetes, chronic kidney disease, and hyperparathyroidism. It produces falsely elevated ankle pressures by hardening the media of the arteries, making the vessels noncompressible.
- *Be suspicious of arterial pressures recorded at less than 40 mm Hg.* This may mean the venous signal has been mistaken for the arterial signal. If the arterial pressure, which is normally 120 mm Hg, is measured at less than 40 mm Hg, ask a colleague to double-check the readings before recording this as an arterial pressure.

Chart 26-2

Range of Ankle-Brachial Index (ABI) Pressure and Ischemic Manifestations

ABI >1.40 is abnormal; indicates noncompressible arteries; requires further testing with a toe-brachial index (TBI)
ABI of 1.00 to 1.40 is normal
ABI of 0.91 to 0.99 is borderline
ABI of ≤0.90 is abnormal
ABI of 0.50 to 0.90 (i.e., moderate to mild insufficiency) is usually found in patients with claudication
ABI of <0.50 is found in patients with ischemic rest pain
ABI of ≤0.40 is found in patients with severe ischemia or tissue loss

Adapted from Gerhard-Herman, M., Gornik, H., Barrett, C., et al. (2016). AHA/ACC Guideline on the management of patients with lower extremity peripheral arterial disease: Executive summary. *Circulation*, *134*(24), 1–208; Zierler, R. E., & Dawson, D. L. (Eds.). (2016). *Strandness's duplex scanning in vascular disorders* (5th ed.). Philadelphia, PA: Wolters Kluwer.

Exercise Testing

Exercise testing is used to determine how long a patient can walk and to measure the ankle systolic blood pressure in response to walking. The patient's brachial systolic blood pressure is obtained on each arm prior to treadmill walking. There are several exercise testing protocols; however, in most instances the patient walks on a treadmill at 1.5 mph with a 12% incline for a maximum of 5 minutes or walks with a gradual rise in speed and incline to the point of claudication. The exercise test can be modified to walking a set distance in a hallway. Most patients can complete the test unless they have significant arterial insufficiency, severe cardiac, pulmonary, or orthopedic problems, or a physical disability. A normal response is little or no drop in ankle systolic pressure after exercise. However, in a patient with true vascular claudication, the ankle pressure drops. Combining this hemodynamic information with the walking time helps to determine whether intervention is necessary. The nurse should reassure the patient that the treadmill test will not require running; rather, the test may require walking on a slight incline. In some instances cycling may be used to evaluate the patient's ability to walk.

Duplex Ultrasonography

Duplex ultrasonography involves B-mode grayscale imaging of the tissue, organs, and blood vessels (arterial and venous) and permits estimation of velocity changes by use of a pulsed Doppler (see Fig. 26-5). Color flow techniques, which can identify vessels, may be used to shorten the examination

time. Duplex ultrasound may be used to determine the level and extent of venous disease as well as chronicity of the disease. Using B mode and Doppler, it is possible to image and assess blood flow, evaluate flow of the distal vessels, locate the disease (stenosis versus occlusion), and determine anatomic morphology and the hemodynamic significance of plaque causing stenosis. Duplex ultrasound findings help in planning treatment and monitoring its outcomes. The test is noninvasive and usually requires no patient preparation. Patients who undergo abdominal vascular duplex ultrasound, however, should be advised to not eat or drink (i.e., NPO status) for at least 6 hours prior to the examination to decrease production of bowel gas that can interfere with the examination. The equipment is portable, making it useful anywhere for initial diagnosis, screening, or follow-up evaluations.

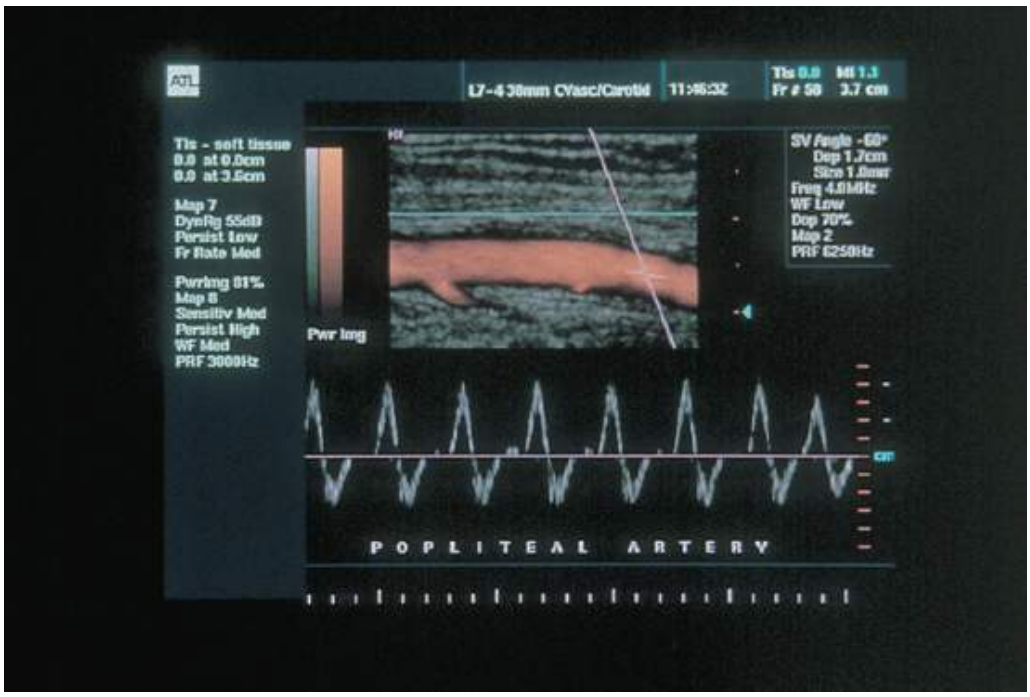

Figure 26-5 • Color flow duplex image of popliteal artery with normal triphasic Doppler flow.

Computed Tomography Scanning

Computed tomography (CT) scanning provides cross-sectional images of soft tissue and visualizes the area of volume changes to an extremity and the compartment where changes take place. CT scans of the abdomen are useful in assessing characteristics and monitoring changes within the aorta, such as an increasing aortic diameter indicating aneurysmal formation. CT of a lymphedematous arm or leg, for example, demonstrates a characteristic honeycomb pattern in the subcutaneous tissue. In multidetector-computed tomography (MDCT), a spiral CT scanner and rapid intravenous (IV) infusion

of contrast agent are used to image very thin sections of the target area, and the results are configured in three dimensions so that the image can be rotated and viewed from multiple angles. The scanner's head moves circumferentially around the patient as the patient passes through the scanner, creating a series of overlapping images that are connected to one another in a continuous spiral. Scan times are short. However, the patient is exposed to x-rays, and a contrast agent is injected to visualize the blood vessels. The high volume of contrast agent injected into a peripheral vein may contraindicate the use of MDCT in children and patients with significantly impaired renal function (Gerhard-Herman et al., 2016).

Nursing Implications

Patients with impaired renal function scheduled for MDCT may require preprocedural treatment to prevent contrast-induced nephropathy. This may include oral or IV hydration 6 to 12 hours preprocedure or administration of sodium bicarbonate, which alkalinizes urine and protects against free radical damage. Studies do not support the use of oral and IV *N*-acetylcysteine for protection against contrast-induced nephropathy (Fähling, Seeliger, Patzak, et al., 2017). The nurse should encourage fluids and monitor the patient's urinary output post procedure, which should be at least 0.5 mL/kg/h. Contrast-induced acute kidney injury may occur within 48 to 96 hours post procedure; therefore, the nurse should follow up with the patient's primary provider if this occurs (see Chapter 48 for discussion of acute kidney injury). Patients who have known iodine or shellfish allergies may need premedication with steroids and histamine blockers.

Angiography

An arteriogram produced by angiography may be used to confirm the diagnosis of occlusive arterial disease when surgery or other interventions are considered. It involves injecting a radiopaque contrast agent directly into the arterial system to visualize the vessels. The location of a vascular obstruction or an **aneurysm** (abnormal dilation of a blood vessel) and the collateral circulation can be demonstrated. Typically, the patient experiences a temporary sensation of warmth as the contrast agent is injected, and local irritation may occur at the injection site. Infrequently, a patient may have an immediate or delayed allergic reaction to the iodine contained in the contrast agent. Manifestations include dyspnea, nausea and vomiting, sweating, tachycardia, and numbness of the extremities. Any reaction must be reported to the interventionist at once; treatment may include the administration of epinephrine, antihistamines, or corticosteroids. Additional procedural risks include vessel injury, acute arterial occlusion, bleeding, or contrast nephropathy.

Magnetic Resonance Angiography

Magnetic resonance angiography (MRA) is performed with a standard magnetic resonance imaging (MRI) scanner and special software programmed to isolate the blood vessels. The resulting images can be rotated and viewed from multiple angles (Gerhard-Herman et al., 2016).

Nursing Implications

MRA is contraindicated in patients with metal implants. Prior to the MRA, the nurse should assess for the presence of any incompatible devices, such as aneurysm clips, old tattoos, which may contain trace elements (newer materials used in tattoos such as nitinol and titanium are MRI compatible), some medication patches, or a cardiac implantable electronic device. Patients with any type of cardiac implantable electronic device need to be screened to determine if they can safely undergo MRI (Indik, Gimbel, Abe, et al., 2017).

The nurse should educate the patient regarding what to expect during and after the procedure. The patient should be prepared to lie on a cold, hard table that slides into an enclosed small tube. The nurse should inform the patient that they will hear noises, including periodic banging and popping sounds. Patients with claustrophobia may be prescribed a sedative prior to the procedure. Patients should be instructed to close their eyes before entering the tube, and to keep them closed, as this may decrease claustrophobic symptoms. Patients should be reassured that they will be provided with a panic button to press if they feel a need to stop the procedure. MRA procedures require the use of IV contrast dye; therefore, nursing implications following MRA are the same as those for MDCT (discussed in CT section).

Contrast Phlebography (Venography)

Also known as venography, contrast phlebography involves injecting a radiopaque contrast agent into the venous system. If a **thrombus** (a blood clot within an artery or vein) exists, the x-ray image reveals an unfilled segment of vein in an otherwise completely filled vein. Injection of the contrast agent may cause brief but painful inflammation of the vein. This test is rarely performed, as duplex ultrasonography is considered the standard for diagnosing lower extremity venous thrombosis (Zierler & Dawson, 2016). The nurse should instruct the patient that they will receive contrast dye through a peripheral vein and will be monitored for 2 hours post venogram for access site oozing or hematoma. The guidelines for nursing care following venogram are the same as those for MDCT (see earlier discussion).

Lymphoscintigraphy

Lymphoscintigraphy involves injection of a radioactively labeled colloid subcutaneously in the second interdigital space. The extremity is then exercised to facilitate the uptake of the colloid by the lymphatic system, and serial images are obtained at preset intervals.

Nursing Implications

The nurse should educate the patient about what to expect. For instance, the blue dye typically used for this procedure may stain the injection site. If the patient has a lymphatic leak, as can occur with groin incisions, there may be blue drainage from the incision until the dye clears from the system, which may take several days.

ARTERIAL DISORDERS

Arterial disorders cause ischemia and tissue necrosis. These disorders may occur because of chronic progressive pathologic changes to the arterial vasculature (e.g., atherosclerotic changes) or an acute loss of blood flow to the tissues (e.g., aneurysm rupture).

Arteriosclerosis and Atherosclerosis

Arteriosclerosis (hardening of the arteries) is the most common disease of the arteries. It is a diffuse process whereby the muscle fibers and the endothelial lining of the walls of small arteries and arterioles become thickened. **Atherosclerosis** involves a different process, affecting the intima of large and medium-sized arteries. These changes consist of the accumulation of lipids, calcium, blood components, carbohydrates, and fibrous tissue on the intimal layer of the artery. These accumulations are referred to as atheromas or plaques.

Although the pathologic processes of arteriosclerosis and atherosclerosis differ, rarely does one occur without the other, and the terms are often used interchangeably. Atherosclerosis is a generalized disease of the arteries, and when it is present in the extremities, it is usually present elsewhere in the body.

Pathophysiology

The most common direct results of atherosclerosis in arteries include stenosis (narrowing) of the lumen, obstruction by thrombosis, aneurysm, ulceration, and rupture. Its indirect results are malnutrition and the subsequent fibrosis of the organs that the sclerotic arteries supply with blood. All actively functioning tissue cells require an abundant supply of nutrients and oxygen and are sensitive to any reduction in the supply of these nutrients. If such reductions are severe and permanent, the cells undergo ischemic necrosis (death of cells

due to deficient blood flow) and are replaced by fibrous tissues, which require much less blood flow.

Atherosclerosis can develop in any part of the vascular system, but certain sites are more vulnerable, such as regions where arteries bifurcate or branch into smaller vessels, with males having more below-the-knee pathology than females (Jelani, Petrov, Martinez, et al., 2018). In the proximal lower extremity, these include the distal abdominal aorta, the common iliac arteries, the orifice of the superficial femoral and profunda femoris arteries, and the superficial femoral artery in the adductor canal, which is particularly narrow. Distal to the knee, atherosclerosis can occur anywhere along the course of the artery.

Although many theories exist about the development of atherosclerosis, no single theory explains the pathogenesis completely; however, tenets of several theories are incorporated into the reaction-to-injury theory. According to this theory, vascular endothelial cell injury results from prolonged hemodynamic forces, such as shearing stresses and turbulent flow, irradiation, chemical exposure, or chronic hyperlipidemia. Injury to the endothelium increases the aggregation of platelets and monocytes at the site of the injury. Smooth muscle cells migrate and proliferate, allowing a matrix of collagen and elastic fibers to form (Norris, 2019).

Atherosclerotic lesions are of two types: fatty streaks and fibrous plaque.

- Fatty streaks are yellow and smooth, protrude slightly into the lumen of the artery, and are composed of lipids and elongated smooth muscle cells. These lesions have been found in the arteries of people of all ages, including infants. It is not clear whether fatty streaks predispose a person to the formation of fibrous plaques or whether they are reversible. They do not usually cause clinical symptoms.
- Fibrous plaques are composed of smooth muscle cells, collagen fibers, plasma components, and lipids. They are white to white-yellow and protrude to various degrees into the arterial lumen, sometimes completely obstructing it. These plaques are found predominantly in the abdominal aorta and the coronary, popliteal, and internal carotid arteries, and they are believed to be progressive lesions (see Fig. 26-6).

Gradual narrowing of the arterial lumen stimulates the development of collateral circulation (see Fig. 26-7). Collateral circulation arises from preexisting vessels that enlarge to reroute blood flow around a hemodynamically significant stenosis or occlusion. Collateral flow allows continued perfusion to the tissues, but it is often inadequate to meet increased metabolic demands, and ischemia results.

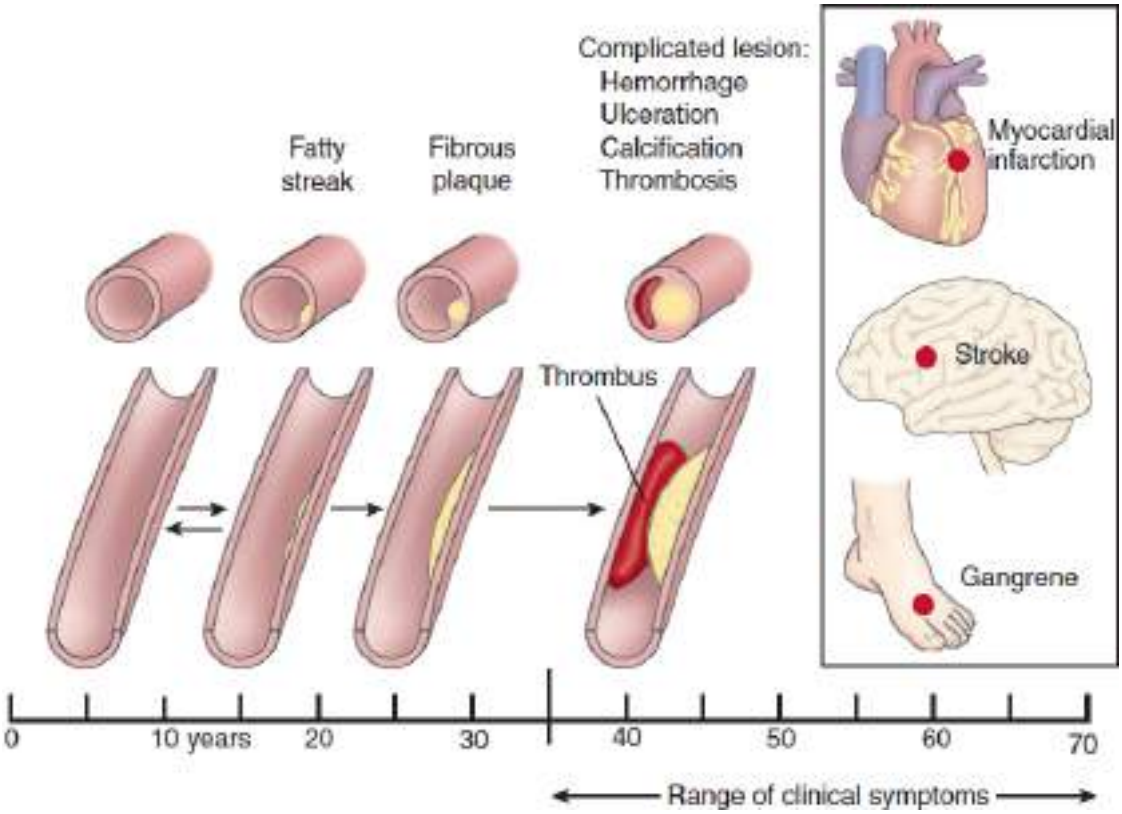

Figure 26-6 • Schematic concept of the progression of atherosclerosis. Fatty streaks are an early manifestation of atherosclerosis. Fatty streaks either regress or progress to fibrous plaques and eventually to atheroma. Atheromatous plaque may be complicated by hemorrhage, ulceration, calcification, or thrombosis leading to myocardial infarction, stroke, claudication, rest pain, or gangrene.

Risk Factors

Many risk factors are associated with atherosclerosis (see Chart 26-3). Although it is not entirely clear whether modification of these risk factors prevents the development of cardiovascular disease, evidence indicates that it may slow the process.

The use of nicotine products may be one of the most important risk factors in the development of atherosclerotic lesions. Nicotine in tobacco decreases blood flow to the extremities and increases heart rate and blood pressure by stimulating the sympathetic nervous system, causing vasoconstriction (Quintella Farah, Silva Rigoni, de Almeida Correia, et al., 2019). It also increases the risk of clot formation by increasing the aggregation of platelets. Carbon monoxide, a toxin produced by burning tobacco, combines more readily with hemoglobin than oxygen, depriving the tissues of oxygen. There is evidence that smoking decreases high-density lipoprotein (HDL; good cholesterol) levels and alters the ratios between HDL and low-density

lipoprotein (LDL; bad cholesterol), HDL and triglycerides, and HDL and total cholesterol levels (see Chapter 23 for discussion of HDL and LDL and their association with atherosclerosis). The amount of tobacco used—inhaled in traditional or e-cigarette form, or chewed—is directly related to the extent of the disease, and cessation of any type of nicotine product use reduces the risk (Jelani et al., 2018).

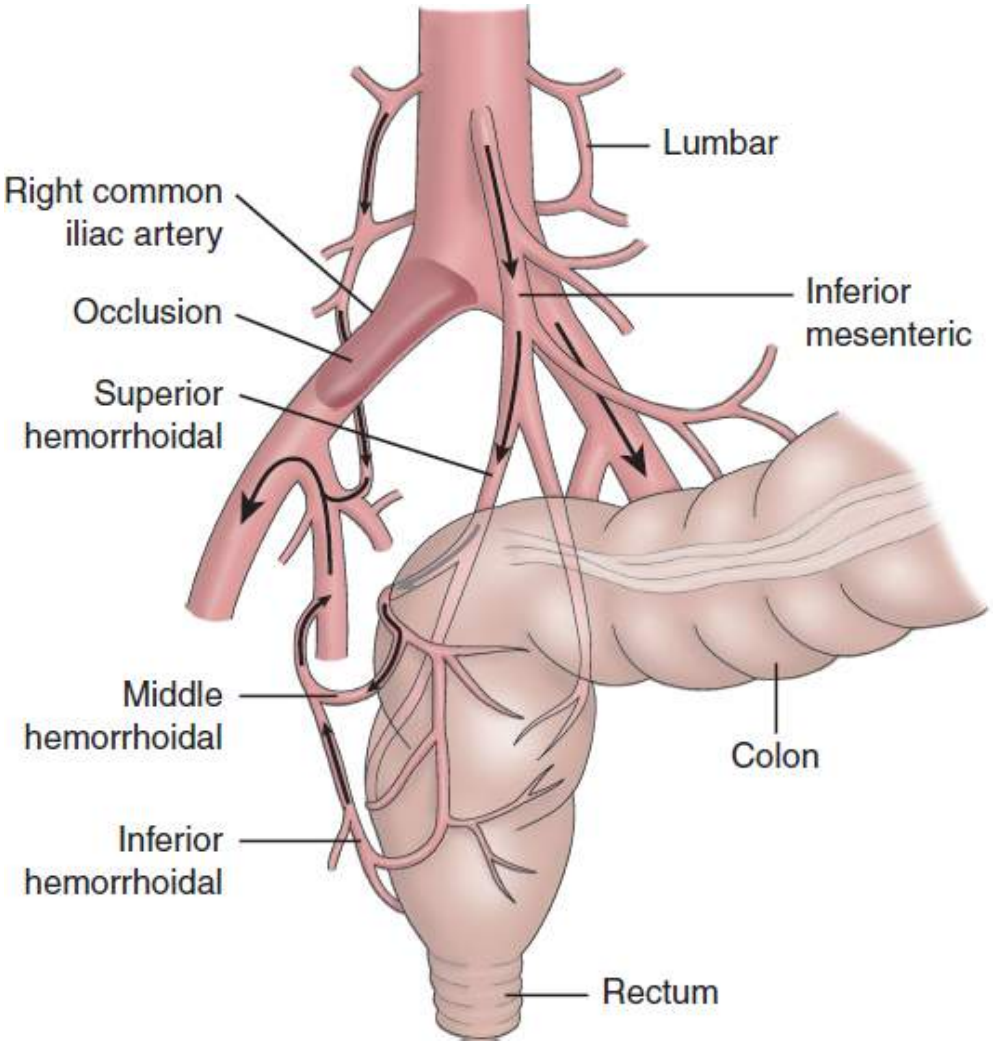

Figure 26-7 • Development of channels for collateral blood flow in response to occlusion of the right common iliac artery and the terminal aortic bifurcation.

Chart 26-3 RISK FACTORS

Atherosclerosis and Peripheral Artery Disease

Modifiable Risk Factors

- Nicotine use (i.e., tobacco product such as cigarettes, e-cigarettes, or chewing tobacco)
- Diabetes (speeds the atherosclerotic process by thickening the basement membranes of both large and small vessels)
- Hypertension
- Hyperlipidemia
- Diet (contributing to hyperlipidemia)
- Stress
- Sedentary lifestyle
- Elevated C-reactive protein
- Hyperhomocysteinemia

Nonmodifiable Risk Factors

- Increasing age
- Familial predisposition/genetics

Adapted from Sidawy, A. N., & Perler, B. A. (2019). *Rutherford's vascular surgery and endovascular therapy* (9th ed.). Philadelphia, PA: Elsevier.

Diabetes increases the overall risk of peripheral artery disease (PAD) two- to fourfold, with amputation rates 5 to 10 times higher than in patients without diabetes. Patients with diabetes show an earlier onset and more rapid progression of PAD than patients without diabetes; furthermore, they also exhibit a different anatomic distribution of pathology, with a greater severity of disease in the profunda femoris and in all segments below the knee (Gerhard-Herman et al., 2016). How diabetes affects the onset and progression of atherosclerosis is multifactorial and includes incitation of inflammatory processes, derangement of various cell types within vessel walls, promotion of coagulation, and inhibition of fibrinolysis (Hazarika & Annex, 2017). Many other factors, such as obesity, stress, and lack of exercise, have been identified as contributing to the disease process.

C-reactive protein (CRP) is a sensitive marker of cardiovascular inflammation, both systemically and locally. Slight increases in serum CRP levels are associated with an increased risk of damage in the vasculature, especially if these increases are accompanied by other risk factors, including increasing age, hypertension, hypercholesterolemia, obesity, elevated blood glucose levels, use of nicotine products, or a positive family history of cardiovascular disease (Hazarika & Annex, 2017).

In some studies, hyperhomocysteinemia has been positively correlated with the risk of peripheral, cerebrovascular, and coronary artery disease as well as

venous thromboembolism (VTE). Homocysteine is a protein that promotes coagulation by increasing factor V and factor XI activity while depressing protein C activation and increasing the binding of lipoprotein(a) in fibrin. These processes increase thrombin formation and the propensity for thrombosis. Folic acid and vitamin B_{12} have been reported to reduce serum homocysteine levels but there are no data demonstrating this therapy reduces adverse cardiovascular events. Thus, the use of B complex vitamins to reduce cardiovascular disease in patients with PAD is not recommended (Gerhard-Herman et al., 2016).

Prevention

Intermittent claudication is a symptom of generalized atherosclerosis and may be a marker of atherosclerosis in other arterial territories, such as the coronary and carotid arteries. The suspicion that a high-fat diet contributes to atherosclerosis means that it is reasonable to measure serum cholesterol and to begin disease prevention efforts that include diet modification. The American Heart Association recommends reducing the amount of fat ingested, substituting unsaturated fats for saturated fats, and decreasing cholesterol intake to reduce the risk of cardiovascular disease.

Certain medications that supplement dietary modification and exercise are used to reduce blood lipid levels. Current evidence-based guidelines established by the American College of Cardiology and the American Heart Association (ACC/AHA) recommend 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase inhibitors (statins) as first-line therapy in patients with PAD for secondary prevention and cardiovascular risk reduction (Conte, Bradbury, Kolh, et al., 2019). These statins may include medications such as atorvastatin, lovastatin, pitavastatin, pravastatin, simvastatin, fluvastatin, and rosuvastatin. Several other classes of medications used to reduce lipid levels include bile acid sequestrants (cholestyramine, colesevelam, colestipol), nicotinic acid (niacin), fibric acid inhibitors (gemfibrozil, fenofibrate), and cholesterol absorption inhibitors (ezetimibe). Patients receiving long-term therapy with these medications require close monitoring.

Hypertension, which may accelerate the rate at which atherosclerotic lesions form in high-pressure vessels, can lead to a stroke, ischemic renal disease, severe PAD, or coronary artery disease. Hypertension is a major risk factor for the development of PAD and may be a more significant risk factor for women than men based on research findings from the classic Framingham Heart Study and a similar study performed in Europe (Jelani et al., 2018). The majority of patients with hypertension require more than two antihypertensive agents to reach target blood pressure, and at least one third require more than three antihypertensive agents to achieve effective blood pressure control

(Sidawy & Perler, 2019). See Chapter 27 for further discussion of hypertension.

Although no single risk factor has been identified as the primary contributor to the development of atherosclerotic cardiovascular disease, it is clear that the greater the number of risk factors, the greater the risk of atherosclerosis. Elimination of all controllable risk factors, particularly nicotine use, is strongly recommended.

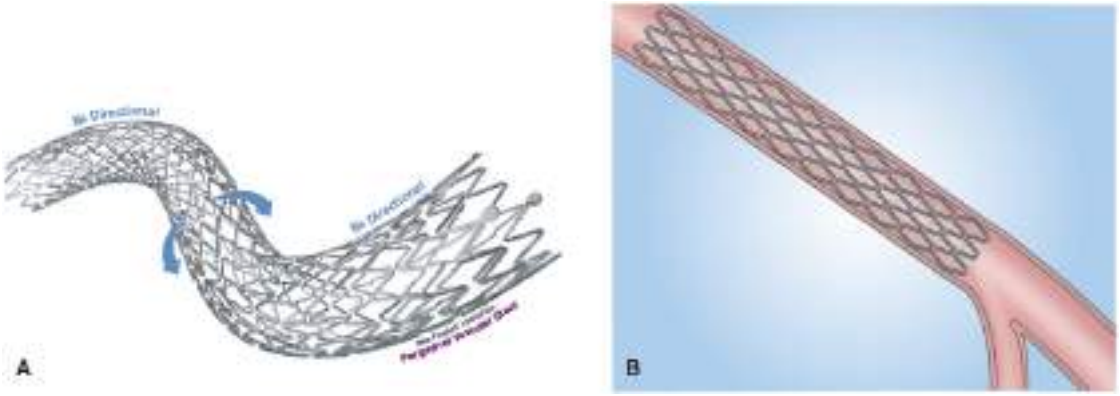

Figure 26-8 • **A.** Flexible stent. Used with permission from QualiMed Innovative Medizinprodukte GmbH, a Q3 Medical Company. **B.** Representation of a common iliac artery with a wall stent.

Clinical Manifestations

The clinical signs and symptoms resulting from atherosclerosis depend on the organ or tissue affected. Coronary atherosclerosis (heart disease), angina, and acute myocardial infarction are discussed in Chapter 23. Cerebrovascular diseases, including transient ischemic attacks and stroke, are discussed in Chapter 62. Atherosclerosis of the aorta, including aneurysm, and atherosclerotic lesions of the extremities are discussed later in this chapter. Renovascular disease (renal artery stenosis and end-stage kidney disease) is discussed in Chapter 48.

Medical Management

The management of atherosclerosis involves modification of risk factors, a controlled exercise program to improve circulation and functional capacity, medication therapy, and interventional or surgical procedures.

Surgical Management

Vascular surgical procedures are divided into two groups: inflow procedures, which improve blood supply from the aorta into the femoral artery, and

outflow procedures, which provide blood supply to vessels below the femoral artery. Inflow surgical procedures are described with diseases of the aorta and outflow procedures with peripheral artery disease.

Endovascular Therapy

Endovascular therapies include various procedures that use a puncture or small incision to place catheters inside a blood vessel to repair it or insert a device and have replaced a large proportion of open surgical approaches to management. If an isolated lesion or lesions are identified on imaging, **angioplasty,** also called *percutaneous transluminal angioplasty* (PTA), or an atherectomy, may be performed. After the patient receives a local anesthetic agent, a balloon-tipped catheter is maneuvered across the area of stenosis. Although some clinicians theorize that PTA improves blood flow by overstretching (and thereby dilating) the elastic fibers of the nondiseased arterial segment, most believe that the procedure widens the arterial lumen by "cracking" and flattening the plaque against the vessel wall (see Chapter 23). An **atherectomy** reduces the plaque buildup within an artery using a cutting device or laser. Complications from PTA and atherectomy include hematoma formation, **embolus** (blood clot, fatty deposit, or air that travels through the blood, lodges in an artery or vein, and blocks flow), **dissection** (separation of the intima) of the vessel, acute arterial occlusion, and bleeding. To decrease the risk of restenosis, stents (small mesh tubes made of nitinol, titanium, or stainless steel) may be inserted to support the walls of the artery and prevent collapse immediately after balloon deflation (see Fig. 26-8). A variety of stents and stent grafts may be used for short-segment stenoses. Complications associated with stent or stent graft use include distal embolization, dissection, and dislodgment. The advantage of angioplasty, atherectomy, stents, and stent grafts is a decreased length of hospital stay; many of the procedures are performed on an outpatient basis.

Nursing Management

An overview of the care of a patient with peripheral artery problems is provided in Chart 26-4.

Improving Peripheral Arterial Circulation

Arterial blood supply to a body part can be enhanced by positioning the body part below the level of the heart. For the lower extremities, this is accomplished by elevating the head of the patient's bed or by having the patient use a reclining chair or sit with the feet resting on the floor.

Concept Mastery Alert

For patients with PAD, blood flow to the lower extremities needs to be enhanced; therefore, the nurse encourages keeping the lower extremities in a neutral or dependent position. In contrast, for patients with venous insufficiency, blood return to the heart needs to be enhanced, so the lower extremities are elevated. Exercise promotes the development of collateral circulation (arterial) and activates the musculovenous pump (venous).

The nurse can assist the patient with walking or other moderate or graded isometric exercises that promote blood flow and encourage the development of collateral circulation. The amount of exercise a patient can tolerate before the onset of pain is determined to provide a baseline for evaluation. The nurse instructs the patient to walk to the point of pain, rest until the pain subsides, and then resume walking so that endurance can be increased as collateral circulation develops. Pain can serve as a guide in determining the appropriate amount of exercise. The onset of pain indicates that the tissues are not receiving adequate oxygen, signaling the patient to rest. A supervised exercise therapy (SET) program should be prescribed for patients with claudication. SET can result in increased walking distance before the onset of claudication (Gerhard-Herman et al., 2016).

Before recommending any exercise program or SET, the patient's primary provider should be consulted. Conditions that worsen with exercise include leg ulcers, cellulitis, gangrene, or acute thrombotic occlusions.

Chart 26-4 **PLAN OF NURSING CARE**

Nursing Diagnosis: Impaired peripheral tissue perfusion associated with compromised circulation
Goal: Increased arterial blood supply to extremities

Nursing Interventions	Rationale	Expected Outcomes
1. Lower the extremities below the level of the heart (if condition is arterial). 2. Encourage moderate amount of walking or enrollment in supervised exercise therapy program if no contraindications exist.	1. Dependency of lower extremities enhances arterial blood supply. 2. Exercise promotes blood flow and the development of collateral circulation.	• Has extremities warm to touch • Has extremities with improved color • Experiences decreased muscle pain with exercise • Able to walk further distances

Goal: Decrease in venous congestion

Nursing Interventions	Rationale	Expected Outcomes
1. Elevate the extremities above the level of the heart (if condition is venous). 2. Discourage standing still or sitting for prolonged periods. 3. Encourage walking.	1. Elevation of extremities counteracts gravity, promotes venous return, and prevents venous stasis. 2. Prolonged standing still or sitting promotes venous stasis. 3. Walking promotes venous return by activating the "calf muscle pump."	• Elevates the extremities as prescribed • Has decreased edema of extremities • Avoids prolonged standing still or sitting • Gradually increases walking time daily

Goal: Promotion of vasodilation and prevention of vascular compression

Nursing Interventions	Rationale	Expected Outcomes
1. Maintain warm temperature and avoid chilling. 2. Discourage use of nicotine products. 3. Counsel to avoid emotional upsets;	1. Warmth promotes arterial flow by preventing vasoconstriction from chilling. 2. Nicotine in all tobacco products causes vasospasm, which	• Protects extremities from cold • Avoids all nicotine products • Uses stress management to

encourage stress management. 4. Encourage avoidance of constrictive clothing and accessories. 5. Encourage avoidance of crossing the legs. 6. Administer vasodilator medications and adrenergic-blocking agents as prescribed, with appropriate nursing considerations.	impedes peripheral circulation. 3. Emotional stress causes peripheral vasoconstriction by stimulating the sympathetic nervous system. 4. Constrictive clothing and accessories impede circulation and promote venous stasis. 5. Crossing the legs causes compression of vessels with subsequent impediment of circulation, resulting in venous stasis. 6. Vasodilators relax smooth muscle; adrenergic-blocking agents block the response to sympathetic nerve impulses or circulating catecholamines.	minimize emotional upset • Avoids constrictive clothing and accessories • Avoids crossing legs • Takes medication as prescribed

Nursing Diagnosis: Chronic pain associated with impaired ability of peripheral vessels to supply tissues with oxygen
Goal: Relief of pain

Nursing Interventions	Rationale	Expected Outcomes
1. Promote increased circulation through exercise (e.g., walking, upper extremity exercises, water aerobics, stationary cycling, supervised exercise therapy). 2. Administer analgesic agents as prescribed, with appropriate nursing considerations.	1. Enhancement of peripheral circulation increases the oxygen supplied to the muscle and decreases the accumulation of metabolites that cause muscle spasms. 2. Analgesic agents help reduce pain and allow the patient to participate in activities and exercises that promote circulation.	• Uses measures to increase arterial blood supply to extremities • Uses analgesic agents as prescribed

Nursing Diagnosis: Risk for impaired skin integrity associated with compromised circulation
Goal: Attainment/maintenance of tissue integrity

Nursing Interventions	Rationale	Expected Outcomes
1. Instruct in ways to avoid trauma to extremities. 2. Encourage wearing protective shoes and padding for pressure points; wear new shoes for short period of time and then inspect feet for signs of injury. 3. Encourage meticulous hygiene: bathing with neutral soaps, applying lotions (avoiding application between toes), and carefully trimming nails; see podiatrist for nail care. 4. Use caution to avoid scratching or vigorous rubbing. 5. Promote good nutrition; adequate intake of vitamins A and C, protein, and zinc; and weight reduction, if the patient is overweight or has obesity.	1. Poorly nourished tissues are susceptible to trauma and microbial invasion; wound healing is delayed or inhibited due to poor tissue perfusion. 2. Protective shoes and padding prevent foot injuries. 3. Neutral soaps and lotions prevent drying and cracking of skin; lotion application between toes increases moisture, which can lead to maceration of tissue. 4. Scratching and rubbing can cause skin abrasions and microbial invasion. 5. Good nutrition promotes healing and prevents tissue breakdown.	• Inspects skin daily for evidence of injury or ulceration • Avoids trauma and irritation to skin • Wears protective shoes • Adheres to meticulous hygiene regimen • Eats a healthy diet that contains adequate protein, zinc, and vitamins A and C

Nursing Diagnosis: Lack of knowledge regarding self-care activities
Goal: Adherence to the self-care program

Nursing Interventions	Rationale	Expected Outcomes
1. Include family/significant others in education. 2. Provide written instructions about foot and leg care and exercise therapy program. 3. Assist to obtain properly fitting clothing, shoes, and stockings. 4. Refer to self-help groups as indicated, such as smoking cessation clinics or stress management,	1. Adherence to the self-care program is enhanced when the patient receives support from family and from appropriate self-help groups and agencies. 2. Written instructions serve as a reminder and reinforcement of information. 3. Constrictive clothing and accessories impede circulation and promote venous stasis.	• Practices frequent position changes as prescribed • Practices postural exercises as prescribed • Takes medications as prescribed • Avoids vasoconstrictors

weight management, and supervised exercise therapy programs.	4. Reducing risk factors may reduce symptoms or slow disease progression.	• Uses measures to prevent trauma • Uses stress management • Accepts condition as chronic but amenable to therapies that will decrease symptoms

Promoting Vasodilation and Preventing Vascular Compression

Arterial dilation increases blood flow to the extremities and is therefore a goal for patients with PAD. However, if the arteries are severely sclerosed, inelastic, or damaged, dilation is not possible. For this reason, measures to promote vasodilation, such as medications, endovascular interventions or surgery, may be only minimally effective.

Nursing interventions may involve applications of warmth to promote arterial flow and instructions to the patient to avoid exposure to cold temperatures, which causes vasoconstriction. Adequate clothing and warm temperatures protect the patient from chilling.

Quality and Safety Nursing Alert

Patients are instructed to test the temperature of bath water and to avoid using hot-water bottles and heating pads on the extremities. It is safer to apply a hot-water bottle or a heating pad to the abdomen; this can cause reflex vasodilation in the extremities.

In patients with vasospastic disorders (e.g., Raynaud's disease), heat may be applied directly to ischemic extremities using a warmed or electric blanket; however, the temperature of the heat source must not exceed body temperature. Even at low temperatures, trauma to the tissues can occur in ischemic extremities.

Quality and Safety Nursing Alert

Excess heat may increase the metabolic rate of the extremities and the need for oxygen beyond that provided by the reduced arterial flow through the diseased artery. Heat must be used with great caution!

Nicotine from any tobacco product causes vasospasm and can thereby dramatically reduce circulation to the extremities. Tobacco smoke also impairs transport and cellular use of oxygen and increases blood viscosity. Patients with arterial insufficiency who smoke, chew tobacco, or use electronic nicotine delivery systems (ENDS), including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars, must be fully informed of the effects of nicotine on circulation and encouraged to stop.

Emotional stress can stimulate the sympathetic nervous system and cause peripheral vasoconstriction. Emotional stress can be minimized to some degree by avoiding stressful situations when possible or by consistently following a stress management program. Counseling services or use of alternative or complementary therapies (e.g., relaxation, yoga, aromatherapy, mindfulness) may be indicated for patients who cannot cope effectively with situational stressors.

Constrictive clothing and accessories such as tight socks or shoelaces may impede arterial circulation to the extremities and promote venous stasis and therefore should be avoided. Crossing the legs for more than 15 minutes at a time should be discouraged because it compresses vessels in the legs.

Relieving Pain

Frequently, the pain associated with peripheral arterial insufficiency is chronic, continuous, and disabling. It limits activities, affects work and life responsibilities, disturbs sleep, and alters the patient's sense of well-being. Patients may be depressed, irritable, and unable to exert the energy necessary to execute prescribed therapies, making pain relief even more difficult. Analgesic agents such as hydrocodone plus acetaminophen, oxycodone, oxycodone plus acetylsalicylic acid, or oxycodone plus acetaminophen may be helpful in reducing pain so that the patient can participate in therapies that can increase circulation and ultimately relieve pain more effectively. Particularly in older patients, these medications can be dangerous, contributing to delirium and falls. In all patients, issues of dependence need to be considered.

Maintaining Tissue Integrity

Poorly perfused tissues are susceptible to damage and infection. Patients with peripheral vascular disease and diabetes are at increased risk. When lesions develop, healing may be delayed or inhibited because of the poor blood supply to the area. Infected, nonhealing ulcerations of the extremities can be

debilitating and may require prolonged and often expensive treatments. Amputation of an ischemic toe, forefoot or limb may eventually be necessary. Measures to prevent these complications must be a high priority and vigorously implemented. Centers of excellence for the prevention of amputation which involve a multidisciplinary, specialty team approach to management have become increasingly important for early intervention and surveillance.

Trauma to the extremities must be avoided. Advising the patient to wear sturdy, well-fitting shoes or slippers to prevent injury to the skin may be helpful, and recommending neutral soaps and body lotions may prevent drying and cracking of skin. However, the nurse should instruct the patient not to apply lotion between the toes, because the increased moisture can lead to maceration of the interdigital skin. Scratching and vigorous rubbing can abrade skin and create sites for microbial invasion; therefore, feet should be patted dry. Stockings should be clean and dry. Fingernails and toenails should be carefully trimmed straight across and sharp corners filed to follow the contour of the nail. If the nails cannot be trimmed safely, it is necessary to consult a podiatrist, who can also remove corns and calluses. Special shoe inserts may be needed to prevent calluses from recurring. Blisters, ingrown toenails, infection, or other problems should be reported to health care professionals for treatment and follow-up. Patients with diminished vision and those with disability that limits mobility of the arms or legs may require assistance in periodically examining the lower extremities for trauma or evidence of inflammation or infection.

Good nutrition promotes healing and prevents tissue breakdown and is therefore included in the plan for patients with peripheral vascular disease. Eating a diet that contains adequate protein and vitamins is necessary for patients with arterial insufficiency. Key nutrients, such as vitamin C and zinc, play specific roles in wound healing. However, a meta-analysis of randomized controlled trials found no evidence to support that supplementation with vitamins and antioxidants prevents vascular diseases (Sultan, Murarka, Jahangir, et al., 2017). Obesity strains the heart, increases venous congestion, and reduces circulation; therefore, a weight reduction plan may be necessary for patients who are overweight or have obesity. A diet low in fats and lipids is indicated for patients with atherosclerosis.

Gerontologic Considerations

In older adults, the symptoms of PAD may be more pronounced than in younger people. In older patients who are inactive, limb ischemia or gangrene may be the first sign of disease (Schorr, Treat-Jacobson, Lindquist, et al., 2017). See the Nursing Research Profile in Chart 26-5. These patients may have adjusted their lifestyle to accommodate the limitations imposed by the

disease and may not walk far enough to develop symptoms of claudication due to other comorbid conditions such as chronic obstructive pulmonary disease (COPD) or heart failure. Circulation is decreased, although this is not apparent to the patient until trauma occurs. At this point, gangrene develops when minimal arterial flow is impaired further by edema formation resulting from the traumatic event.

Intermittent claudication may occur after walking only one half to one block or after walking up a slight incline. Any prolonged pressure on the foot can cause pressure injuries that may become ulcerated, infected, or gangrenous. The outcomes of arterial insufficiency can include reduced mobility and activity as well as a loss of independence. Older adults with reduced mobility are less likely to remain in the community setting, have higher rates of hospitalizations, and experience a poorer quality of life. Those with cognitive impairment may also be unable to verbalize symptoms such as pain.

Chart 26-5 **NURSING RESEARCH PROFILE**

Understanding the Relationship Between Peripheral Artery Disease (PAD) Symptoms and Ischemia

Schorr, E. N., Treat-Jacobson, D., Lindquist, R. (2017). The relationship between peripheral artery disease symptomatology and ischemia. *Nursing Research*, *66*(5), 378–387.

Purpose

Peripheral artery disease (PAD) impacts over eight million Americans and is associated with an increased risk for cardiovascular disease and mortality. It is typically identified when patients report claudication (i.e., aching, cramping pain, fatigue in calves with activity). However, less than 33% of individuals who have a diagnosis of PAD report classic claudication, potentially resulting in underdiagnosis of PAD. A better understanding of symptom presentation and changes in tissue oxygenation may enhance earlier detection and treatment of PAD. The aim of this study was to explore the range of symptoms (typical versus atypical, location, and description) that patients with PAD experience to better understand the relationship between symptom variation and calf muscle ischemia.

Design

This descriptive study explored symptoms during exercise testing and recovery in patients with a diagnosis of PAD. Individuals who were English speaking, 21 years of age or older, and met specific diagnostic criteria were recruited from a larger study. Participants with uncontrolled hypertension, angina or dyspnea on exercise testing, or vascular procedures performed within the last 3 months were excluded. Demographic and clinical data were collected. Ankle-brachial index (ABI) was used as a measure of disease severity. Participants exercised on a treadmill with a near-infrared spectroscopy device to measure calf muscle tissue saturation index (TSI). In addition, participants rated symptom intensity using a numerical rating scale (NRS) and provided self-report of symptom location and descriptors. Data were collected at three points (e.g., rest, exercise, recovery) during three successive treadmill tests. Descriptive statistics were generated and symptom variables and relevant demographic and clinical data (e.g., age, gender, race, ABI, diabetes, neuropathy) were examined with the TSI measurements during exercise and recovery using multilevel modeling procedures.

Findings

Three successive episodes of treadmill testing with 40 participants resulted in 120 exercise tests. The majority of participants were Caucasian males (80%) with an average age of 68 years (SD 0.92). More than half (69.2%) of tests were stopped due to discomfort in the calf, with only 55% of participants reporting typical descriptors of claudication. TSI declined rapidly between the start of exercise and symptom onset. The lowest TSI was often reached

before reported maximum discomfort. Changes in TSI were related to exercise time ($p < 0.001$), baseline TSI ($p < 0.001$), exercise rating ($p < 0.001$), and ABI ($p < 0.5$). In the recovery phase, TSI steadily increased as pain reduced; TSI was associated with recovery rating ($p < 0.001$) and ABI ($p < 0.03$).

Nursing Implications

Recognizing variations in symptom presentation (e.g., intensity, location, description) and associated ischemic changes in PAD is important in understanding individual patient experiences and tailoring education and treatment. Nurses should be aware that some patients with PAD may use terms such as *burn, pressure,* or *tight* to describe related discomfort and that patients may report discomfort in atypical locations, such as the foot. A better understanding of the full range of ischemic symptoms in PAD may prompt earlier diagnosis and facilitate risk factor modification and exercise therapy. Unlike other medical conditions, where the onset of pain indicates the potential of increasing tissue damage with ongoing activity, pain in PAD can be used as an indicator to adjust the exercise program to extend the person's walking distance. Exercise prescription can greatly reduce the progression of atherosclerosis, limiting not only distal disease but also coronary and cerebral disease. Although additional research is needed, nurses can consider these findings when planning care for patients with PAD to ensure they are providing appropriate education and encouraging safe exercise regimens.

Promoting Home, Community-Based, and Transitional Care

The self-care program is planned with the patient so that activities that promote arterial and venous circulation, relieve pain, and promote tissue integrity are acceptable. The patient and family are helped to understand the reasons for each aspect of the plan, the possible consequences of nonadherence, and the importance of keeping follow-up appointments. Long-term care of the feet and legs is of prime importance in the prevention of trauma, ulceration, and gangrene. Chart 26-6 provides detailed patient instructions for foot and leg care.

Peripheral Artery Disease

Arterial insufficiency of the extremities occurs most often in men and is a common cause of disability. The legs are most frequently affected; however, the upper extremities may be involved. The age of onset and the severity are influenced by the type and number of atherosclerotic risk factors (see Chart 26-3). In PAD, obstructive lesions are predominantly confined to segments of

the arterial system extending from the aorta below the renal arteries to the popliteal artery (see Fig. 26-9). Distal occlusive disease is frequently seen in patients with diabetes and in older patients (Gerhard-Herman et al., 2016).

Chart 26-6 **HOME CARE CHECKLIST**

Foot and Leg Care in Peripheral Vascular Disease

At the completion of education, the patient and/or caregiver will be able to:

- Describe the rationale for proper foot and leg care in managing peripheral vascular disease.
- Demonstrate daily foot hygiene: Wash between toes with mild soap and lukewarm water, then rinse thoroughly and pat rather than rub dry.
- Recognize the dangers of thermal injury.
  - Wear clean, loose, soft cotton socks (they are comfortable, allow air to circulate, and absorb moisture).
  - In cold weather, wear extra socks in extra-large shoes.
  - Avoid heating pads, whirlpools, and hot tubs.
  - Avoid sunburn.
- Identify safety concerns.
  - Inspect feet daily with a mirror for redness, dryness, cuts, blisters, and so forth.
  - Always wear soft shoes or slippers when out of bed.
  - Trim nails straight across after showering.
  - Consult podiatrist to trim nails if vision is decreased and for care of corns, blisters, and ingrown nails.
  - Clear pathways in house to prevent injury.
  - Avoid wearing thong sandals.
  - Use lamb's wool or foam between toes if they overlap or rub each other.
- Demonstrate the use of comfort measures.
  - Wear leather shoes with an extra-depth toe box. Synthetic shoes do not allow air to circulate.
  - If feet become dry and scaly, use cream or lotion with emollient. Never put cream or lotion between toes unless it has been prescribed.
  - Avoid scratching or vigorous rubbing, which could cause abrasions.
  - If feet perspire, especially between toes, use lamb's wool between toes to promote drying.
- Demonstrate strategies to decrease risk of constricting blood vessels.
  - Avoid circumferential compression around feet or legs—for example, by knee-high stockings or tight socks or constricting bandages.
  - Do not cross legs at knees.
  - Stop using all nicotine products (i.e., smoking or chewing) because nicotine causes vasoconstriction and vasospasm.

- Participate in regular walking or supervised exercise therapy to stimulate circulation.

- Recognize when to seek medical attention.
  - Contact health care provider at the onset of skin breakdown such as abrasions, blisters, fungal infection (athlete's foot), or pain.
  - Do not use any medication on feet or legs unless prescribed.
  - Avoid using iodine, alcohol, corn/wart-removing compound, or adhesive products before checking with primary provider.
- State understanding of community resources and referrals (if any).

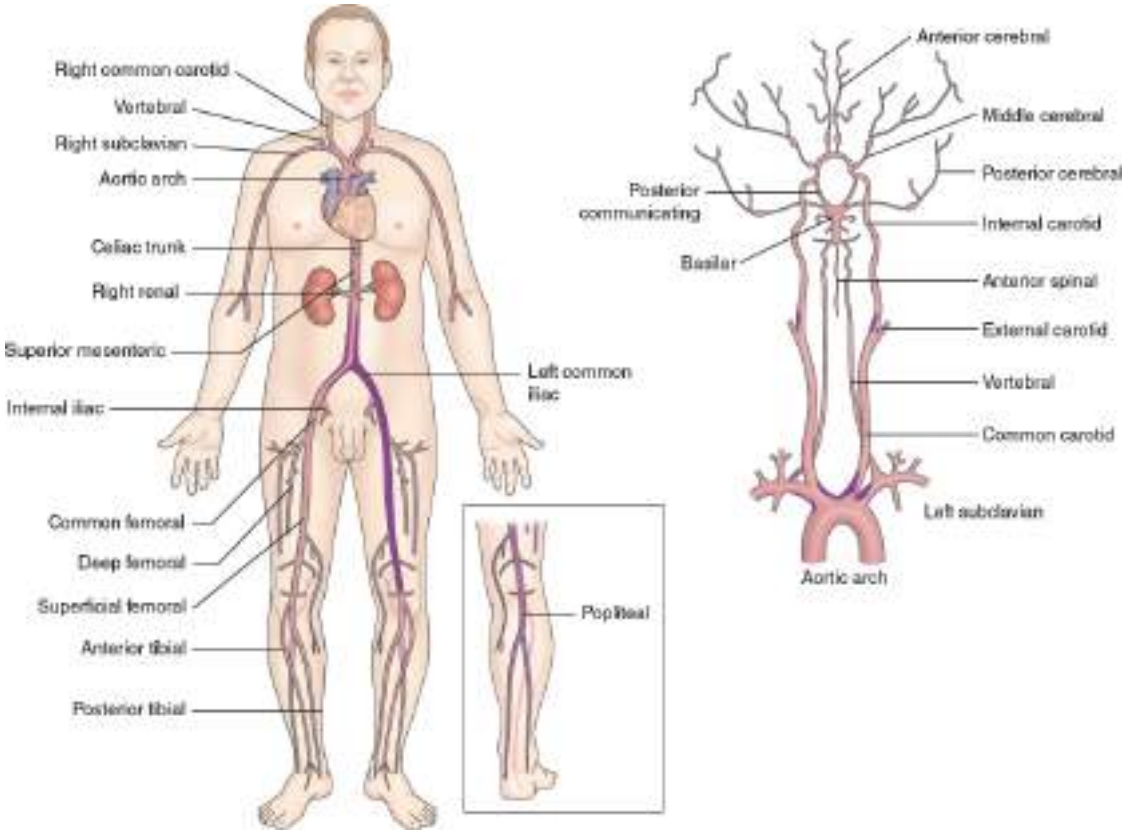

Figure 26-9 • Common sites of atherosclerotic obstruction in major arteries.

Clinical Manifestations

The hallmark symptom is intermittent claudication described as aching, cramping, or inducing fatigue or weakness that occurs with some degree of activity or exercise, which is relieved with rest. The pain commonly occurs in muscle groups distal to the area of stenosis or occlusion. As the disease progresses, the patient may have a decreased ability to walk the same distance as before or may notice increased pain with ambulation. When the arterial insufficiency becomes severe, the patient has rest pain. This pain is associated

with critical ischemia of the distal extremity and is described as persistent, aching, or boring; it may be so excruciating that it is unrelieved by opioids and can be disabling. Ischemic rest pain is usually worse at night and often wakes the patient. Elevating the extremity or placing it in a horizontal position increases the pain, whereas placing the extremity in a dependent position reduces the pain. In an attempt to prevent or relieve the pain, some patients sleep with the affected leg hanging over the side of the bed or sleep in a reclining chair.

Assessment and Diagnostic Findings

A sensation of coldness or numbness in the extremities may accompany intermittent claudication and is a result of reduced arterial flow. The extremity is cool and pale when elevated or ruddy and cyanotic when placed in a dependent position. Skin and nail changes, ulceration, gangrene, and muscle atrophy may be evident. Bruits may be auscultated with a stethoscope. Peripheral pulses may be diminished or absent.

Examination of the peripheral pulses is an important part of assessing PAD. Unequal pulses between extremities or the absence of a normally palpable pulse is a sign of PAD.

The presence, location, and extent of PAD are determined by a careful history of the symptoms and by physical examination. The color and temperature of the extremity are noted and the pulses palpated. The nails may be thickened and opaque, and the skin may be shiny, atrophic, and dry, with sparse or absent hair. The assessment includes comparison of the right and left extremities.

The diagnosis of PAD may be made using CW Doppler and ABIs, treadmill testing for claudication, duplex ultrasonography, or other imaging studies described earlier in this chapter.

Medical Management

Generally, patients feel better and have fewer symptoms of claudication after they participate in a SET program. SET programs are covered by insurance for a specific number of sessions. Reimbursement requires that SET is administered under direct provider supervision. A provider (e.g., physician, nurse practitioner, clinical nurse specialist, physician assistant) must be immediately and physically available, although not necessarily physically present, while SET is provided. The person providing the program supervision must be trained in the optimal delivery of SET and in both basic life support and advanced cardiac life support techniques. Unsupervised walking exercise programs are attractive for many patients with PAD with limited access to a SET program. Two recent trials in patients with PAD had similar findings

between the supervised and unsupervised groups, suggesting no greater therapeutic benefit for those who engage in supervised walking programs (McDermott, 2018). These findings suggest that home-based programs may be a viable and efficacious option for patients unable to participate in a structured, on-site, supervised exercise program. If a walking program is combined with weight reduction and cessation of nicotine use, patients often can further improve their activity tolerance. Patients should not be promised that their symptoms will be relieved if they stop nicotine use, however, because claudication may persist, and they may lose their motivation to stop using nicotine. In addition to these interventions, arm-ergometer exercise training effectively improves physical fitness, central cardiorespiratory function, and walking capacity in patients with claudication (Treat-Jacobson, McDermott, Beckman, et al., 2019).

Pharmacologic Therapy

Cilostazol is approved by the U.S. Food and Drug Administration (FDA) for the treatment of claudication. Cilostazol, a phosphodiesterase III inhibitor, is a direct vasodilator that inhibits platelet aggregation. Studies have shown it plays a role in decreasing intimal hyperplasia after angioplasty and stenting. Furthermore, patients prescribed cilostazol report improvement in maximal walking distance and pain-free walking distance within 4 to 6 weeks (Farkas, Járai, & Kolossváry, 2017). This agent is contraindicated in patients with a history of heart failure.

Antiplatelet agents, such as aspirin or clopidogrel, prevent the formation of thromboemboli which can lead to myocardial infarction and stroke and are recommended to treat patients with symptomatic PAD (Gerhard-Herman et al., 2016). Aspirin has been shown to reduce the risk of cardiovascular events (e.g., myocardial infarction, stroke, cardiovascular death) in patients with vascular disease; however, adverse events associated with aspirin use include gastrointestinal upset or bleeding (Gerhard-Herman et al., 2016).

Use of dual antiplatelet agents, such as aspirin and clopidogrel, in patients with symptomatic PAD has not been well established. However, dual antiplatelet agents may be effective and may be reasonable to reduce limb-threatening events after revascularization. Statins improve endothelial function in patients with PAD. Studies suggest that statins reduce severity of intermittent claudication and increase walking distance to the onset of claudication (Gerhard-Herman et al., 2016). These medications have beneficial effects on vascular inflammation, plaque stabilization, endothelial dysfunction, and thrombosis, and have been linked to decreased rates of repeat peripheral interventions, amputations, and major adverse cardiovascular events up to 3 years post procedure (Saxon, Safley, & Mena-Hurtado, 2020).

Endovascular Management

Endovascular interventions can include a balloon angioplasty, stent, stent graft, or an atherectomy. These revascularization procedures are less invasive than conventional surgery; their objective is to establish adequate inflow to the distal vessels. A meta-analysis reported that the efficacy and safety of all of these endovascular procedures are comparable to surgical interventions. Some stents that may be selected are drug eluting. Although costly, these are particularly efficacious in patients who have recurrent disease. By releasing antiproliferative drugs, drug-eluting balloons and stents have been shown to reduce the risk of restenosis. Eligible candidates for drug-eluting stents must be able to take antiplatelet medications for at least 6 months post procedure (Sidawy & Perler, 2019).

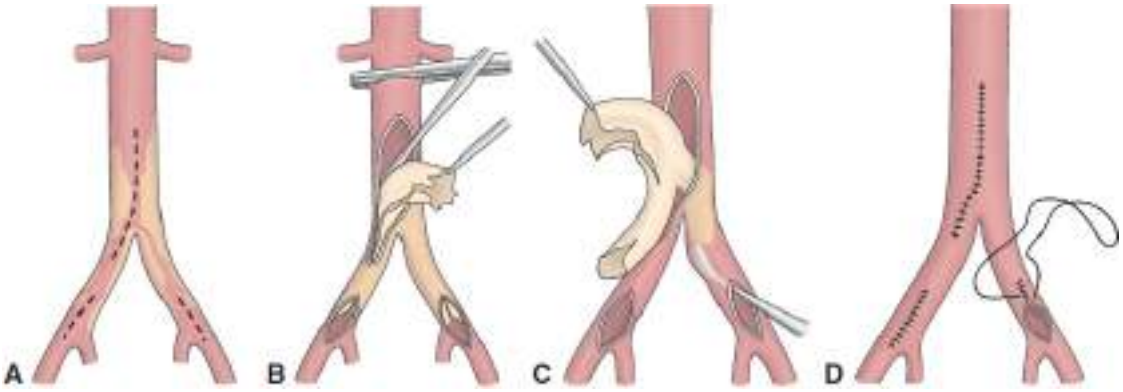

Figure 26-10 • In an aortoiliac endarterectomy, the vascular surgeon identifies the diseased area (**A**), clamps off the blood supply to the vessel (**B**), removes the plaque (**C**), and sutures the vessel shut (**D**), after which blood flow is restored. Adapted with permission from Sidawy, A. N., & Perler, B. A. (2019). *Rutherford's vascular surgery and endovascular therapy* (9th ed.). Philadelphia, PA: Elsevier.

Surgical Management

Surgery is reserved for the treatment of rest pain, severe and disabling claudication, or when the limb is at risk for amputation because of tissue necrosis. The choice of the surgical procedure depends on the degree, length, and location of the stenosis or occlusion and whether there are single or multiple lesions. Other important considerations are the overall health of the patient, the length of the procedure, and anesthesia required. If endarterectomy is performed, an incision is made into the artery and the atheromatous obstruction is removed (see Fig. 26-10).

Bypass grafts are performed to reroute the blood flow around the stenosis or occlusion. Before bypass grafting, the surgeon determines where the distal **anastomosis** (site where the vessels are surgically joined) will be placed. The distal outflow vessel must be at least 50% patent for the graft to remain open.

If the atherosclerotic occlusion is below the inguinal ligament in the superficial femoral artery, the surgical procedure of choice is the femoral-to-popliteal graft. This procedure is further classified as above- and below-knee grafts, referring to the location of the distal anastomosis. Bypass grafts may be synthetic materials or autologous vein. Several synthetic materials are available for use as a peripheral bypass graft: woven or knitted Dacron or expanded polytetrafluoroethylene (PTFE). Cryopreserved saphenous veins and umbilical veins are also available. When using an autologous conduit (i.e., the patient's own veins), the vein is either grafted to the artery in situ (the vein remains in place with the valves stripped and the vein is anastomosed to the proximal and distal target arteries), or the vein is harvested, reversed, and anastomosed to the proximal and distal target arteries.

Lower leg or ankle vessels with occlusions may also require grafts. Occasionally, the popliteal artery is completely occluded and only collateral vessels maintain perfusion. The distal anastomosis may be made onto any of the tibial arteries (posterior tibial, anterior tibial, or peroneal arteries) or the dorsalis pedis or plantar artery. The distal anastomosis site is determined by the ease of exposure of the vessel in surgery and by which vessel provides the best flow to the distal limb. These grafts require the use of an autologous vein to ensure patency. The greater or lesser saphenous vein or a combination of one of the saphenous veins and an upper extremity vein such as the cephalic vein is used to provide the required length.

How long the graft remains patent is determined by several factors, including the size of the graft, graft location, and development of intimal hyperplasia at anastomosis sites (Sidawy & Perler, 2019). Infection of synthetic grafts may result in sepsis and almost always requires removal.

If a vein graft is the surgical choice, care must be taken in the operating room not to damage the vein after harvesting (removing the vein from the patient's body). The vein is occluded at one end and inflated with a heparinized solution to check for leakage and competency. The graft is then placed in a heparinized solution to keep it from becoming dry and brittle until use during the operative procedure.

For patients who cannot tolerate an extensive vascular surgical procedure, a palliative approach involving primary amputation rather than an endarterectomy or bypass may be considered (Conte et al., 2019).

Nursing Management

Nursing care for patients with PAD is reviewed in Chart 26-4. Nursing care for the patient who has had endovascular revascularization procedures mostly mirrors the care of patients who have had endovascular repair to aortic aneurysms (see later section). The patient who has had an endovascular

procedure may be discharged home the day of the procedure, or by the following day.

Nursing Care of the Postoperative Patient

During the postoperative period, the nurse's care focuses on maintaining circulation, identifying and managing potential complications, and discharge planning.

Maintaining Circulation

The primary objective in the postoperative period is to maintain adequate circulation through the arterial repair. Pulses, Doppler assessment, color and temperature, capillary refill, and sensory and motor function of the affected extremity are checked and compared with those of the other extremity; these observations are recorded initially every 15 minutes and then at progressively longer intervals if the patient's status remains stable. Doppler evaluation of the vessels distal to the bypass graft should be performed, because it is more sensitive than palpation for pulses. The ABI is monitored at least once every 8 hours for the first 24 hours (not usually assessed with pedal artery bypasses due to the risk of compression of the anastomosis by the cuff) and then once each day until discharge; the typical hospital length of stay is 3 to 5 days. An adequate circulating blood volume should be established and maintained. Disappearance of a pulse that was present may indicate thrombotic occlusion of the graft; the surgeon is immediately notified.

Monitoring and Managing Potential Complications

Continuous monitoring of urine output, central venous pressure, mental status, and pulse rate and volume permits early recognition and treatment of fluid imbalances. Bleeding can result from the heparin given during surgery or from an anastomotic leak. A hematoma may form as well. The nurse should review the operative report to determine if the heparin was reversed (usually with protamine sulfate) in the operating room.

Leg crossing and prolonged extremity dependency are avoided to prevent thrombosis. Edema is a normal postoperative finding due to increased arterial flow; however, elevating the extremities and encouraging the patient to exercise the extremities while in bed reduces edema. Graduated compression or anti-embolism stockings may be prescribed for some patients, but care must be taken to avoid compressing distal vessel bypass grafts, inducing pressure injuries, and obscuring visualization of the extremity. Severe edema of the extremity, pain, and decreased sensation of toes or fingers can be an indication of compartment syndrome (see Chapter 37).

Promoting Home, Community-Based, and Transitional Care

Discharge planning includes assessing the patient's ability to manage activities of daily living (ADLs) independently. The nurse determines whether the patient has a network of family and friends to assist with ADLs. The patient is encouraged to make the lifestyle changes necessitated by the onset of disease, including pain management and modifications in diet, activity, and hygiene (skin care). The nurse ensures that the patient has the knowledge and ability to assess for any postoperative complications such as infection, occlusion of the artery or graft, and decreased blood flow. The nurse assists the patient in developing and implementing a plan to stop using tobacco products.

Upper Extremity Arterial Disease

Arterial stenosis and occlusions occur less frequently in the upper extremities (arms) than in the legs, and cause less severe symptoms because the collateral circulation is significantly better in the arms. The arms also have less muscle mass and are not subjected to the workload of the legs.

Clinical Manifestations

Stenosis and occlusions in the upper extremity result from atherosclerosis or trauma. The stenosis usually occurs at the origin of the vessel proximal to the vertebral artery, which results in the vertebral artery becoming the dominant vessel for blood flow. The patient typically complains of arm fatigue and pain with exercise (forearm claudication), inability to hold or grasp objects (e.g., combing hair, placing objects on shelves above the head), and occasionally difficulty driving.

The patient may develop a "subclavian steal" syndrome characterized by reverse flow in the vertebral and basilar arteries to provide blood flow to the arm. This syndrome may cause vertebrobasilar (cerebral) symptoms, including vertigo, ataxia, syncope, or bilateral visual changes.

Assessment and Diagnostic Findings

Findings on assessment include coolness and pallor of the affected extremity, decreased capillary refill, and a difference in arm blood pressures of more than 15 to 20 mm Hg (Zierler & Dawson, 2016). Noninvasive studies performed to evaluate upper extremity arterial occlusions include upper and forearm blood pressure determinations and duplex ultrasonography to identify the anatomic location of the lesion and to evaluate the hemodynamics of blood flow. Transcranial Doppler evaluation is performed to evaluate the intracranial circulation and to detect any siphoning of blood flow from the posterior

circulation to provide blood flow to the affected arm. If an endovascular or surgical procedure is planned, a diagnostic arteriogram may be necessary.

Medical Management

If a short focal lesion is identified in an upper extremity artery, a PTA with possible stent or stent graft placement may be performed. If the lesion involves the subclavian artery with documented siphoning of blood flow from the intracranial circulation and an endovascular procedure is not possible, a surgical bypass may be performed.

Nursing Management

Nursing assessment involves bilateral comparison of upper arm blood pressures (obtained by stethoscope and Doppler), radial, ulnar, and brachial pulses, motor and sensory function, temperature, color changes, and capillary refill every 2 hours. Disappearance of a pulse or Doppler flow that had been present may indicate an acute occlusion of the vessel, and the primary provider is notified immediately.

After surgery or an endovascular procedure, the arm is kept at heart level or elevated, with the fingers at the highest level. Pulses are monitored with Doppler assessment of the arterial flow every hour for 2 hours and then every shift. Blood pressure (obtained by stethoscope and Doppler) is also assessed every hour for 4 hours and then every shift. Motor and sensory function, warmth, color, and capillary refill are monitored with each arterial flow (pulse) assessment.

Quality and Safety Nursing Alert

Before surgery and for 24 hours after surgery, the patient's arm is kept at heart level and protected from cold, venous and arterial punctures, tape, pressure, and constrictive dressings.

Discharge planning is similar to that for the patient with PAD. Chart 26-4 describes nursing care for patients with peripheral vascular disease.

Aortoiliac Disease

If collateral circulation has developed, patients with a stenosis or occlusion of the aortoiliac segment may be asymptomatic, or they may complain of buttock or low back discomfort associated with walking. Men may have erectile

dysfunction or experience impotence. These patients may have decreased or absent femoral pulses.

Medical Management

The treatment of aortoiliac disease is essentially the same as that for atherosclerotic PAD. An endovascular procedure, such as bilateral common iliac stents, may be attempted if the aorta has a less than 50% diameter reduction (Gerhard-Herman et al., 2016). If there is significant aortic disease, the surgical procedure of choice is the aortoiliac graft. If possible, the distal graft is anastomosed to the iliac artery, and the entire surgical procedure is performed within the abdomen. If the iliac vessels are occluded, the distal anastomosis is made to the femoral arteries (aortobifemoral graft). A femoral–femoral crossover graft may also be needed to maintain circulation. Bifurcated woven or knitted Dacron grafts are preferred for this surgical procedure.

Nursing Management

Preprocedural or preoperative assessment, in addition to the standard parameters (see Chapter 14), includes evaluating the brachial, radial, ulnar, femoral, popliteal, posterior tibial, and dorsalis pedis pulses to establish a baseline for follow-up after arterial lines are placed and postoperatively. Patient education includes an overview of the procedure to be performed, the preparation for an endovascular procedure or surgery, and the anticipated postprocedural or postoperative plan of care. Sights, sounds, and sensations that the patient may experience are discussed.

Postprocedural endovascular care mirrors the care described for the patient who has had endovascular repair of an aortic aneurysm (see later discussion). Postoperative care includes monitoring for signs of thrombosis in arteries distal to the surgical site. The nurse assesses color and temperature of the extremity, capillary refill time, sensory and motor function, and pulses by palpation and Doppler initially every 15 minutes and then at progressively longer intervals if the patient's status remains stable. Any dusky or bluish discoloration, coldness, decrease in sensory or motor function, or decrease in pulse quality is reported immediately to the primary provider.

Postoperative care also includes monitoring urine output and ensuring that output is at least 0.5 mL/kg/h. Renal function may be impaired as a result of hypoperfusion from hypotension, ischemia to the renal arteries during the surgical procedure, hypovolemia, or embolization of the renal artery or renal parenchyma. Vital signs, pain, and intake and output are monitored with the pulse and extremity assessments. Results of laboratory tests are monitored and reported to the primary provider. Abdominal assessment for bowel sounds and paralytic ileus is performed at least every 8 hours. Bowel sounds may not

return before the third postoperative day. The absence of bowel sounds, absence of flatus, and abdominal distention are indications of paralytic ileus. Manual manipulation of the bowel during surgery may have caused bruising, resulting in decreased peristalsis. Nasogastric suction may be necessary to decompress the bowel until peristalsis returns. A liquid bowel movement before the third postoperative day may indicate bowel ischemia, which may occur when the mesenteric blood supply (celiac, superior mesenteric, or inferior mesenteric arteries) is occluded. Ischemic bowel usually causes increased pain and a markedly elevated white blood cell count (20,000 to 30,000 cells/mm^3).

Aneurysms

An aneurysm is a localized sac or dilation formed at a weak point in the wall of the artery (see Fig. 26-11). It may be classified by its shape or form. The most common forms of aneurysms are saccular and fusiform. A saccular aneurysm projects from only one side of the vessel. If an entire arterial segment becomes dilated, a fusiform aneurysm develops. Very small aneurysms due to localized infection are called *mycotic aneurysms.*

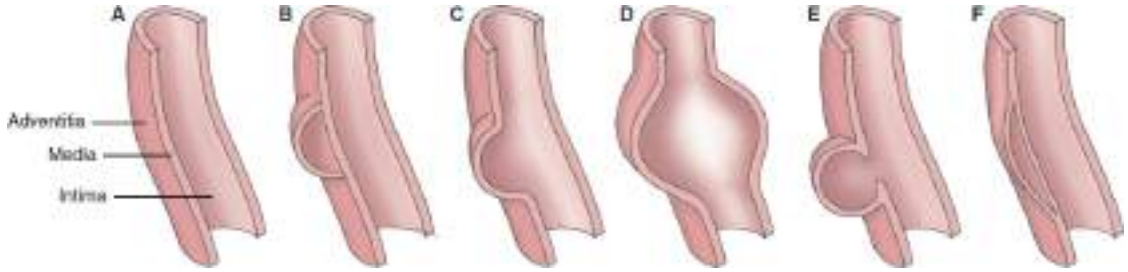

Figure 26-11 • Characteristics of arterial aneurysm. **A.** Normal artery. **B.** False aneurysm—actually a pulsating hematoma. The clot and connective tissue are outside the arterial wall. **C.** True aneurysm. One, two, or all three layers of the artery may be involved. **D.** Fusiform aneurysm—symmetric, spindle-shaped expansion of entire circumference of involved vessel. **E.** Saccular aneurysm—a bulbous protrusion of one side of the arterial wall. **F.** Dissecting aneurysm—this usually is a hematoma that splits the layers of the arterial wall. Adapted with permission from Sidawy, A. N., & Perler, B. A. (2019). *Rutherford's vascular surgery and endovascular therapy* (9th ed.). Philadelphia, PA: Elsevier.

Historically, the cause of abdominal aortic aneurysm, the most common type of degenerative aneurysm, has been attributed to atherosclerotic changes in the aorta. Other causes of aneurysm formation are listed in Chart 26-7.

Aneurysms are potentially serious; if they are located in large vessels that rupture, this can lead to hemorrhage and death.

Chart 26-7

Etiologic Classification of Arterial Aneurysms

Anastomotic (postarteriotomy) and graft aneurysms: Infection, arterial wall failure, suture failure, graft failure

Congenital: Primary connective tissue disorders (Marfan syndrome, Ehlers–Danlos syndrome) and other diseases (focal medial agenesis, tuberous sclerosis, Turner syndrome, Menkes syndrome)

Infectious (mycotic): Bacterial, fungal, spirochetal infections

Inflammatory (noninfectious): Associated with arteritis (Takayasu disease, giant cell arteritis, systemic lupus erythematosus, Behçet syndrome, Kawasaki disease) and periarterial inflammation (i.e., pancreatitis)

Mechanical (hemodynamic): Poststenotic and arteriovenous fistula and amputation related

Pregnancy-related degenerative: Nonspecific, inflammatory variant

Traumatic (pseudoaneurysms): Penetrating arterial injuries, blunt arterial injuries, pseudoaneurysms

Adapted from Sidawy, A. N., & Perler, B. A. (2019). *Rutherford's vascular surgery and endovascular therapy* (9th ed.). Philadelphia, PA: Elsevier.

Thoracic Aortic Aneurysm

Approximately 70% of all cases of thoracic aortic aneurysm are caused by atherosclerosis. They occur most frequently in men between the ages of 50 and 70 years, and are estimated to affect 10 of every 100,000 older adults. The thoracic area is the most common site for a dissecting aneurysm. Thoracic aortic emergencies are associated with high morbidity and mortality rates, but with the emergence of endovascular aortic repair there is an improvement in the mortality rate; in particular, the mortality rate for patients treated at high-volume aortic centers can be as low as 4.8% (Harris, Olson, Panthofer, et al., 2019).

Clinical Manifestations

Symptoms vary and depend on how rapidly the aneurysm dilates and how the pulsating mass affects surrounding intrathoracic structures. Some patients are asymptomatic. In most cases, pain is the most prominent symptom. The pain is usually constant and boring but may occur only when the person is supine. Other conspicuous symptoms are dyspnea, the result of pressure of the aneurysm sac against the trachea, a main bronchus, or the lung itself; cough,

frequently paroxysmal and with a brassy quality; hoarseness, stridor, or vocal weakness or aphonia (complete loss of the voice), resulting from pressure against the laryngeal nerve; and dysphagia (difficulty in swallowing) due to impingement on the esophagus by the aneurysm.

Assessment and Diagnostic Findings

When large veins in the chest are compressed by the aneurysm, the superficial veins of the chest, neck, or arms become dilated, and edematous areas on the chest wall and cyanosis are often evident. Pressure against the cervical sympathetic chain can result in unequal pupils. Diagnosis of a thoracic aortic aneurysm is principally made by chest x-ray, computed tomography angiography (CTA), MRA, or transesophageal echocardiography (TEE). CTAs are typically performed because they are widely available, can be completed rapidly, and can remove cardiac motion artifacts, enhancing their accuracy (Sidawy & Perler, 2019).

Medical Management

Treatment is based on whether the patient is symptomatic and whether the aneurysm is expanding in size, caused by an iatrogenic injury, contains a dissection, or involves branch vessels. General measures such as controlling blood pressure and correcting risk factors are helpful. For decades, beta-blockers (e.g., atenolol, metoprolol, carvedilol) have been the mainstay of medical treatment for aortic aneurysms; however, angiotensin receptor blockers (ARBs) (e.g., losartan, valsartan, irbesartan) may also retard aortic dilation (Rurali, Perrucci, Pilato, et al., 2018). It is also important to control blood pressure in patients with dissecting aneurysms. Preoperatively, the systolic pressure is maintained at approximately 90 to 120 mm Hg in order to maintain a mean arterial pressure at 65 to 75 mm Hg with a beta-blocker such as esmolol or metoprolol. Occasionally, antihypertensive agents such as hydralazine are used for this purpose. Sodium nitroprusside is the most established drug used for this purpose; it is given by continuous IV drip to emergently lower the blood pressure, as it has a rapid onset and short action of duration and is easily titrated (Sidawy & Perler, 2019). The goal of surgery is to repair the aneurysm and restore vascular continuity with a vascular graft. Intensive monitoring is required after this type of surgery, and the patient is cared for in the critical care unit.

Repair of thoracic aneurysms using endovascular grafts placed percutaneously in an interventional suite (e.g., interventional radiology, cardiac catheterization laboratory) or combined interventional suite and operating room (hybrid suite) may decrease postoperative recovery time and decrease complications compared with traditional surgical techniques. Thoracic

endografts are made of PTFE material reinforced with nitinol or titanium stents. These endovascular grafts are inserted into the thoracic aorta via various vascular access routes, usually the brachial or femoral artery. Because a large surgical incision is not necessary to gain vascular access, the overall patient recovery time tends to be shorter than with open surgical repair. Despite the absence of aortic cross-clamping, there is still a 2% to 15% chance of spinal cord ischemia as a potential complication (Miranda, Sousa, & Mansilha, 2018). To decrease the chances of spinal cord ischemia and paraplegia, lumbar spinal drains are usually placed in patients undergoing an endovascular repair of thoracic aortic aneurysms. Cerebrospinal fluid drainage is performed to decrease the arterial to cerebral spinal fluid gradient, thereby improving spinal perfusion. What appears to be most important in preventing neurologic deficit is to maintain the cerebrospinal fluid pressure less than or equal to 10 mm Hg (14 cm H_2O) and to keep the mean arterial pressure greater than 90 mm Hg for the first 36 to 48 hours postoperatively (Scali, Kim, Kubilis, et al., 2018).

Abdominal Aortic Aneurysm

The most common cause of abdominal aortic aneurysm is atherosclerosis. This condition affects men two to six times more often than women, is two to three times more common in White versus Black men, and is most prevalent in patients older than 65 years of age (Sidawy & Perler, 2019). Most of these aneurysms occur below the renal arteries (infrarenal aneurysms). Untreated, the eventual outcome may be rupture and death.

Pathophysiology

All aneurysms involve a damaged media layer of the vessel. This may be caused by congenital weakness, trauma, or disease. After an aneurysm develops, it tends to enlarge. Risk factors include genetic predisposition, nicotine use, and hypertension; more than half of patients with aneurysms have hypertension.

Clinical Manifestations

Only about 40% of patients with abdominal aortic aneurysms have symptoms. Some patients complain that they can feel their heart beating in their abdomen when lying down, or they may say that they feel an abdominal mass or abdominal throbbing. If the abdominal aortic aneurysm is associated with thrombus, a major vessel may be occluded or smaller distal occlusions may result from emboli. Small cholesterol, platelet, or fibrin emboli may lodge in

the interosseous or digital arteries, causing cyanosis and mottling of the toes (also referred to as trashing or trash toes).

Signs of impending rupture include severe back or abdominal pain, which may be persistent or intermittent. Abdominal pain is often localized in the middle or lower abdomen to the left of the midline. Low back pain may be present because of pressure of the aneurysm on the lumbar nerves. Indications that the abdominal aortic aneurysm may be leaking or rupturing include constant, intense back pain; falling blood pressure; and decreasing hematocrit. Rupture into the peritoneal cavity is rapidly fatal. A retroperitoneal rupture (contained rupture) of an aneurysm may result in hematomas in the scrotum, perineum, flank, or penis. Signs of heart failure or a loud bruit may suggest a rupture into the vena cava. If the aneurysm adheres to the adjacent vena cava, the vena cava may become damaged when rupture or leak of the aneurysm occurs. Rupture into the vena cava results in higher-pressure arterial blood entering the lower-pressure venous system and causing turbulence, which is heard as a bruit. The high blood pressure and increased blood volume returning to the right side of the heart from the vena cava may cause heart failure.

Assessment and Diagnostic Findings

The most important diagnostic indication of an abdominal aortic aneurysm is a pulsatile mass in the middle and upper abdomen. Most clinically significant aortic aneurysms are palpable during routine physical examination; however, the sensitivity depends on the size of the aneurysm, abdominal girth of the patient (i.e., more difficult to find in the patient with obesity), and the skill of the examiner (Sidawy & Perler, 2019). A systolic bruit may be heard over the mass. Duplex ultrasonography or CTA is used to determine the size, length, and location of the aneurysm. When the aneurysm is small, ultrasonography is conducted at 6-month intervals until the aneurysm reaches a size so that surgery to prevent rupture is of more benefit than the possible complications of a surgical procedure. Some aneurysms remain stable over many years of monitoring.

Gerontologic Considerations

Most abdominal aortic aneurysms occur in patients between 60 and 90 years of age. Rupture is likely with coexisting hypertension and with aneurysms more than 6 cm wide. In most cases at this point, the chances of rupture are greater than the chances of death during surgical repair. If the older patient is considered at risk for complications related to surgery or anesthesia, the aneurysm is not repaired until it is at least 5.5 cm (2 inches) wide (Chaikof, Dalman, Eskandari, et al., 2018).

Medical Management

Medical management consists of pharmacologic, endovascular, and surgical interventions.

Pharmacologic Therapy

If the aneurysm is stable in size based on serial duplex ultrasound scans, the blood pressure is closely monitored over time, because there is an association between increased blood pressure and aneurysm rupture (Sidawy & Perler, 2019). Antihypertensive agents, including diuretics, beta-blockers, ACE inhibitors, ARBs, and calcium channel blockers, are frequently prescribed to maintain the patient's blood pressure within acceptable limits (see Chapter 27).

Endovascular and Surgical Management

An expanding or enlarging abdominal aortic aneurysm is likely to rupture. When an abdominal aortic aneurysm measured at least 5.5 cm (2 inches) wide or was enlarging, the standard treatment had been open surgical repair of the aneurysm by resecting the vessel and sewing a bypass graft in place. However, endovascular aortic repair has become a mainstay of therapy for treating an infrarenal abdominal aortic aneurysm and involves the transluminal placement and attachment of a sutureless aortic graft across the aneurysm (see Fig. 26-12). This procedure can be performed under local or regional anesthesia. Endovascular grafting of abdominal aortic aneurysms may be performed if the patient's abdominal aorta and iliac arteries are not extremely tortuous, small, calcified, or filled with thrombi. Results from multiple, prospective studies suggest comparable mortality rates among patients with aneurysms treated by endovascular grafting and those treated with surgical repair, with similar 5-year survival rates (Chaikof et al., 2018). Potential complications include bleeding, hematoma, or wound infection at the arterial insertion site; distal ischemia or embolization; dissection or perforation of the aorta; graft thrombosis or infection; break of the attachment system; graft migration; proximal or distal graft leaks; delayed rupture; and bowel ischemia.

Nursing Management

Before endovascular repair or surgery, nursing assessment is guided by anticipating rupture and recognizing that the patient may have cardiovascular, cerebral, pulmonary, and renal impairment from atherosclerosis. The functional capacity of all organ systems should be assessed. Medical therapies designed to stabilize physiologic function should be promptly implemented. Hemorrhage that leads to shock is a serious adverse consequence that must be treated decisively (see Chapter 11).

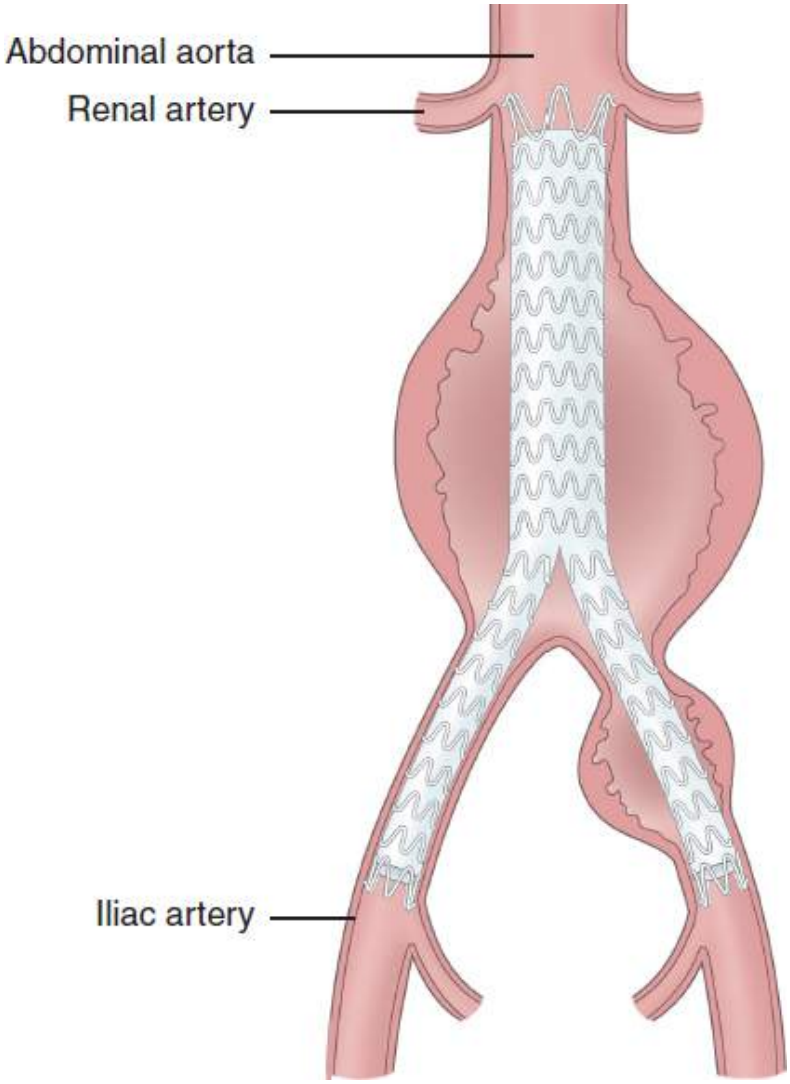

Figure 26-12 • Endograft repair of an abdominal aortic aneurysm.

The patient who has had an endovascular repair must lie supine for 6 hours; the head of the bed may be elevated up to 45 degrees after 2 hours. The patient needs to use a bedpan or urinal while on bed rest. Vital signs and Doppler assessment of peripheral pulses are performed initially every 15 minutes and then at progressively longer intervals if the patient's status remains stable. The access site (usually the femoral artery) is assessed when vital signs and pulses are monitored. The nurse assesses for bleeding and hematoma formation. Skin changes of the lower extremity, lumbar area, or buttocks that might indicate signs of embolization, such as extremely tender, irregularly shaped, cyanotic areas, as well as any changes in vital signs, pulse quality, bleeding, pulsation, swelling, pain, or hematoma, are immediately reported to the primary provider.

The patient's temperature should be monitored every 4 hours, and any signs of postimplantation syndrome should be reported. Postimplantation syndrome typically begins within 24 hours of stent graft placement and consists of a spontaneously occurring fever, leukocytosis, and occasionally, transient

thrombocytopenia. This condition has been attributed to complex immunologic changes that occur because of manipulations with sheaths and catheters with the aortic lumen, although the exact etiology is unknown. The symptoms are thought to be related to the activation of cytokines (Martinelli, Di Girolamo, Belli, et al., 2019). They can be managed with a mild analgesic (e.g., acetaminophen) or an anti-inflammatory agent (e.g., ibuprofen) and usually subside within a week.

Because of the increased risk of hemorrhage, the primary provider is also notified of persistent coughing, sneezing, vomiting, or systolic blood pressure greater than 180 mm Hg. Most patients can resume their preprocedure diet and are encouraged to drink fluids. An IV infusion may be continued until the patient can drink normally. Fluids are important to maintain blood flow through the arterial repair site and to assist the kidneys with excreting IV contrast agents and other medications used during the procedure. Six hours after the procedure, the patient may be able to roll from side to side and may be able to ambulate with assistance to the bathroom. Once the patient can take adequate fluids orally, the IV infusion may be discontinued.

Postoperative care requires frequent monitoring of pulmonary, cardiovascular, renal, and neurologic status. Possible complications of surgery include arterial occlusion, hemorrhage, infection, ischemic bowel, kidney injury, and erectile dysfunction.

Other Aneurysms

Aneurysms may also arise in the peripheral vessels, most often as a result of atherosclerosis. These may involve such vessels as the subclavian artery, renal artery, femoral artery, or (most frequently) popliteal artery. Between 50% and 60% of popliteal aneurysms are bilateral; the true incidence is unknown but has been reported to be between 0.1% and 3% of the adult population and is associated with abdominal aortic aneurysms (Sidawy & Perler, 2019).

The aneurysm produces a pulsating mass and disturbs peripheral circulation distal to it. Pain and swelling develop because of pressure on adjacent nerves and veins. Diagnosis is made by duplex ultrasonography or CTA to determine the size, length, and extent of the aneurysm. Arteriography may be performed to evaluate the level of proximal and distal involvement. The major complication associated with popliteal artery aneurysms is not rupture but distal embolization (Sidawy & Perler, 2019). Surgical repair is performed with replacement grafts. As an alternative, endovascular repair using a stent graft or wall graft, which is a Dacron or PTFE graft with external structures made from a variety of materials (e.g., nitinol, titanium, stainless steel) may be selected for additional support.

Aortic Dissection

Occasionally, in an aorta diseased by arteriosclerosis, a tear develops in the intima or the media degenerates, resulting in a dissection (see Fig. 26-11). Aortic dissections are three times more common in men than in women, occur most commonly in the 50- to 70-year age group and are associated with hypertension (Sidawy & Perler, 2019).

Pathophysiology

Aortic dissections (separations) are commonly associated with poorly controlled hypertension, blunt chest trauma, and cocaine use. The profound increase in sympathetic response caused by cocaine use creates an increase in the force of left ventricular contraction that causes heightened shear forces upon the aortic wall leading to disruption of the intima (Sidawy & Perler, 2019). Dissection is caused by rupture in the intimal layer. A rupture may occur through adventitia or into the lumen through the intima, allowing blood to reenter the main channel and resulting in chronic dissection (e.g., pseudoaneurysm) or occlusion of branches of the aorta.

As the separation progresses, the arteries branching from the involved area of the aorta shear and occlude. The tear occurs most commonly in the region of the aortic arch, with the highest mortality rate associated with ascending aortic dissection (Sidawy & Perler, 2019). The dissection of the aorta may progress backward in the direction of the heart, obstructing the openings to the coronary arteries or producing hemopericardium (effusion of blood into the pericardial sac) or aortic insufficiency, or it may extend in the opposite direction, causing occlusion of the arteries supplying the gastrointestinal tract, kidneys, spinal cord, and legs.

Clinical Manifestations

Onset of symptoms is usually sudden. Severe and persistent pain, described as tearing or ripping, may be reported. The pain is in the anterior chest or back and extends to the shoulders, epigastric area, or abdomen. Aortic dissection may be mistaken for an acute myocardial infarction, which confuses the clinical picture and initial treatment. Cardiovascular, neurologic, and gastrointestinal symptoms are responsible for other clinical manifestations, depending on the location and extent of the dissection. The patient may appear pale. Sweating and tachycardia may be detected. Blood pressure may be elevated or markedly different from one arm to the other if dissection involves the orifice of the subclavian artery on one side.

Assessment and Diagnostic Findings

Arteriography, multidetector-computed tomography angiography (MDCTA), TEE, duplex ultrasonography, and MRA, while limited in terms of expediency during an emergency situation, may aid in the diagnosis.

Medical Management

The medical or surgical treatment of an aortic dissection depends on the type of dissection present and follows the general principles outlined for the treatment of thoracic aortic aneurysms.

Nursing Management

A patient with an aortic dissection requires the same nursing care as a patient with an aortic aneurysm requiring intervention, as described earlier in this chapter. Nursing care as described in Chart 26-4 is also appropriate.

Arterial Embolism and Arterial Thrombosis

Acute vascular occlusion may be caused by an embolus or acute thrombosis. Acute arterial occlusions may result from iatrogenic injury, which can occur during insertion of invasive catheters such as those used for arteriography, PTA or stent placement, or an intra-aortic balloon pump, or it may occur as a result of illicit IV drug use. Other causes include trauma from a fracture or dislocation, crush injury, compartment syndrome, and penetrating wounds that disrupt the arterial intima. The accurate diagnosis of an arterial occlusion as embolic or thrombotic in origin is necessary to initiate appropriate treatment.

Pathophysiology

Arterial emboli arise most commonly from thrombi that develop in the chambers of the heart as a result of atrial fibrillation, myocardial infarction, infective endocarditis, or chronic heart failure. These thrombi become detached and are carried from the left side of the heart into the arterial system, where they lodge in and obstruct an artery that is smaller than the embolus. Emboli may also develop in advanced aortic atherosclerosis because the atheromatous plaques ulcerate or become rough. Acute thrombosis frequently occurs in patients with preexisting ischemic symptoms.

Clinical Manifestations

Symptoms of arterial emboli depend primarily on the size of the embolus, organ involvement, and the state of collateral vessels. The immediate effect is

cessation of distal blood flow. The blockage can progress distal and proximal to the site of the obstruction. Secondary vasospasm can contribute to the ischemia. The embolus can fragment or break apart, resulting in occlusion of distal vessels. Emboli tend to lodge at arterial bifurcations and areas narrowed by atherosclerosis. Cerebral, mesenteric, renal, and coronary arteries are often involved in addition to the large arteries of the extremities.

The symptoms of acute arterial embolism in extremities with poor collateral flow are acute, severe pain, and a gradual loss of sensory and motor function. The six Ps associated with acute arterial embolism are *p*ain, *p*allor, *p*ulselessness, *p*aresthesia, *p*oikilothermia (coldness), and *p*aralysis. Eventually, superficial veins may collapse because of decreased blood flow to the extremity. Because of ischemia, the part of the extremity distal to the occlusion is markedly colder and paler than the part proximal to the occlusion.

Arterial thrombosis can also acutely occlude an artery. A thrombosis is a slowly developing clot that usually occurs where the arterial wall has become damaged, generally as a result of atherosclerosis. Thrombi may also develop in an arterial aneurysm. The manifestations of an acute thrombotic arterial occlusion are similar to those described for an embolic occlusion. However, treatment is more difficult with a thrombus because the arterial occlusion has occurred in a degenerated vessel and requires more extensive reconstructive surgery to restore flow than is required with an embolic event (Sidawy & Perler, 2019).

Assessment and Diagnostic Findings

An arterial embolus is usually diagnosed on the basis of the sudden onset of symptoms and an apparent source for the embolus. Two-dimensional transthoracic echocardiography or transthoracic echocardiogram (TTE), chest x-ray, and electrocardiography (ECG) may reveal underlying cardiac disease. Noninvasive duplex and Doppler ultrasonography can determine the presence and extent of underlying atherosclerosis, and arteriography may be performed.

Medical Management

Management of arterial thrombosis depends on its cause. Management of acute embolic occlusion usually requires surgery because there is only a 4- to 6-hour window to restore blood flow before irreversible death of tissue. The event is acute with no collateral circulation developed, and the patient quickly moves through the list of six Ps to paralysis, the most advanced stage. Heparin therapy is initiated immediately to prevent further development of emboli and to prevent the extension of existing thrombi. Typically, an initial IV bolus of 60 to 80 U/kg body weight is given, followed by a continuous infusion of 12 to

18 U/kg/h until the patient undergoes an endovascular intervention or surgery (Comerford & Durkin, 2020; IBM Watson Health, 2020).

Endovascular Management

Emergency embolectomy is the procedure of choice if the involved extremity is viable (see Fig. 26-13). Arterial emboli are usually treated by insertion of an embolectomy catheter. The catheter is passed through an incision into the affected artery and extended through the embolus that is causing the arterial occlusion. The embolectomy catheter balloon is inflated with sterile saline solution, and the thrombus is extracted as the catheter is withdrawn. This procedure involves incising the vessel and removing the clot.

Percutaneous mechanical thrombectomy devices may also be used for the treatment of an acute thrombosis. All endovascular devices necessitate obtaining access to the patient's arterial system and inserting a catheter into the patient's artery to obtain access to the thrombus. The approach is similar to that used for angiograms, in that it is typically made through the groin to the femoral artery. In select cases, the radial or brachial artery can be accessed, allowing patients to be ambulatory post procedure. To qualify for this approach, the height of the patient is considered to ensure that the length of the catheter can reach the thrombus. Patients who are 5 feet 6 inches or shorter are potential candidates.

Some endovascular devices require that a small incision (cut-down) be made into the patient's artery. These devices may use a jet of fluid to disrupt the thrombus and then aspirate the particles; a rotating, sinusoidal-shaped wire that mixes a thrombolytic agent that simultaneously dissolves the clot; or high-frequency, low-energy ultrasound to dissolve an occlusive thrombus. Complications arising from the use of any endovascular device may include arterial dissection or distal artery embolization.

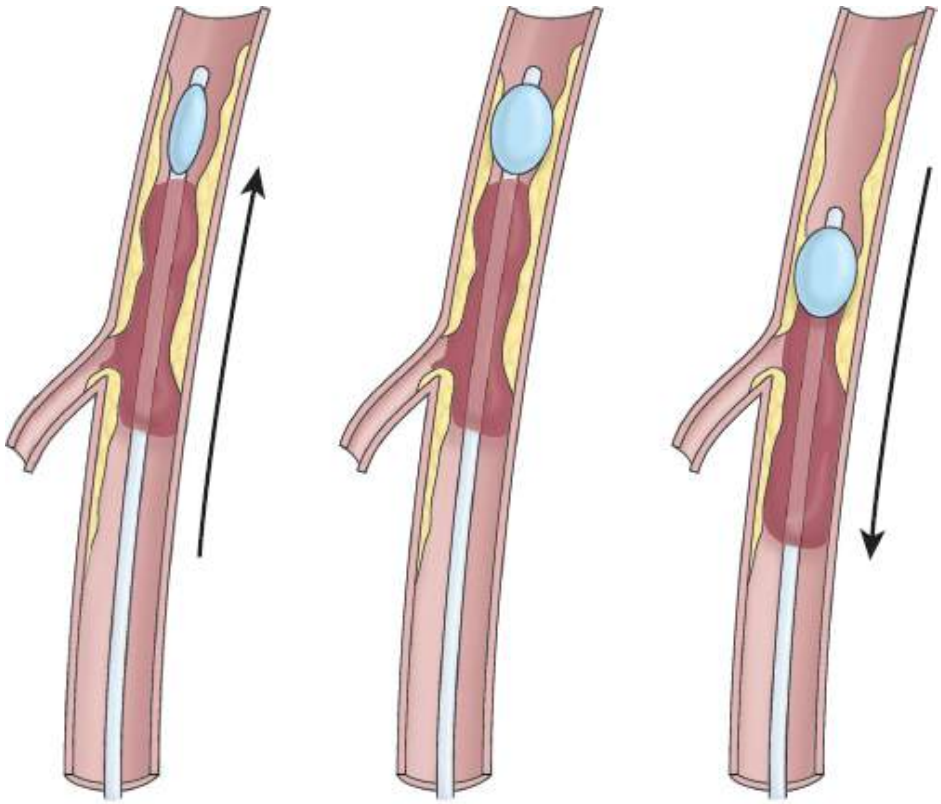

Figure 26-13 • Extraction of an embolus by a balloon-tipped embolectomy catheter. The deflated balloon-tipped catheter is advanced past the embolus, inflated, and then gently withdrawn, carrying the embolic material with it. Adapted with permission from Sidawy, A. N., & Perler, B. A. (2019). *Rutherford's vascular surgery and endovascular therapy* (9th ed.). Philadelphia, PA: Elsevier.

Pharmacologic Therapy

When the patient has adequate collateral circulation, treatment may include IV anticoagulation with heparin, which can prevent the thrombus from extending and reduce muscle necrosis. Intra-arterial thrombolytic medications are used to dissolve the embolus. Thrombolytic medications (e.g., tissue plasminogen activator [t-PA] and single-chain urokinase-type plasminogen activator) interact with plasminogen to generate plasmin which then breaks down fibrin clots. If t-PA is used for the treatment, heparin is usually given to prevent another thrombus from forming at the site of the lesion. The t-PA activates plasminogen on the thrombus, but it does not decrease the clotting factors as much as other thrombolytic therapies; therefore, patients receiving t-PA can make new thrombi more readily than if they receive other thrombolytics. Other thrombolytic medications are reteplase and tenecteplase (Millar & Laffan, 2017). Although these agents differ in their pharmacokinetics, they are given in a similar manner: A catheter is advanced under x-ray visualization to the clot, and the thrombolytic agent is infused.

Thrombolytic therapy should not be used when there are known contraindications to therapy or when the extremity cannot tolerate the several additional hours of ischemia that it takes for the agent to lyse (disintegrate) the clot. Contraindications to peripheral thrombolytic therapy include active internal bleeding, cerebrovascular hemorrhage, recent major surgery, uncontrolled hypertension, and pregnancy.

Nursing Management

Before an intervention or surgery, the patient remains on bed rest with the affected extremity level or slightly dependent (15 degrees). The affected extremity is kept at room temperature and protected from trauma. Heating and cooling pads are contraindicated because ischemic extremities are easily traumatized by alterations in temperature. If possible, tape and ECG electrodes should not be used on the extremity to protect from trauma. Pressure injury prevention through offloading the heel with a heel device and lifting the bedsheets using a bed cradle are important to protect the affected leg (European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel, Pan Pacific Pressure Injury Alliance [EPUAP/NPIAP/PPPIA], 2019).

If the patient is treated with thrombolytic therapy, the dose is based on the patient's weight. The patient is admitted to a critical care unit for continuous monitoring. Vital signs are taken initially every 15 minutes and then at progressively longer intervals if the patient's status remains stable. The patient is closely monitored for bleeding. The nurse minimizes the number of punctures for inserting IV lines and obtaining blood samples, avoids intramuscular injections, prevents any possible tissue trauma, and applies pressure at least twice as long as usual after any puncture is performed.

During the recovery phase, the nurse collaborates with the primary provider about the patient's appropriate activity level based on the patient's condition. Generally, every effort is made to encourage the patient to move the extremity to stimulate circulation and prevent stasis. Anticoagulant therapy may be continued postendovascular intervention to prevent thrombosis of the affected artery and to diminish the development of subsequent thrombi at the initiating site. The nurse assesses for evidence of local and systemic hemorrhage, including mental status changes, which can occur when anticoagulants are given. Pulses, Doppler signals, ABI, and motor and sensory function are assessed every hour for the first 24 hours, because significant changes may indicate reocclusion. Metabolic abnormalities, acute kidney injury, and compartment syndrome may be complications after an acute arterial occlusion.

Raynaud's Phenomenon and Other Acrosyndromes

Raynaud's phenomenon is a form of intermittent arteriolar vasoconstriction that results in coldness, pain, and pallor of the fingertips or toes. There are two forms of this disorder. Primary or idiopathic Raynaud's (Raynaud's disease) occurs in the absence of an underlying disease. Secondary Raynaud (Raynaud syndrome) occurs in association with an underlying disease, usually a connective tissue disorder, such as systemic lupus erythematosus, rheumatoid arthritis, or scleroderma; trauma; or obstructive arterial lesions. Symptoms may result from a defect in basal heat production that eventually decreases the ability of cutaneous vessels to dilate. Episodes may be triggered by emotional factors, stress, or by unusual sensitivity to cold. Raynaud's phenomenon is five times more common in women with the typical onset before age 30 (Dean, 2018). Acrocyanosis has been thought to be a variant of Raynaud's phenomenon because both are aggravated by cold and emotional stress and both present with blue discoloration of the fingers and hyperhidrosis (excessive sweating).

The prognosis for patients with Raynaud's phenomenon varies; some slowly improve, some become progressively worse, and others show no change. Raynaud symptoms may be mild so that treatment is not required. However, secondary Raynaud is characterized by vasospasm and fixed blood vessel obstructions that may lead to ischemia, ulceration, and gangrene. Acrocyanosis is a poorly understood phenomenon that may be benign and require little or no treatment, or the patient may have chronic pain and ulcerations.

Clinical Manifestations

The classic clinical picture of Raynaud reveals pallor brought on by sudden vasoconstriction. The skin then becomes cyanotic because of pooling of deoxygenated blood during vasospasm. As a result of hyperemia (exaggerated reflow) due to vasodilation, rubor is produced when oxygenated blood returns to the digits after the vasospasm stops. The characteristic sequence of color change of Raynaud's phenomenon is described as white, blue, and red. Numbness, tingling, and burning pain occur as the color changes. The manifestations tend to be bilateral and symmetric and may involve toes and fingers.

Acrocyanosis is differentiated from Raynaud by a relative persistence of skin color changes, symmetry, and an absence of the paroxysmal pallor that is found with Raynaud. Almost all patients with acrocyanosis have marked clamminess and hyperhidrosis of their hands and feet, which tend to worsen in warmer temperatures while the color changes improve. Finger color normalizes when the hands are transferred from the dependent to horizontal position (Dean, 2018).

Medical Management

Avoiding the particular stimulus (e.g., cold, nicotine) that provokes vasoconstriction is a primary factor in controlling Raynaud's phenomenon. Decongestants and other over-the-counter preparations containing sympathomimetics should be avoided. Calcium channel blockers (nifedipine, amlodipine) may be effective in relieving symptoms. Sympathectomy (interrupting the sympathetic nerves by removing the sympathetic ganglia, or blocking or dividing their branches) may help some patients.

Avoidance of exposure to cold and trauma and implementing measures to improve local circulation are the primary focus of treatment for acrocyanosis. Calcium channel blockers have not been effective in treating acrocyanosis (Belch, Carlizza, Carpentier, et al., 2017).

Nursing Management

The nurse instructs the patient with Raynaud or acrocyanosis to avoid situations that may be stressful or unsafe. Stress management strategies may be helpful. Exposure to cold must be minimized, and in areas where the fall and winter months are cold, the patient should wear layers of clothing when outdoors. Hats and gloves or mittens should be worn at all times when outside. Fabrics specially designed for cold climates (e.g., Thinsulate™) are recommended. Patients should wear gloves when accessing freezers. Patients should warm up their vehicles before getting in so that they can avoid touching a cold steering wheel or door handle, which could elicit an attack. During summer, a sweater should be available when entering air-conditioned rooms.

Patients are often concerned about serious complications, such as gangrene and amputation; however, these complications are uncommon unless the patient has another underlying disease causing arterial occlusions. Patients should avoid all forms of nicotine, which may induce attacks; this includes nicotine gum or patches used to aid smoking cessation.

Patients should be cautioned to handle sharp objects carefully to avoid injuring their fingers. In addition, patients should be informed about the orthostatic hypotension that may result from medications, such as calcium channel blockers, used to treat Raynaud's phenomenon.

VENOUS DISORDERS

Venous disorders cause a reduction in venous blood flow, which results in stasis of blood. This may then cause a host of pathologic changes, including coagulation defects, edema, tissue breakdown, and an increased susceptibility to infections.

Venous Thromboembolism

Deep vein thrombosis (DVT) and pulmonary embolism (PE) collectively make up the condition called **venous thromboembolism (VTE).** The annual incidence of VTE is estimated at 1 to 2 per 1000 population (Peñaloza-Martínez, Demelo-Rodríguez, Proietti, et al., 2018; Serhal & Barnes, 2019). The incidence of VTE is 10% to 20% in general medical patients and up to 80% in critically ill patients. VTE is frequently not diagnosed because DVT and PE are often clinically silent or asymptomatic. It is estimated that as many as 30% of patients hospitalized with VTE develop long-term postthrombotic complications. In surgical patients, most symptomatic thromboembolic complications occur after hospital discharge due to shorter lengths of stay (Stubbs, Assareh, Curnow, et al., 2018).

COVID-19 Considerations

An underlying cause of death in patients with severe coronavirus disease 2019 (COVID-19) has been linked to VTE or primary pulmonary thrombi. The majority of patients who are severely ill with COVID-19 have a markedly elevated D-dimer assay (blood test for evidence of blood clots) and a presumed prothrombotic state. Because of this, routine thromboprophylaxis of all hospitalized patients with COVID-19 is recommended regardless of their risk score (see later discussion) (Obi, Barnes, Wakefield, et al., 2020). The systemic inflammatory changes in the vascular system in patients with COVID-19 likely contribute to thrombosis, hemodynamic instability, and autonomic dysregulation. Early reports suggest long-term cardiovascular effects of COVID-19 may include accelerated atherosclerosis, VTE, arterial thromboembolic disease, and aortic aneurysm formation (Becker, 2020).

Pathophysiology

Superficial veins, such as the greater saphenous, short saphenous (also known as lesser saphenous), cephalic, basilic, and external jugular veins, are thick-walled muscular structures that lie just under the skin. In contrast, deep veins are thin walled and have less muscle in the media. Deep veins run parallel to arteries and bear the same names as the arteries. Deep and superficial veins have valves that permit unidirectional flow back to the heart. The valves lie at the base of a segment of vein that is expanded into a sinus. This arrangement enables the valves to open without coming into contact with the wall of the vein, thus permitting rapid closure when the blood starts to flow backward. Other types of veins are known as perforating veins. These veins have valves that allow one-way blood flow from the superficial venous system to the deep venous system.

Although the exact cause of VTE remains unclear, three factors, known as Virchow triad, are believed to play a significant role in its development: endothelial damage, venous stasis, and altered coagulation (see Chart 26-8). Damage to the intimal lining of blood vessels creates a site for clot formation. Direct trauma to the veins may occur with fractures or dislocation, diseases of the veins, and chemical irritation of the vein from IV medications or solutions. Venous stasis occurs when blood flow is reduced, as in heart failure or shock; when veins are dilated, as an effect of some medication therapies; and when skeletal muscle contraction is reduced, as in immobility, paralysis of the extremities, or anesthesia. Altered coagulation occurs most commonly in patients for whom anticoagulant medications have been abruptly withdrawn. Oral contraceptive use, elevated CRP levels (Cauci, Francescato, Colannino, et al., 2020), and several blood dyscrasias (abnormalities) also can lead to hypercoagulability, with prevalence depending on the ethnicity of the patient. For example, factor V Leiden and prothrombin G20210A mutation is more prevalent in White persons, whereas antithrombin III deficiency, protein C deficiency, and protein S deficiency are found more commonly in patients of Southeast Asian descent (Sidawy & Perler, 2019). An increase in factor VIII concentrations is more common among African Americans (Folsom, Basu, Hong, et al., 2019). Pregnancy is also considered a hypercoagulable state, as it is accompanied by an increase in circulating clotting factors that may not return to baseline until longer than 6 weeks postpartum, increasing the risk of thrombosis. In addition, during pregnancy there is a 50% decrease in venous outflow due to hormonally decreased venous capacitance and reduced venous outflow due to compression from the uterus (Zheng, Chen, Fu, et al., 2019).

Chart 26-8 **RISK FACTORS**

Deep Vein Thrombosis and Pulmonary Embolism

Endothelial Damage

- Central venous catheters
- Dialysis access catheters
- Local vein damage
- Pacing wires
- Repetitive motion injury
- Surgery
- Trauma

Venous Stasis

- Age (>65 years)
- Bed rest or immobilization
- Heart failure
- History of varicosities
- Obesity
- Spinal cord injury

Altered Coagulation

- Antiphospholipid antibody syndrome
- Antithrombin III deficiency
- Cancer
- Elevated factors II, VIII, IX, XI
- Factor V Leiden defect
- Hyperhomocysteinemia
- Oral contraceptive use
- Polycythemia
- Pregnancy
- Protein C deficiency
- Protein S deficiency
- Prothrombin G20210A defect
- Septicemia

Adapted from Patel, K., Fasanya, A., Yadam, S., et al. (2017). Pathogenesis and epidemiology of venous thromboembolic disease. *Critical Care Nursing Quarterly*, *40*(3), 191–200.

Deep Vein Thrombosis

Deep vein thrombosis (DVT) refers to thrombus formation in the deep veins, usually in the thigh or calf, but sometimes in the arm (e.g., patients with peripherally inserted central catheters).

Pathophysiology

Formation of a thrombus frequently accompanies phlebitis, which is an inflammation of the vein walls. When a thrombus develops initially in the veins as a result of stasis or hypercoagulability but without inflammation, the process is referred to as phlebothrombosis. Venous thrombosis can occur in any vein, but it occurs more often in the veins of the lower extremities. The superficial and deep veins of the extremities may be affected.

Upper extremity venous thrombosis accounts for 5% to 10% of all cases of DVT, but its incidence may be as high as 93% in the presence of central venous cannulation or upper extremity compression (Mintz & Levy, 2017). It typically involves more than one venous segment, with the subclavian vein the most frequently affected. In addition, upper extremity venous thrombosis is more common in patients with IV catheters or in patients with an underlying disease that causes hypercoagulability, such as cancer. Internal trauma to the vessels may result from pacemaker leads, chemotherapy ports, dialysis catheters, or parenteral nutrition lines. The lumen of the vein may be decreased as a result of the catheter or from external compression, such as by neoplasms or an extra cervical rib. Effort thrombosis, also known as Paget–Schroetter syndrome, of the upper extremity is caused by repetitive motion (e.g., as seen in competitive swimmers, tennis players, baseball players, weight lifters, or construction workers) that irritates the vessel wall, causing inflammation and subsequent thrombosis and is a manifestation of venous thoracic outlet syndrome where the veins becomes distorted and narrowed (Sidawy & Perler, 2019).

Venous thrombi are aggregates of platelets attached to the vein wall that have a tail-like appendage containing fibrin, white blood cells, and many red blood cells. The “tail” can grow or can propagate in the direction of blood flow as successive layers of the thrombus form. A propagating venous thrombosis is dangerous because parts of the thrombus can break off and occlude the pulmonary blood vessels. Fragmentation of the thrombus can occur spontaneously as it dissolves naturally, or it can occur with an elevated venous pressure, as may occur after standing suddenly or engaging in muscular activity after prolonged inactivity. After an episode of acute DVT, reestablishment of the lumen of the vessel, or recanalization, typically occurs. Lack of recanalization within the first 6 months after DVT appears to be an important predictor of postthrombotic syndrome, which is one complication of venous thrombosis (Sidawy & Perler, 2019) (see later discussion). Other complications of venous thrombosis are listed in Chart 26-9.

Clinical Manifestations

A major challenge in recognizing DVT is that the signs and symptoms are nonspecific. The exception is phlegmasia cerulea dolens (massive iliofemoral venous thrombosis), in which the entire extremity becomes massively swollen, tense, painful, and cool to the touch. The large DVT creates severe and sudden venous hypertension that leads to tissue ischemia with resultant translocation of fluid into the interstitial space. Venous gangrene occurs in 20% to 50% of cases and is associated with poor survival (Sidawy & Perler, 2019).

Chart 26-9

Complications of Venous Thrombosis

Chronic venous occlusion
Pulmonary emboli from dislodged thrombi
Valvular destruction:

- Chronic venous insufficiency
- Increased venous pressure
- Varicosities
- Venous ulcers

Venous obstruction:

- Edema
- Fluid stasis
- Increased distal pressure
- Venous gangrene

Adapted from Kahn, S. R., Galanaud, J. P., Vedantham, S., et al. (2016). Guidance for the prevention and treatment of the post-thrombotic syndrome. *Journal of Thrombosis and Thrombolysis*, *41*(1), 144–153.

Deep Veins

Clinical manifestations of obstruction of the deep veins include edema and swelling of the extremity because the outflow of venous blood is inhibited. The affected extremity may feel warmer than the unaffected extremity, and the superficial veins may appear more prominent. Tenderness, which usually occurs later, is produced by inflammation of the vein wall and can be detected by gently palpating the affected extremity. In some cases, signs and symptoms of a PE are the first indication of DVT.

Superficial Veins

Thrombosis of superficial veins, or superficial thrombophlebitis, produces pain or tenderness, redness, and warmth in the involved area. The risk of the superficial venous thrombi becoming dislodged or fragmenting into emboli is

very low because most of them dissolve spontaneously. This condition can be treated at home with bed rest, elevation of the leg, analgesic agents, and possibly, anti-inflammatory medication.

Assessment and Diagnostic Findings

Careful assessment is invaluable in detecting early signs of venous disorders of the lower extremities (see Chart 26-8). Diagnostic tests for VTE include laboratory and venous duplex studies. Laboratory tests are conducted to determine baseline levels and include complete blood count (CBC) and coagulation studies that include prothrombin time (PT), activated partial thromboplastin time (aPTT), and international normalized ratio (INR). If an underlying hypercoagulable state is suspected, additional laboratory testing may include CRP, factor V Leiden, prothrombin G20210A mutation, antithrombin III, protein C, and protein S (Fischbach & Fischbach, 2018). Duplex ultrasound findings may show veins that appear larger than normal with thrombus formation or veins that are incompressible and dilated. The thrombus may appear to be adherent to the vein wall or mobile with a thrombus tail.

Prevention

Patients with a prior history of VTE are at increased risk of a new episode; the rate of recurrence can be as high as 13.7% in men and 14.1% in women (Serhal & Barnes, 2019). VTE can be prevented, especially if patients who are considered at high risk are identified and preventive measures are instituted without delay. Preventive measures include encouragement of early ambulation and leg exercises, the application of graduated compression stockings, and the use of intermittent pneumatic compression devices (see later discussion). An additional method to prevent venous thrombosis in surgical patients is administration of subcutaneous unfractionated heparin or low-molecular-weight heparin (LMWH). Patients should be advised to make lifestyle changes as appropriate, which may include weight loss, smoking cessation, and regular exercise.

Medical Management

The objectives of treatment for DVT are to prevent the thrombus from extending and fragmenting (thus risking PE), recurrent thromboemboli, and postthrombotic syndrome (discussed later in the chapter) (Peñaloza-Martínez et al., 2018). Anticoagulant therapy involves the administration of a medication to delay the clotting time of blood, prevent the formation

of a thrombus in postoperative patients, and forestall the extension of a thrombus after it has formed; it can be used to meet the treatment goals for DVT (Witt, Nieuwlaat, Clark, et al., 2018). However, anticoagulant agents cannot dissolve a thrombus that has already formed. Combining anticoagulation with mechanical thrombectomy and ultrasound-guided thrombolytic therapy may eliminate venous obstruction, maintain venous patency, and prevent postthrombotic syndrome by early removal of the thrombus (Kruger, Eikelboom, Douketis, et al., 2019).

Pharmacologic Therapy

Medications for preventing or reducing blood clotting within the vascular system are indicated in patients diagnosed with DVT. These medications are also indicated for patients with thrombophlebitis, recurrent embolus formation, persistent leg edema from heart failure, and in select patients who must be immobilized for a protracted time (e.g., older adults with hip fractures). The primary pharmacologic treatment for the prevention and management of DVT is anticoagulant therapy which consists of vitamin K antagonists (e.g., warfarin), indirect and direct thrombin inhibitors, and factor Xa inhibitors (see Table 26-2).

Endovascular Management

Endovascular management is necessary for DVT when anticoagulant or thrombolytic therapy is contraindicated, the danger of PE is extreme, or venous drainage is so severely compromised that permanent damage to the extremity is likely. A thrombectomy may be necessary. This mechanical method of clot removal may involve using intraluminal catheters with a balloon or other devices. Some of these spin to break the clot, and others use oscillation to break up the clot to facilitate removal. Ultrasound-assisted thrombolysis may be another option. This intervention uses bursts or continuous high-frequency ultrasound waves emanating from the catheters to cause cavitation of the thrombus, making it more permeable to the thrombolytic agent (Kruger et al., 2019). A vena cava filter may be placed at the time of the thrombectomy or thrombolysis; this filter traps large emboli and prevents PE (see later discussion). Retrievable caval filters can be left in place and retrieved up to 6 months after placement. In patients with chronic iliac vein compression (e.g., as is seen in May–Thurner syndrome), balloon angioplasty with stent placement may successfully treat the patient's chronic leg symptoms (Ignatyev, Pokrovsky, & Gradusov, 2019).

Nursing Management

When performing the nursing assessment, key concerns include limb pain, a feeling of heaviness, functional impairment, ankle engorgement, and edema; increase in the surface temperature of the leg, particularly the calf or ankle; and areas of tenderness or superficial thrombosis (i.e., cordlike venous segment). The amount of swelling in the extremity can be determined by measuring the circumference of the affected extremity at various levels (i.e., thigh to ankle) with a tape measure and comparing one extremity with the other at the same level to determine size differences. If both extremities are swollen, a size difference may be difficult to detect. Homan sign (pain in the calf after the foot is sharply dorsiflexed) is *not* a reliable sign of DVT because it can be elicited in any painful condition of the calf and has no clinical value in assessment for DVT.

Assessing and Monitoring Anticoagulant Therapy

If the patient is receiving anticoagulant therapy, the nurse monitors laboratory values as indicated. The aPTT, PT, INR, ACT, hemoglobin and hematocrit values, platelet count, and fibrinogen levels can be affected, depending on the anticoagulant prescribed; baseline assessments before the initiation of therapy should be performed. Close observation is required to detect bleeding; if bleeding occurs, it must be reported immediately and anticoagulant therapy reversed or discontinued if appropriate (see Table 26-2).

Monitoring and Managing Potential Complications

Potential complications of anticoagulant therapy consist of bleeding, thrombocytopenia, and drug–drug interactions. The nurse should monitor for these potential complications, be familiar with medications approved to reverse effects of various anticoagulants, and educate patients and caregivers on ways to reduce these potential risks (see Table 26-2 and Chart 26-10).

Reducing Discomfort

Elevation of the affected extremity, graduated compression stockings (see later discussion), and analgesic agents for pain relief are adjuncts to therapy. They help improve circulation and increase comfort. Warm

packs applied to the affected extremity reduce the discomfort associated with DVT.

Positioning the Body and Encouraging Exercise

When the patient is on bed rest, the feet and lower legs should be elevated periodically above the level of the heart. This position allows the superficial and tibial veins to empty rapidly and to remain collapsed. Active and passive leg exercises, particularly those involving calf muscles, should be performed to increase venous flow. Early ambulation is most effective in preventing venous stasis. The patient is encouraged to walk once anticoagulation therapy has been initiated and is advised that walking is better than standing or sitting for long periods. Once ambulatory, the patient is instructed to avoid sitting for more than an hour at a time. The goal is to walk at least 10 minutes every 1 to 2 hours. The patient is also instructed to perform active and passive leg exercises as frequently as necessary when they cannot ambulate, such as during long car, bus, train, and plane trips. In addition, deep breathing exercises are beneficial because they produce increased negative pressure in the thorax, which assists in emptying the large veins.

TABLE 26-2 Select Anticoagulant and Thrombolytic Agents Prescribed to Treat Venous Thromboemboli (VTE)

Medication	Mechanism of Action	Actions and Effects	Nursing Considerations
Unfractionated Heparin			
Heparin	Binds to antithrombin; inactivates clotting factors XII, Xa; half-life of 60–90 min	Prevent extension of thrombus Prevent development of new thrombus	Can be administered subcutaneously or intermittently or continuous intravenously (IV); IV dosing is weight based Administer continuous IV infusions using an electronic infusion device Requires monitoring of aPTT and platelet count; monitor platelet counts for HIT Assess patient for bleeding Administer protamine sulfate for overdose or to reverse effects, as prescribed; monitor patient for hypotension and bradycardia if administered
Low-Molecular-Weight Heparin (LMWH)			
Dalteparin Enoxaparin	Inhibit factor Xa	Prevent extension of thrombus Prevent development of new thrombus	Can be administered subcutaneously once daily or twice a day Associated with fewer bleeding complications than unfractionated heparin Has lower risk of HIT Administer protamine sulfate for overdose or to reverse effects, as prescribed; monitor patient for hypotension and bradycardia if administered; protamine sulfate is less effective in reversing LMWH compared to unfractionated heparin Can be used in pregnancy if clearly indicated; however, patients should be monitored closely for bleeding
Oral Anticoagulant			
Warfarin	Vitamin K	Has narrow	Administer once a day at the

	antagonist inhibits synthesis of vitamin K–dependent clotting factors: II, VII, IX, X Inhibits synthesis of vitamin K–dependent proteins: protein C and protein S	therapeutic window Has slow onset of action Anticoagulant effect occurs 12–24 h after first dose Antithrombotic effect occurs 2–7 days after first dose	same time each day Requires routine monitoring of PT with goal of 1.5–2 times normal; and INR with goal of 2.0–3.0 Requires administration with heparin during drug initiation until desired anticoagulation is achieved Monitor for food and drug–drug interactions (see Chart 26-10) Assess patient for bleeding Administer vitamin K, fresh-frozen plasma, or prothrombin complex concentrate as prescribed for overdose or to reverse effects Requires periprocedural bridging (i.e., giving a short-acting anticoagulant, usually heparin or LMWH, if warfarin needs to be temporarily discontinued) Contraindicated in pregnancy
Factor Xa Inhibitor			
Fondaparinux	Selective inhibitor of factor Xa	Prevent DVT or PE in patients undergoing orthopedic surgery (e.g., hip or knee arthroplasty) Treatment of DVT or PE Excreted unchanged via kidneys Does not affect aPTT or ACT	Administer subcutaneously once daily Use with caution in patients with renal insufficiency Monitor creatinine Routine coagulation tests are not necessary
Oral Direct Factor Xa Inhibitor			
Rivaroxaban	Direct inhibitor of factor Xa	Fixed-dose regimen for	Administer once or twice daily as prescribed based on indication

		treatment of DVT and PE Fixed-dose regimen to prevent recurrent DVT and PE Not indicated for patients with creatinine clearance less than 30 mL/min	Assess renal function Alter dose in individuals with obesity May require periprocedural bridging Administer andexanet alfa or activated charcoal as prescribed for overdose or to reverse effects
Apixaban		Fixed-dose regimen for treatment of DVT and PE Fixed-dose regimen to prevent recurrent DVT and PE Not indicated for patients with creatinine clearance less than 25 mL/min.	Administer twice a day Assess renal function Alter dose in patients 80 yrs of age or older and weight ≤60 kg Administer andexanet alfa or activated charcoal as prescribed for overdose or to reverse effects
Edoxaban		Fixed-dose regimen for treatment of DVT and PE	Administer once daily Assess renal function Alter dose for patients who weigh ≤60 kg
Betrixaban		Prevent DVT and PE in adults hospitalized for acute medical illness	Administer once daily Assess renal function No antidote available to reverse effects
Direct Thrombin Inhibitor			
Argatroban Lepirudin	Reversibly binds to thrombin active site, inhibiting thrombin-	Prevention and treatment of thrombosis in patients with HIT or at risk	Administer as an IV bolus followed by a continuous infusion Assess hepatic function Monitor aPTT and ACT

	mediated stimulation of coagulation factors	for HIT during PCI	
Oral Direct Thrombin Inhibitor			
Dabigatran	Reversibly binds to thrombin active site, inhibiting thrombin-mediated stimulation of coagulation factors	Fixed-dose regimen for treatment of DVT Fixed-dose regimen to prevent recurrent DVT Not indicated for patients with creatinine clearance <30 mL/min	Administer twice a day Assess renal function Routine coagulation tests are not necessary; however if measured, aPTT levels may be prolonged 1.5–2 times normal Administer idarucizumab as prescribed to reverse effects
Thrombolytic			
Alteplase Reteplase Tenecteplase Urokinase	Binds to fibrin within the thrombus converting plasminogen to plasmin. Plasmin degrades fibrin, fibrinogen, and factors V, VIII, and XII.	Lyse and dissolve existing thrombus	Monitor lab values prior to initiation: CBC, platelets, aPTT; repeat during and post therapy Monitor for bleeding and hemorrhage Contraindicated with active bleeding

ACT, activated clotting time; aPTT, activated partial thromboplastin time; CBC, complete blood count; DVT, deep vein thrombosis; HIT, heparin-induced thrombocytopenia; INR, international normalized ratio; PCI, percutaneous coronary intervention; PE, pulmonary emboli; PT, prothrombin time; PTT, partial thromboplastin time.

Adapted from Cohen, A. T., Lip, G. Y., De Caterina, R., et al. (2018). State of play and future direction with NOACs: An expert consensus. *Vascular Pharmacology*, *106*, 9–21; Comerford, K. C., & Durkin, M. T. (Eds.). (2020). *Nursing2020 Drug Handbook*. Philadelphia, PA: Wolters Kluwer; Kruger, P. C., Eikelboom, J. W., Douketis, J. D., et al. (2019). Deep vein thrombosis:

Update on diagnosis and management. *Medical Journal of Australia*, *210*(11), 516–524; Peñaloza-Martínez, E., Demelo-Rodríguez, P., Proietti, M., et al. (2018). Update on extended treatment for venous thromboembolism. *Annals of Medicine*, *50*(8), 666–674; Serhal, M., & Barnes, G. D. (2019). Venous thromboembolism: A clinician update. *Vascular Medicine*, *24*(2), 122–131.

Chart 26-10 **PATIENT EDUCATION**

Taking Anticoagulant Medications

The nurse instructs the patient as follows:

- Take anticoagulation medication as prescribed.
- Do not stop taking your anticoagulation medication unless directed.
- If prescribed warfarin, take at the same time each day.
- Wear or carry identification indicating anticoagulant medication being taken.
- Keep all scheduled appointments for blood tests.
- Be aware that other medications may affect the action of the anticoagulant medication; if taking warfarin, consult with your health care provider before taking any of the following medications or supplements: vitamins, cold medicines, antihistamines, antibiotics, aspirin, laxatives, and anti-inflammatory agents, such as ibuprofen, and similar medications or herbal or nutritional supplements. Your primary provider should be contacted before taking any over-the-counter drugs.
- Avoid alcohol if taking warfarin because it may change the body's response to the warfarin. There are no interactions with the oral factor Xa inhibitors (e.g., rivaroxaban, apixaban, edoxaban) and alcohol.
- Avoid marked changes in eating habits, especially involving foods high in vitamin K, such as green leafy vegetables, which can reduce anticoagulation effectiveness if taking warfarin; dietary habits have no interactions with the oral factor Xa inhibitors.
- When seeking treatment from any health care provider, be sure to inform them that you are taking an anticoagulant medication.
- Contact your provider who manages your anticoagulation therapy before having dental work or surgery.
- Describe potential side effects of coagulation, such as bruising and bleeding, and identify ways to prevent bleeding.
  - Avoid the use of sharps (razors, knives, etc.) to prevent cuts; shave with an electric shaver.
  - Use a toothbrush with soft bristles to prevent gum injury.
  - Avoid contact sports or activities that may result in an injury that causes bleeding.
- If taking warfarin, report the following immediately to your primary provider:
  - Any bleeding—for example, cuts that do not stop bleeding

- Bruises that enlarge, nosebleeds, or unusual bleeding from any part of the body
- Reddish or brownish urine
- Red or black bowel movements

- *For women:* Notify your primary provider and obstetrical provider if you suspect pregnancy.

Promoting Home, Community-Based, and Transitional Care

In addition to instructing the patient on how to apply graduated compression stockings as indicated (see later discussion) and explaining the importance of elevating the legs and exercising adequately, the nurse provides education about the prescribed anticoagulant, its purpose, and the need to take the correct amount at the specific times, especially if warfarin is prescribed (see Chart 26-10). The patient should also be aware that if warfarin is prescribed, periodic blood tests are necessary to determine if a change in medication or dosage is required. If the patient fails to adhere to the therapeutic regimen, continuation of the medication therapy should be questioned. In patients with liver disease, the potential for bleeding may be exacerbated by anticoagulant therapy.

Pulmonary Embolism

Pulmonary embolism (PE) refers to the obstruction of the pulmonary artery or one of its branches by a thrombus (or thrombi) that originate(s) somewhere in the venous system or in the right side of the heart.

Pathophysiology

Most commonly, PE is due to a dislodged or fragmented DVT (see previous pathophysiology discussion in DVT). However, there are other types of emboli that may be implicated: air, fat, amniotic fluid, and septic (from bacterial invasion of the thrombus) (Norris, 2019).

A PE is described as an occlusion of the outflow tract of the main pulmonary artery or of the bifurcation of the pulmonary arteries. Multiple small emboli can lodge in the terminal pulmonary arterioles, producing multiple small infarctions of the lungs. A pulmonary infarction causes ischemic necrosis of part of the lung (Thompson & Kabrhel, 2020).

When a thrombus completely or partially obstructs a pulmonary artery or its branches, the alveolar dead space is increased. The area, although continuing to be ventilated, receives little or no blood flow. Therefore, gas exchange is impaired or absent in this area. In addition, various substances are released from the clot and surrounding area that cause regional blood vessels and bronchioles to constrict. This results in an increase in pulmonary vascular resistance—a reaction that compounds the ventilation–perfusion (V./Q.) imbalance that ensues.

The hemodynamic consequences are increased pulmonary vascular resistance due to the regional vasoconstriction and reduced size of the pulmonary vascular bed. In severe instances, this may result in an increase in pulmonary arterial pressure and, in turn, an increase in right ventricular work to maintain pulmonary blood flow. When the work requirements of the right ventricle exceed its capacity, right ventricular failure occurs, leading to a decrease in cardiac output followed by a decrease in systemic blood pressure and the development of shock (Norris, 2019).

Clinical Manifestations

Symptoms of PE depend on the size of the thrombus and the area of the pulmonary artery occluded by the thrombus; they may be nonspecific. Dyspnea is the most frequent symptom; the duration and intensity of the dyspnea depend on the extent of embolization. Chest pain is common and is usually sudden and pleuritic in origin; however, it may be substernal and may mimic angina (Thompson & Kabrhel, 2020). Other symptoms include anxiety, fever, tachycardia, apprehension, cough, diaphoresis, hemoptysis, and syncope. The most frequent sign is tachypnea (rapid respiratory rate) (De Palo, 2020).

In many instances, PE causes few signs and symptoms, whereas in other instances, it mimics various other cardiopulmonary disorders (e.g., pneumonia, heart failure). Obstruction of the pulmonary artery can result in pronounced dyspnea, sudden substernal pain, rapid and weak pulse, shock, syncope, and sudden death (Thompson & Kabrhel, 2020).

Assessment and Diagnostic Findings

Because the symptoms of PE can vary from few to severe, a diagnostic workup is performed to rule out other diseases. The initial diagnostic workup may include chest x-ray, ECG, pulse oximetry, arterial blood gas

analysis, D-dimer assay and MDCTA or pulmonary arteriogram or V./Q. scan. The chest x-ray is usually normal but may show infiltrates, atelectasis, elevation of the diaphragm on the affected side, or a pleural effusion. The chest x-ray is most helpful in excluding other possible causes. In addition to sinus tachycardia, the most frequent ECG abnormality is nonspecific ST-T wave abnormalities. If an arterial blood gas analysis is performed, it may show hypoxemia and hypocapnia (from tachypnea); however, arterial blood gas measurements may be normal even in the presence of PE (De Palo, 2020).

MDCTA is the criterion standard for diagnosing PE. The MDCTA can be performed quickly and provides the advantage of high-quality visualization of the lung parenchyma (Weinberger, Cockrill, & Mandel, 2019). If MDCTA is not available, pulmonary angiography is considered a reasonable alternative diagnostic method (Ouellette, 2019). The pulmonary angiogram allows for direct visualization under fluoroscopy of the arterial obstruction and accurate assessment of the perfusion deficit. A specially trained team must be available to perform the procedure, in which a catheter is threaded through the vena cava to the right side of the heart to inject dye, similar to a cardiac catheterization.

The V./Q. scan continues to be used to diagnose PE, especially in facilities that do not use pulmonary angiography or do not have access to MDCTA. The V./Q. scan is minimally invasive and requires IV administration of a contrast agent. This scan evaluates different regions of the lung (upper, middle, lower) and allows comparisons of the percentage of V./Q. in each area. This test has a high sensitivity but is not as accurate as an MDCTA or pulmonary angiogram (De Palo, 2020).

Medical Management

Medical management of the patient with PE revolves around whether the patient is diagnosed with a hemodynamically unstable PE (also called a *massive PE*) or a stable PE. The patient with a hemodynamically unstable PE, which comprises a life-threatening emergency, may evidence hypotension, tachycardia, confusion, and cardiovascular collapse.

Medical Management of Unstable Pulmonary Embolism

The immediate objective is to stabilize the cardiopulmonary system in the patient with a hemodynamically unstable PE. A sudden increase in

pulmonary resistance increases the work of the right ventricle, which can cause acute right-sided heart failure with cardiogenic shock. Emergent measures are initiated to improve respiratory and cardiovascular status (see Chapter 11 for discussion of management of the patient in shock).

After emergency measures have been initiated, the treatment goal is to lyse (dissolve) the existing embolus and prevent new ones from forming. Thrombolytic therapy with t-PA or other agents such as reteplase (see Table 26-2) is used in treating unstable PE, particularly in patients who are severely compromised (e.g., those who are hypotensive and have significant hypoxemia despite oxygen supplementation) (Ouellette, 2019). Thrombolytic therapy lyses the thrombi or emboli quickly and restores hemodynamic functioning of the pulmonary circulation, thereby reducing pulmonary hypertension and improving perfusion, oxygenation, and cardiac output. However, the risk of bleeding is significant. Contraindications to thrombolytic therapy include having had a stroke within the past 2 months, other active intracranial processes, active bleeding, surgery within 10 days of the thrombotic event, recent labor and delivery, trauma, or severe hypertension. Consequently, thrombolytic agents are advocated only for PE affecting a significant area of blood flow to the lung and causing hemodynamic instability (Tapson & Weinberg, 2020).

Before thrombolytic therapy is started, INR, aPTT, hematocrit, and platelet counts are obtained. Any anticoagulant is stopped prior to administration of a thrombolytic agent. During therapy, all but essential invasive procedures are avoided because of potential bleeding. After the thrombolytic infusion is completed (which varies in duration according to the agent used), maintenance anticoagulation therapy is initiated.

A surgical embolectomy is rarely performed but may be indicated if there are contraindications to thrombolytic therapy. Embolectomy can be performed using catheters or surgically. Surgical removal must be performed by a cardiovascular surgical team with the patient on cardiopulmonary bypass (Ouellette, 2019).

For patients who have recurrent PE despite therapeutic anticoagulation, an inferior vena cava (IVC) filter may be inserted (Tapson, 2019). IVC filters are not recommended for the initial treatment of patients with PE and should not be used in patients receiving anticoagulants. The IVC filter provides a screen in the IVC, allowing blood to flow unobstructed while large emboli from the pelvis or lower extremities are blocked or fragmented before reaching the lung.

Numerous devices have been developed since the introduction of the original Greenfield filter (see Fig. 26-14).

Medical Management of Stable Pulmonary Embolism

In patients with PE who do not demonstrate any cardiopulmonary instability (e.g., normotensive, no evidence of hypoxemia) immediate anticoagulation is indicated to prevent recurrence or extension of the thrombus and may continue for 10 days (Tapson, 2019). Long-term anticoagulation is also indicated up to 6 months following the PE and is critical in preventing recurrence of VTE. This duration may be extended indefinitely in patients who are at high risk for recurrence (Weinberger et al., 2019).

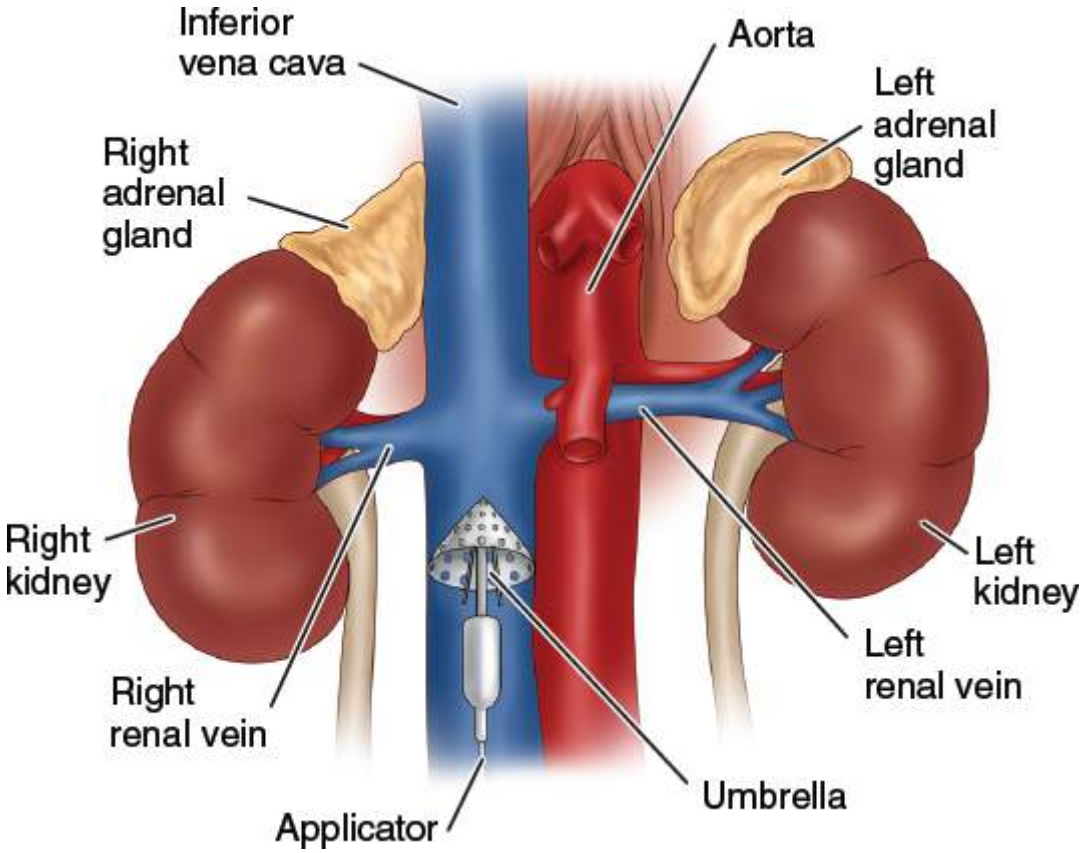

Figure 26-14 • An umbrella filter is in place in the inferior vena cava to prevent PE. The filter (compressed within an applicator catheter) is inserted through an incision in the right internal jugular vein. The applicator is withdrawn when the filter fixes itself to the wall of the inferior vena cava after ejection from the applicator.

In patients with stable PE, the initial anticoagulant selected may include an LMWH (e.g., enoxaparin), unfractionated heparin, or a direct oral anticoagulant (DOAC), such as a direct thrombin inhibitor (e.g., dabigatran), or a factor Xa inhibitor (e.g., fondaparinux, rivaroxaban, apixaban, edoxaban) (Tapson & Weinberg, 2020) (see Table 26-2).

In select patients with PE who are hemodynamically stable, outpatient therapy can be started by administering the first dose in the emergency department or urgent care center and the remaining doses given at home. Although there are not specific selection criteria for outpatient treatment, the patient is usually at low risk of death, has no respiratory or hemodynamic compromise, does not require opioids for pain control, has no risk factors for bleeding, has no serious comorbid conditions, and has stable baseline mental status with a good understanding of the benefits and risks of treatment (Tapson, 2019). The ideal agent for outpatient administration is not empirically confirmed, although the DOACs are often prescribed.

Long-term treatment options include warfarin and the DOACs. An LMWH may also be selected but is usually not prescribed for long-term therapy since it is given via a subcutaneous injection. Warfarin dosing requires regular blood draws for INR monitoring and has a higher bleeding risk, but it has long been the standard of care prior to the development of DOACs. An antidote (vitamin K) is available if the INR is high and there is a risk of bleeding. Warfarin does have interactions with several medications (see Chart 26-10) and has dietary restrictions. DOACs do not require regular blood test monitoring; however, they are more costly than warfarin. The choice of warfarin versus a DOAC is dependent upon risk of bleeding, cost, presence of comorbidities, and provider preference (The Joint Commission [TJC], 2019).

Nursing Management

Monitoring Thrombolytic Therapy

The nurse is responsible for monitoring the patient's response to thrombolytic and anticoagulant therapy. During the thrombolytic infusion, while the patient remains on bed rest, vital signs are frequently assessed and invasive procedures are avoided. Tests to determine INR or aPTT are performed 3 to 4 hours after the thrombolytic infusion is started to confirm that the fibrinolytic systems have been activated.

Quality and Safety Nursing Alert

Because of the prolonged clotting time, only essential arterial punctures or venipunctures are performed in patients who have received thrombolytics, and manual pressure is applied to any puncture site for at least 30 minutes. Pulse oximetry is used to monitor changes in oxygenation. The thrombolytic infusion is discontinued immediately if uncontrolled bleeding occurs.

Managing Pain

Chest pain, if present, is usually pleuritic rather than cardiac in origin. A semi-Fowler position provides a more comfortable position for breathing. However, the nurse must continue to turn patients frequently and reposition them to improve V./Q.. The nurse administers opioid analgesic agents as prescribed for severe pain.

Managing Oxygen Therapy

Careful attention is given to the proper use of oxygen. The patient must understand the need for continuous oxygen therapy. The nurse assesses the patient frequently for signs of hypoxemia and monitors the pulse oximetry values to evaluate the effectiveness of the oxygen therapy. Deep breathing and incentive spirometry are indicated for all patients to minimize or prevent atelectasis and improve ventilation (see Chapter 19 for discussion of incentive spirometry). Nebulizer therapy or percussion and postural drainage may be used for management of secretions.

Relieving Anxiety

The nurse encourages the patient who is stabilized to talk about any fears or concerns related to this frightening episode, answers the patient's and family's questions concisely and accurately, explains the therapy, and describes how to recognize untoward effects early.

Monitoring for Complications

When caring for a patient who has had PE, the nurse must be alert for the potential complication of cardiogenic shock or right ventricular failure subsequent to the effect of PE on the cardiovascular system. (Nursing

activities for managing shock are found in Chapter 11; see Chapter 25 for nursing management of right ventricular failure.)

Providing Postoperative Nursing Care

If the patient has undergone surgical embolectomy, the nurse measures the patient's pulmonary arterial pressure and urinary output. The nurse also assesses the insertion site of the arterial catheter for hematoma formation and infection. Maintaining the blood pressure at a level that supports perfusion of vital organs is crucial. To prevent peripheral venous stasis and edema of the lower extremities, the nurse elevates the foot of the bed and encourages isometric exercises, the use of intermittent pneumatic compression devices, and walking when the patient is permitted out of bed. Sitting for long periods is discouraged, because hip flexion compresses the large veins in the legs.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

Before hospital discharge and at follow-up visits to the clinic, the nurse educates the patient about preventing recurrence and reporting signs and symptoms. Patient education instructions, presented in Chart 26-11, are intended to help prevent recurrences and side effects of treatment.

Chart 26-11 **HOME CARE CHECKLIST**

Prevention of Recurrent Pulmonary Embolism

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of pulmonary embolism (PE) on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- State changes in lifestyle (e.g., diet, activity) necessary to restore health.
- State the name, dose, side effects, frequency, and schedule for all medications.
- Name the anticoagulant prescribed and describe relevant patient education related to taking anticoagulants described in Chart 26-10.
- Describe the importance of follow-up appointments with providers.
- Describe strategies to prevent recurrent deep venous thrombosis and pulmonary emboli:
  - Continue to wear anti-embolism stockings (compression hose) as long as directed.
  - Avoid sitting with legs crossed or sitting for prolonged periods of time.
  - When traveling, change position regularly, walk occasionally, and do active exercises of moving the legs and ankles while sitting.
  - Drink fluids, especially while traveling and in warm weather, to avoid hemoconcentration due to fluid deficit.
- Describe the signs and symptoms of lower extremity circulatory compromise and potential deep venous thrombosis: calf or leg pain, swelling, pedal edema.
- Describe the signs and symptoms of pulmonary compromise related to recurrent PE (e.g., dyspnea, chest pain, anxiety, fever, tachycardia, apprehension, cough, syncope, diaphoresis, hemoptysis).
- Describe how and when to contact the primary provider if symptoms of circulatory compromise or pulmonary compromise are identified.
- Identify the need for health promotion, disease prevention, and screening activities.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Continuing and Transitional Care

During follow-up or home visits, the nurse monitors the patient's adherence to the prescribed management plan and reinforces previous instructions. The nurse also monitors the patient for residual effects of the PE and recovery. The patient is reminded about the importance of keeping follow-up appointments for coagulation tests, if indicated, and appointments with the primary provider.

Chronic Venous Insufficiency/Postthrombotic Syndrome

Venous insufficiency results from obstruction of the venous valves in the legs or a reflux of blood through the valves. Superficial and deep leg veins can be involved. Resultant venous hypertension can occur whenever there has been a prolonged increase in venous pressure, such as occurs with DVT. Because the walls of veins are thinner and more elastic than the walls of arteries, they distend readily when venous pressure is consistently elevated. In this state, leaflets of the venous valves are stretched and prevented from closing completely, causing a backflow or reflux of blood in the veins. Duplex ultrasonography confirms the obstruction and identifies the level of valvular incompetence. Twenty percent to 50% of patients who have had a DVT develop deep vein incompetence leading to postthrombotic syndrome (Sidawy & Perler, 2019) (see Fig. 26-15).

Clinical Manifestations

Postthrombotic syndrome is characterized by chronic venous stasis, resulting in edema, altered pigmentation, pain, and stasis dermatitis. The patient may notice the symptoms less in the morning and more in the evening. Obstruction or poor calf muscle pumping in addition to valvular reflux must be present for the development of severe postthrombotic syndrome and stasis ulcers. Superficial veins may be dilated. The disorder is long-standing, difficult to treat, and often disabling (Kahn, Galanaud, Vedantham, et al., 2016).

Stasis ulcers develop as a result of the rupture of small skin veins and subsequent ulcerations. When these vessels rupture, red blood cells escape into surrounding tissues and then degenerate, leaving a brownish discoloration of the tissues, called *hemosiderin staining*. The pigmentation and ulcerations usually occur in the lower part of the extremity, in the area of the medial malleolus of the ankle. The skin becomes dry, cracks, and itches; subcutaneous tissues fibrose and atrophy. The risk of injury and infection of the extremities is increased.

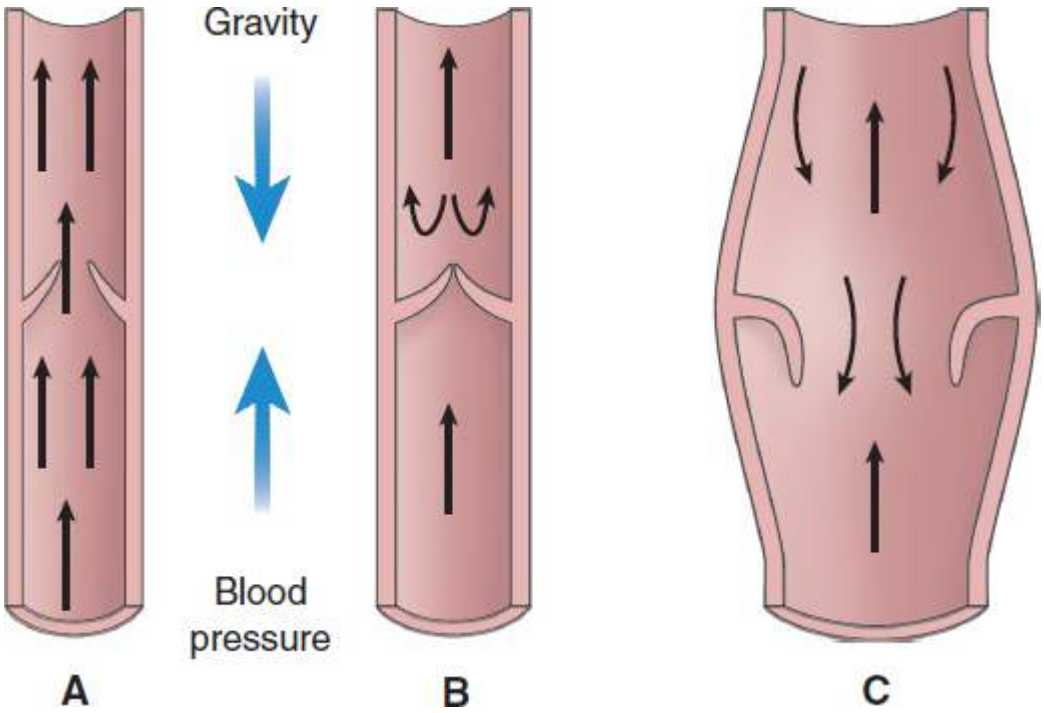

Figure 26-15 • Competent valves showing blood flow patterns when the valve is open (**A**) and closed (**B**), allowing blood to flow against gravity. **C**. With faulty or incompetent valves, the blood cannot move toward the heart.

Complications

Venous ulceration is the most serious complication of chronic venous insufficiency and can be associated with other conditions affecting the circulation of the lower extremities. Cellulitis or dermatitis may complicate the care of chronic venous insufficiency and venous ulcerations.

Management

Management of the patient with venous insufficiency is directed at reducing venous stasis and preventing ulcerations. Extremities with venous insufficiency must be carefully protected from trauma; the skin is kept clean, dry, and soft. Signs of ulceration are immediately reported to the primary provider for treatment and follow-up. Measures that increase venous blood flow are antigravity activities, such as elevating the leg, and compression of superficial veins with graduated compression stockings and other compression therapies.

Elevating the legs decreases edema, promotes venous return, and provides symptomatic relief. The legs should be elevated frequently throughout the day (at least 15 to 20 minutes four times daily). At night, the patient should sleep with the foot of the bed elevated about 15 cm (6 inches). Prolonged sitting or standing in one position is detrimental; walking should be encouraged. When sitting, the patient should avoid placing pressure on the popliteal spaces, as occurs when crossing the legs or sitting with the legs dangling over the side of the bed. Constricting garments, especially socks that are tight at the top or that leave marks on the skin, should be avoided.

Compression of the legs with graduated compression stockings reduces the pooling of venous blood, enhances venous return to the heart, and is recommended for people with venous insufficiency.

Providing Compression Therapy

Stockings

Graduated compression stockings usually are prescribed for patients with venous disease as soon as possible after diagnosis (Bjork & Ehmann, 2019). The amount of pressure gradient is determined by the amount and severity of venous disease. For example, a pressure gradient of 20 to 30 mm Hg is prescribed for patients with asymptomatic varicose veins, whereas at least a pressure gradient of 30 to 40 mm Hg at the ankle is recommended for patients with venous stasis ulceration (Bjork & Ehmann, 2019). Compression stockings with at least 30 to 40 mm Hg pressure can be used during the 6 months post DVT to decrease symptoms and reduce the development of postthrombotic syndrome (Zierler & Dawson, 2016). These stockings should not be confused with anti-embolism stockings (i.e., thromboembolic deterrent [TED] stockings) that provide less compression (12 to 20 mm Hg at the ankle). Graduated compression stockings are designed to apply 100% of the prescribed pressure gradient at the ankle and then decrease along the

length of the stocking, reducing the caliber of the superficial veins in the leg and increasing flow in the deep veins. Each stocking should fit so that pressure is greater at the foot and ankle and then gradually declines to a lesser pressure at the knee or groin. These stockings may be knee high, thigh high, or pantyhose. Several colors, fabrics, and styles are available to promote patient adherence. Stockings should be applied after the legs have been elevated for a period, when the amount of blood in the leg veins is at its lowest.

Quality and Safety Nursing Alert

Any type of stocking can inadvertently become a tourniquet if applied incorrectly (i.e., rolled tightly at the top). In such instances, the stockings produce—rather than prevent—venous stasis. For ambulatory patients, graduated compression stockings can be removed at night and reapplied before the legs are lowered from the bed to the floor in the morning.

When the stockings are off, the skin is inspected for signs of irritation, and the calves are examined for tenderness. Any skin changes or signs of tenderness are reported. Stockings are contraindicated in patients with severe PAD, epifascial arterial bypass, severe cardiac insufficiency, allergy to compression material, and severe diabetic neuropathy with sensory loss or microangiopathy (Rabe, Partsch, Morrison, et al., 2020).

Gerontologic Considerations

Older patients have decreased strength and manual dexterity and may be unable to apply graduated compression stockings. If this is the case, a family member or friend should be taught to assist the patient to apply the stockings so that they do not cause excessive pressure on any part of the feet or legs. Frames and other devices have been designed to assist patients with applying stockings, and if there is any concern regarding patients' physical abilities, they should be referred to an occupational therapist who can provide examples of and training in the use of stocking assistance devices (Balcombe, Miller, & McGuiness, 2017).

External Compression Devices and Bandages

Short-stretch elastic bandages may be applied from the toes to the knee in a 50% spiral overlap. These bandages are available in a two-layer

system, which includes an inner layer of soft padding. These bandages have extension indicators that are rectangular and become squares when extended correctly, which reduces the possibility of bandaging a leg too loosely or too tightly. Three- and four-layer systems are also available (e.g., Profore, Dyna-Care), but these may be used only once compared with the two-layer system, which can be used multiple times.

Other types of compression are available. The Unna boot, which consists of a paste bandage impregnated with zinc oxide, glycerin, gelatin, and sometimes calamine, is applied without tension in a circular fashion from the base of the toes to the tibial tuberosity with a 50% spiral overlap. The foot must remain dorsiflexed at a 90-degree angle to the leg, thus avoiding excess pressure or trauma to the anterior ankle area. Once the bandage dries, it provides a constant and consistent compression to the venous system. This type of compression may remain in place for as long as 1 week, although it may be too heavy for patients who are too frail to tolerate. The Unna boot is more commonly used with venous insufficiency.

The CircAid, a nonelastic leg wrap with a series of overlapping, interlocking Velcro straps, augments the effect of muscle while the patient is walking. The CircAid is usually worn during the day. Patients may find the CircAid easier to apply and wear than the Unna boot because it is lighter, can be removed to shower, and is adjustable. However, its adjustability may also be problematic; if patients loosen the straps, the compression achieved may not be adequate.

Intermittent Pneumatic Compression Devices

Intermittent pneumatic compression devices can be used in conjunction with elastic bandages or graduated compression stockings to support venous circulation and prevent DVT. Compression devices consist of an electric controller that is attached by air hoses to either knee-high or thigh-high sleeves. The sleeves are divided into compartments, which sequentially fill to apply pressure to the ankle, calf, and thigh at variable pressures from 30 to 70 mm Hg. Intermittent pneumatic compression devices can increase blood velocity beyond that produced by elastic bandages or stockings. Intermittent pneumatic compression devices are prescribed for patients who are not physically able to apply compression bandages or wraps, or don a pair of stockings (Nicolaides, 2020). Nursing measures in caring for patients who use these devices include ensuring that sleeves are properly encircling the extremity and the

prescribed pressures are set and not exceeded, assessing for patient comfort, and ensuring adherence to therapy.

Leg Ulcers

A leg ulcer is an excavation of the skin surface that occurs when inflamed necrotic tissue sloughs off. In the United States the most common lower extremity ulcerations have a venous etiology (estimated between 80% and 90%), with PAD the second leading cause. The coexistence of both venous and arterial disease is estimated to be present in 26% of patients with leg ulcers (Singer, Tassiopoulos, & Kirsner, 2017).

Pathophysiology

Inadequate exchange of oxygen and other nutrients in the tissue is the metabolic abnormality that underlies the development of leg ulcers. When cellular metabolism cannot maintain energy balance, cell necrosis (death) results. Alterations in blood vessels at the arterial, capillary, and venous levels may affect cellular processes and lead to the formation of ulcers.

Clinical Manifestations

The characteristics of leg ulcers are determined by the cause of the ulcer (Ermer-Selton, 2016). Most ulcers, especially in older patients, have more than one cause. The symptoms depend on whether the problem is arterial or venous in origin (see Table 26-1). The severity of the symptoms depends on the extent and duration of the vascular insufficiency. The ulcer itself appears as an open, inflamed sore. The area may be exuding or covered by eschar (dark, hard crust).

Figure 26-16 • **A.** Ulcers resulting from arterial emboli. **B.** Gangrene of the toes resulting from severe arterial ischemia. **C.** Ulcer from venous stasis.

Arterial Ulcers

Chronic arterial disease is characterized by intermittent claudication. The patient may also complain of digital or forefoot pain at rest. If the onset of arterial occlusion is acute, ischemic pain is unrelenting and rarely relieved even with opioids. Typically, arterial ulcers are small, circular, deep ulcerations on the tips of toes or in the web spaces between the toes. Ulcers often occur on the medial side of the hallux or lateral fifth toe and may be caused by a combination of ischemia and pressure (see Fig. 26-16).

Venous Ulcers

Chronic venous insufficiency is characterized by pain described as aching or heavy. The foot and ankle may be edematous. Ulcerations are in the area of the medial or lateral malleolus (gaiter area) and are typically large, superficial, and highly exudative. Venous hypertension causes extravasation of blood, which discolors the area (see Fig. 26-16). Studies report the average venous ulcer requires as long as 6 to 12 months to heal completely and in patients who do not adhere to compression therapy (see discussion later in the chapter), the recurrence rate is nearly 100% within 36 months (Nicolaides, 2020). Patients with neuropathy (e.g., a common occurrence in patients with diabetes) frequently have ulcerations on the side of the foot over the metatarsal heads. These ulcers are painless and are described in further detail in Chapter 46.

Assessment and Diagnostic Findings

The cause of each ulcer needs to be identified so that appropriate therapy can be prescribed. The history of the condition is important in determining arterial or venous insufficiency. The pulses of the lower extremities (femoral, popliteal, posterior tibial, and dorsalis pedis) are carefully examined. More conclusive diagnostic aids include Doppler and duplex ultrasound studies, arteriography, and venography. Cultures of the ulcer bed may be necessary to determine whether an infection is contributing to tissue destruction.

Medical Management

Patients with ulcers can be effectively managed by advanced practice nurses or wound-ostomy-continence nurses in collaboration with the

patients' primary provider. All ulcers have the potential to become infected.

Pharmacologic Therapy

Antiseptic agents, such as povidone–iodine, cadexomer iodine, and silver, inhibit growth and development of most microbes, are broad spectrum, generate relatively little antimicrobial resistance, and can be used for short periods of time. Once a wound is infected (e.g., erythema, induration, exudate, edema, wound breakdown, malodor), a systemic antibiotic is necessary (Swanson, Angel, Sussman, et al., 2016). The specific antibiotic agent selected is based on culture and sensitivity test results. Oral antibiotics usually are prescribed because topical antibiotics have not proven to be effective for leg ulcers and promote antimicrobial resistance (Swanson et al., 2016).

Pharmacologic therapy also is important in the management of wound-related pain.

Compression Therapy

After the circulatory status of the patient is assessed and an absolute ankle pressure of greater than 60 mm Hg and an ABI that exceeds 0.80 are confirmed, compression therapy can be used up to 40 mm Hg without impeding arterial perfusion (Singer et al., 2017). See the discussion on compression therapy in the Chronic Venous Insufficiency section.

Cleansing and Débridement

To promote healing, the wound bed is prepared by removing excessive wound exudate and nonviable tissue. The usual cleansing method is to flush the area with water or normal saline solution or clean it with a noncytotoxic wound-cleansing agent (Saf-Clens™, Biolex™, Restore™). If this is unsuccessful, therapeutic wound cleansing and/or débridement may be necessary (Swanson et al., 2016).

Therapeutic wound cleansing includes mechanical cleaning with a cleansing solution or gel such as:

- Polyhexamethylene biguanide (PHMB)
- Octenidine dihydrochloride
- Superoxidised solution with hypochlorous acid (HOCL) and sodium hypochlorite (NaOCL)
- Povidone–iodine

Many older antiseptics are no longer recommended due to the risk of tissue damage associated with their use. However, these agents may still be used for wound management in low-resource settings, where alternative, contemporary antiseptics are not always available. Solutions not recommended include:

- Hydrogen peroxide
- High-concentration sodium hypochlorite (EUSOL™, Milton, Dakin's solution)
- Chlorhexidine gluconate
- Chlorhexidine gluconate and cetrimide (Savlon™)
- High-concentration acetic acid
- Antibiotics for systemic administration
- High-concentration potassium permanganate

Débridement is the removal of nonviable tissue from wounds. Removing nonviable tissue is important, particularly for infection and biofilms (i.e., the microorganisms that grow on the surface of the wound). Biofilms have now been established as an important factor in wound healing and the need for serial débridement is important to disrupt the biofilm and allow the penetration of topical and systemic antimicrobial agent (Swanson et al., 2016).

Débridement can be accomplished by several different methods:

- Surgical débridement is the fastest method and can be performed by a primary provider under aseptic conditions using instruments to excise nonviable tissue. It is usually performed in the operating room with access to anesthesia and hemostasis.
- Conservative sharp wound débridement can be performed at the bedside or in a clinic by a primary provider, skilled advanced practice nurse or wound-ostomy-continence nurse in collaboration with the primary provider or advanced practice nurse. Instruments are used to remove loose, avascular, and insensate nonviable tissue and topical anesthetics may be used to manage procedural pain.
- Chemical débridement involves the application of chemical agents (e.g., cadexomer iodine, hypertonic saline) for the controlled removal of nonviable tissue. There may be some cytotoxic effects to healthy cells in the wound.
- Ultrasonic débridement uses ultrasonography to disrupt the attachment of the nonviable tissue.

- Hydrosurgical débridement uses a water-jet–powered wound débridement tool to cut nonviable tissue.
- Biologic débridement, or larval therapy, involves the deliberate infestation of disinfected fly larvae that secrete a proteolytic enzyme which liquifies and ingests nonviable tissues.
- Enzymatic débridement involves the application of ointments containing enzymes. The ointment is applied to the ulcer but not to surrounding skin. Most enzymatic ointments are covered with a secondary dressing that will not soak up the ointment. The enzymatic ointment is discontinued when the nonviable tissue has been débrided, and an appropriate wound dressing is applied.
- Autolytic débridement is achieved through the application of dressings that allow the lysozymes in wound exudate to naturally break down the nonviable tissue. These include calcium alginate dressings (e.g., Kaltostat™, Sorbsan™) or gelling fiber dressings (e.g., Aquacel Hydrofiber™) and may be used for débridement when absorption of exudate is needed. These dressings are changed when the exudate seeps through the secondary dressing, or at least every 7 days. Calcium alginate dressings can be used on areas that are bleeding after débriding, because the material helps stop the bleeding. As the dry fibers absorb exudate, they become a gel that can be painlessly removed from the ulcer bed. Calcium alginate and gelling fiber dressings should not be used on dry or nonexudative wounds.

Nonselective débridement by applying and removing saline dressings of fine mesh gauze (wet to dry) are not recommended for vascular wounds because of the risk of removing viable tissue and wound-related pain. Preprocedural pain management is usually necessary.

Arterial insufficiency may result in gangrene of the toe(s), or digital gangrene, which is usually caused by trauma. The toe is stubbed and then turns black (see Fig. 26-16). Usually, patients with this problem are older people without adequate circulation. Débridement is contraindicated in these instances. Although the toe is gangrenous, it is dry. Managing dry gangrene is preferable to débriding the toe and causing an open wound that will not heal because of insufficient circulation. If the toe were to be amputated, the lack of adequate circulation would prevent healing and might make higher-level amputation necessary—a below- or an above-

knee amputation. A higher-level amputation in an older adult could result in a loss of independence and possibly the need for institutional care. Dry gangrene of the toe in an older adult with poor circulation is usually left undisturbed. The nurse keeps the toe clean and dry, if it is stable, until it autoamputates or separates (without creating an open wound).

Topical Therapy

A variety of topical agents can be used in conjunction with cleansing and débridement to promote healing of leg ulcers. The goals of treatment are to remove nonviable tissue and biofilm, and keep the ulcer clean and moist while healing takes place. The treatment should not destroy developing tissue. For topical treatments to be successful, adequate nutrition must be maintained.

Wound Dressing

Semiocclusive or occlusive wound dressings prevent evaporative fluid loss from the wound and retain warmth; these factors favor healing. When determining the appropriate dressing to apply, the following should be considered: simplicity of application, frequency of required dressing changes, ability to absorb wound exudate, expense, and patient comfort (see Chapter 56 for further discussion of wound dressings).

Knowledge deficit, frustration, fear, anxiety, and depression can decrease the patient's and family's adherence with the prescribed therapy; therefore, patient and family education is necessary before beginning and throughout the wound care program.

Stimulated Healing

Tissue-engineered human skin equivalent (e.g., Apligraf™ [Graftskin™]) is a skin product cultured from human dermal fibroblasts and keratinocytes used in combination with therapeutic compression. When applied, it interacts with the patient's cells within the wound to stimulate the production of growth factors. Application is not difficult, no suturing is involved, and the procedure is painless. A dermal repair scaffold (e.g., PriMatrix™) is a bioactive and regenerative extracellular matrix that binds with the patient's own cells and growth factors. PriMatrix™ has been used successfully for tunneling wounds, as well as wounds with exposed tendon and bone, in which Apligraf™ cannot be used.

Dermagraft™, which is a human fibroblast–derived dermal replacement, demonstrates efficacy similar to Apligraf™ (Nicolaides, 2020).

Hyperbaric Oxygenation

Hyperbaric oxygenation (HBO) may be beneficial as an adjunct treatment in patients with diabetes with no signs of wound healing after 30 days of standard wound treatment. HBO is accomplished by placing the patient into a chamber that increases barometric pressure while the patient is breathing 100% oxygen. Treatment regimens vary from 90 to 120 minutes once daily for 30 to 90 sessions. The process by which HBO is thought to work involves several mechanisms. The edema in the wound area is decreased because high oxygen tension facilitates vasoconstriction and enhances the ability of leukocytes to phagocytize and kill microbes. In addition, HBO is thought to increase diffusion of oxygen to the hypoxic wound, thereby enhancing epithelial migration and improving collagen production. The two most common adverse effects of HBO are middle-ear barotrauma and confinement anxiety. The benefit from this therapy on wound healing in patients without diabetes is unclear (Bonifant & Holloway, 2019).

Negative Pressure Wound Therapy

Research suggests that negative pressure wound therapy (NPWT) using vacuum-assisted closure (e.g., VAC™) devices decreases time to healing in complex wounds that have not healed in a 3-week period. Groin incisions, common in vascular surgery, may be complicated by wound dehiscence, lymphatic fistula, or infections in 5% to 10% of patients. NPWT has been found to be effective in treating patients who develop postoperative groin wound infections, decreasing hospital lengths of stay, rates of graft infection, and likelihood of limb loss (Apelqvist, Willy, Fagerdahl, et al., 2017). Patients who are ambulatory may be given small, portable NPWT devices, giving them the freedom to perform their ADLs (Harding, Chrysostomou, Mohamud, et al., 2017). Additional features such as instillation therapy (Veraflow™) are now available. This therapy facilitates cleansing via instillation of fluid followed by a negative pressure cycle. Research to evaluate the microbial load and changes in the bacterial spectrum in wounds while using a growing number of NPWT devices is ongoing (Kim, Applewhite, Dardano, et al., 2018).

NURSING PROCESS

The Patient with Leg Ulcers

Assessment

A focused nursing history and assessment are important. The extent and type of pain are carefully assessed, as are the appearance and temperature of the skin of both legs. The quality of all peripheral pulses is assessed, and the pulses in both legs are compared. The legs are checked for edema. If the extremity is edematous, the degree of edema is determined. Any limitation of mobility and activity that results from vascular insufficiency is identified. The patient's nutritional status is assessed, and a history of diabetes, collagen disease, or varicose veins is obtained.

Diagnosis

NURSING DIAGNOSES

Based on the assessment data, major nursing diagnoses may include:

- Impaired skin integrity associated with vascular insufficiency
- Impaired mobility associated with activity restrictions of the therapeutic regimen and pain
- Impaired nutritional status associated with increased need for nutrients that promote wound healing

COLLABORATIVE PROBLEMS/POTENTIAL COMPLICATIONS

Potential complications may include the following:

- Infection
- Gangrene

Planning and Goals

The major goals for the patient may include restoration of skin integrity, improved physical mobility, adequate nutrition, and absence of complications.

Nursing Interventions

Caring for these patients can be challenging, whether the patient is in the hospital, in a long-term care facility, or at home. Leg ulcers are often long term and disabling causing a substantial drain on the patient's physical, emotional, and economic resources.

RESTORING SKIN INTEGRITY

To promote wound healing, measures are used to keep the area clean. Cleansing requires very gentle handling, a neutral skin cleanser, and lukewarm water. Positioning of the legs depends on whether the ulcer is of arterial or venous origin. If there is arterial insufficiency, the patient should be referred for evaluation of vascular reconstruction. If there is venous insufficiency, dependent edema can be avoided by elevating the lower extremities and initiating graduated compression therapy. A decrease in edema promotes the exchange of cellular nutrients and waste products in the area of the ulcer, promoting healing.

Avoiding trauma to the lower extremities is imperative in promoting skin integrity. Heel suspension devices such as protective boots may be used (e.g., Rooke vascular boots, Prevalon); they are soft and provide warmth and protection from injury and displace tissue pressure to prevent pressure injury. If the patient is on bed rest or has reduced mobility, it is important to relieve pressure on the heels to prevent heel pressure injuries. When the patient is in bed, a bed cradle can be used to relieve pressure from bed linens and to prevent anything from touching the legs. When the patient is ambulatory, all obstacles are moved from the patient's path so that the patient's legs are not bumped. Heating pads, hot-water bottles, or hot baths are avoided, because they increase the oxygen demands and thus the blood flow demands of the already compromised tissue. The patient with diabetes and neuropathy has decreased sensation; therefore, heating pads may cause a burn without the patient noticing.

IMPROVING PHYSICAL MOBILITY

Generally, physical activity is initially restricted to promote wound healing. When infection resolves and healing begins, ambulation should resume gradually and progressively. Activity promotes arterial blood flow and venous return and is encouraged after the acute phase of the ulcer process. Until full activity is resumed, the patient is advised to move about when in bed, to turn from side to side frequently, and to exercise the upper extremities to maintain muscle tone and strength. Meanwhile, diversional activities are encouraged. Consultation with an occupational therapist and physical therapist may be helpful if prolonged immobility and inactivity are anticipated.

If pain limits the patient's activity, analgesic agents may be prescribed. The wound-related pain is typically chronic and often

disabling. Analgesic agents may be taken before scheduled activities to help the patient participate more comfortably.

PROMOTING ADEQUATE NUTRITION

Nutritional deficiencies are common, requiring dietary alterations to remedy them. There is conflicting evidence that dietary supplementation aids in healing of ulcerations. Comorbidities that may contribute to ulceration may also cause ongoing inflammation, disuse atrophy, and other metabolic disturbances; these may have a greater effect on wound healing than nutritional intake. Further research is needed; however, eating a diet that is high in protein, vitamins C and A, iron, and zinc is encouraged to promote healing (Bonifant & Holloway, 2019). Particular consideration should be given to iron intake, because many patients are older adults who are at risk for iron deficiency anemia. After a dietary plan has been developed that meets the patient's nutritional needs and promotes healing, dietary instruction is provided to the patient and family.

PROMOTING HOME, COMMUNITY-BASED, AND TRANSITIONAL CARE

The self-care program is planned with the patient so that activities that promote arterial and venous circulation, relieve pain, and promote tissue integrity are encouraged. Reasons for each aspect of the program are explained to the patient and family. Leg ulcers are often chronic and difficult to heal; they frequently recur, even when the patient follows the plan of care. Long-term care of the feet and legs to promote healing of wounds and prevent recurrence of ulcerations is the primary goal. Leg ulcers increase the patient's risk of infection, may be painful, and may limit mobility, necessitating lifestyle changes. Participation of family members and home health care providers may be necessary for treatments such as dressing changes, reassessments, reinforcement of instruction, and evaluation of the effectiveness of the plan of care. Regular follow-up with a primary provider is necessary.

Evaluation

Expected patient outcomes may include:

1. Demonstrates restored skin integrity
    a. Exhibits absence of inflammation
    b. Exhibits absence of drainage
    c. Has negative wound culture
    d. Avoids trauma to the legs

2. Increases physical mobility
   a. Progresses gradually to optimal level of activity
   b. Reports that pain does not impede activity
3. Attains adequate nutrition
   a. Selects foods high in protein, vitamins C and A, iron, and zinc
   b. Discusses with family members dietary modifications that need to be made at home
   c. Plans, with the family, a diet that is nutritionally sound

Varicose Veins

Varicose veins (varicosities) are abnormally dilated, tortuous, superficial veins caused by incompetent venous valves (see Fig. 26-15). Most commonly, this condition occurs in the lower extremities, the saphenous veins, or the lower trunk, but it can occur elsewhere in the body, such as the esophagus (e.g., esophageal varices; see Chapter 43).

It is estimated that varicose veins occur in 23% of American adults, and if spider telangiectasias and reticular veins are included in these statistics, the prevalence increases to 80% of men and 85% of women (Sidawy & Perler, 2019). The condition is most common in people whose occupations require prolonged standing, such as salespeople, hairstylists, teachers, nurses and ancillary medical personnel, and construction workers. A hereditary weakness of the vein wall may contribute to the development of varicosities, and it commonly occurs in several members of the same family. Varicose veins are rare before puberty. Pregnancy may cause varicosities because of hormonal effects related to decreased venous outflow, increased pressure by the gravid uterus, and increased blood volume (Della Torre, Sutherland, & Digiovanni, 2019).

Pathophysiology

Varicose veins may be primary (without involvement of deep veins) or secondary (resulting from obstruction of deep veins). A reflux of venous blood results in venous stasis. If only the superficial veins are affected, the person may have no symptoms but may be concerned by the appearance of the veins.

Clinical Manifestations

Symptoms, if present, may include dull aches, muscle cramps, increased muscle fatigue in the lower legs, ankle edema, and a feeling of heaviness of the legs. Nocturnal cramps are common. When deep venous obstruction results in varicose veins, the patient may develop the signs and symptoms of chronic venous insufficiency: edema, pain, pigmentation, and ulcerations. Susceptibility to injury and infection is increased, thus increasing risk for ulceration.

Assessment and Diagnostic Findings

Diagnostic tests for varicose veins include the duplex ultrasound scan, which documents the anatomic site of reflux and provides a quantitative measure of the severity of valvular reflux. These scans are typically performed in a reverse Trendelenburg position or with the patient standing. Venography is now rarely performed due to the availability of ultrasound. However, when it is used, it involves injecting a radiopaque contrast agent into the leg veins so that the vein anatomy can be visualized by x-ray studies during various leg movements. CT venography can be helpful, especially if the pelvic venous structures are involved.

Prevention and Medical Management

The patient should avoid activities that cause venous stasis, such as wearing socks that are too tight at the top or that leave marks on the skin, crossing the legs at the thighs, and sitting or standing for long periods. Changing position frequently, elevating the legs 3 to 6 inches higher than heart level when they are tired, and getting up to walk for several minutes of every hour promote circulation. The patient is encouraged to walk 30 minutes each day if there are no contraindications. Walking up the stairs rather than using the elevator or escalator is helpful, and swimming is good exercise.

Graduated compression stockings, especially knee-high stockings, are useful. The patient who is overweight should be encouraged to begin a weight reduction plan.

The most common treatment options for venous insufficiency and varicose veins are thermal ablation with radiofrequency and laser therapy, micro (stab) phlebectomy, and foam sclerotherapy. Surgical

ligation and stripping are reserved for select cases not amenable to other treatment options.

Thermal Ablation

Thermal ablation is a nonsurgical approach using thermal energy. Radiofrequency ablation uses an electrical contact inside the vein. As the device is withdrawn, the vein is sealed. Laser ablation uses a laser fiber tip that seals the vein (decompressed). Topical gel may be used first to numb the skin along the course of the saphenous vein. To protect the surrounding tissue, several small punctures are made along the vein, and 100 to 200 mL of dilute lidocaine is delivered to the perivenous space using ultrasound guidance. The goal of this tumescent anesthesia (i.e., anesthesia that causes localized swelling) is to provide analgesia, thermal protection (the cuff of fluid surrounds the veins and accompanying nerves), and extrinsic compression of the vein (Poder, Fisette, Bédard, et al., 2018). The saphenous vein is entered percutaneously near the knee using ultrasound guidance. A catheter is introduced into the saphenous vein and advanced to the saphenofemoral junction. The device is then activated and withdrawn, sealing the vein. Bandages or graduated compression stockings are applied after the procedure. A simultaneous microphlebectomy of branch varicosities may be performed; this is associated with a lower incidence of thrombophlebitis. This is also associated with quality of life improvements such as decreased leg swelling, pain, skin changes and healing of ulcerations, because all symptomatic veins may be treated at one time (Berti-Hearn & Elliott, 2019).

Cyanoacrylate embolization is approved for the treatment of an incompetent greater saphenous vein. Cyanoacrylate adhesive has been used for the treatment of arteriovenous malformations and a modified cyanoacrylate adhesive was developed that has rapid polymerization on contact with blood and tissue, flexibility sufficient to tolerate dynamic movements in the legs without generation of symptoms or be perceptible by the patient, and has a high viscosity to decrease the risk of propagation or embolization into the deep veins (Sidawy & Perler, 2019). During this procedure, a sheath is placed into the greater saphenous vein (guided by ultrasound). A catheter is advanced to the proximal saphenous vein and injections of cyanoacrylate are given, followed by local compression, and then repeated injections with repeated compression until the entire length of the target vein segment is

treated. Cyanoacrylate embolization has been associated with less procedural ecchymosis because heat is not needed during this procedure.

Microphlebectomy

If there are superficial varicose veins that are close to the surface, a microphlebectomy may be performed. This procedure involves removal of a superficial varicosity using anywhere from one to 20 small incisions. There can be extensive bruising and risk of infection with this procedure (Sidawy & Perler, 2019).

Sclerotherapy

Sclerotherapy involves injection of an irritating chemical into a vein to produce localized phlebitis and fibrosis, thereby obliterating the lumen of the vein. This treatment may be performed alone for small varicosities or may follow vein ablation, ligation, or stripping. Sclerotherapy is typically performed in a procedure room and does not require sedation. After the sclerosing agent is injected, graduated compression stockings are applied to the leg and are worn for approximately 1 week after the procedure. Ultrasound-guided foam sclerotherapy has been found to be more effective in achieving closure of the branch veins. It is also associated with decreased symptoms of leg aching, itching, and edema, less skin changes and ulcerations, and increased patient satisfaction (Berti-Hearn & Elliott, 2019). After sclerotherapy, walking is encouraged to activate the calf muscle pump and maintain blood flow in the leg.

Ligation and Stripping

Surgery for symptomatic varicose veins requires that the deep veins be patent and functional. The saphenous vein is ligated high in the groin, where the saphenous vein meets the femoral vein. In addition, the vein may be stripped (removed). After the vein is ligated, an incision is made 2 to 3 cm below the knee, and a metal or plastic wire is passed the full length of the vein to the point of ligation. The wire is then withdrawn, pulling (stripping) the vein as it is removed. Pressure and elevation minimize bleeding during surgery.

Nursing Management

Thermal ablation is performed in an outpatient or clinic setting. The patient is advised to maintain compression on the affected limb for at least 24 hours and then wear compression stockings while ambulatory for at least 1 week post procedure. Patients have no activity restrictions, but are advised to avoid strenuous exercise, such as weight lifting, bicycle riding, or swimming for 2 weeks. The patient is informed that bruising may occur along the course of the saphenous vein and that they may experience leg cramps for a few days and may find it difficult to straighten the knee for up to 1.5 weeks. Nonsteroidal anti-inflammatory medications such as ibuprofen and cool compresses are used as needed for pain.

Ligation and stripping can be performed in an outpatient setting, or the patient may be admitted to the hospital on the day of surgery and discharged the same or next day if a bilateral procedure is to be performed or the patient is at high risk for postoperative complications. If the procedure is performed in an outpatient setting, nursing measures are the same as if the patient were hospitalized. Bed rest is discouraged, and the patient is encouraged to ambulate as soon as sedation has worn off. The patient is instructed to walk every hour for 5 to 10 minutes while awake for the first 24 hours if they can tolerate the discomfort, and then to increase walking and activity as tolerated. Graduated compression stockings are worn continuously for about 1 week after vein stripping. The nurse assists the patient to perform exercises and move the legs. The foot of the bed should be elevated. Standing and sitting are discouraged.

Promoting Comfort and Understanding

Analgesic agents are prescribed to help the patient move the affected extremities more comfortably. Dressings are inspected for bleeding, particularly in the groin, where the risk of bleeding is greatest. The nurse is alert for reported sensations of “pins and needles.” Hypersensitivity to touch in the involved extremity may indicate a temporary or permanent nerve injury resulting from surgery, because the saphenous vein and nerve are close to each other in the leg. Any of these signs or symptoms should be reported to the primary provider.

Usually, the patient may shower after 24 hours. A clean towel is used to gently pat dry, not rub, the incisions. Application of skin lotion is avoided until the incisions are completely healed to avoid infection. The patient is instructed to apply sunscreen to the incisional area prior to sun

exposure; otherwise, hyperpigmentation of the incision, scarring, or both may occur.

If the patient has undergone sclerotherapy, a burning sensation in the injected leg may be experienced for 1 to 2 days. The nurse encourages the use of a mild analgesic medication as prescribed and walking to provide relief.

Promoting Home, Community-Based, and Transitional Care

Long-term venous compression is essential after discharge, and the patient needs to obtain adequate supplies of graduated compression stockings or elastic bandages. Exercise of the legs is necessary; the development of an individualized plan requires consultation with the patient and the health care team.

LYMPHATIC DISORDERS

The lymphatic system consists of a set of vessels that spread throughout most of the body, as described previously in this chapter. The fluid drained from the interstitial space by the lymphatic system is called *lymph*. The flow of lymph depends on the intrinsic contractions of the lymph vessels, the contraction of muscles, respiratory movements, and gravity. The lymphatic system of the abdominal cavity maintains a steady flow of chyle (digested fatty food) from the intestinal mucosa to the thoracic duct. In other parts of the body, the lymphatic system's function is regional; the lymphatic vessels of the head, for example, empty into clusters of lymph nodes located in the neck, and those of the extremities empty into nodes of the axillae and the groin.

Lymphangitis and Lymphadenitis

Lymphangitis is an acute inflammation of the lymphatic channels. It arises most commonly from a focal area of infection in an extremity. Usually, the infectious organism is a *hemolytic streptococcus*. The characteristic red streaks that extend up the arm or the leg from an infected wound outline the course of the lymphatic vessels as they drain.

The lymph nodes located along the course of the lymphatic channels also become enlarged, red, and tender; this is referred to as acute lymphadenitis. They can also become necrotic and form an abscess, called suppurative lymphadenitis. The nodes involved most often are those in the groin, axilla, or cervical region.

Because these infections are nearly always caused by organisms that are sensitive to antibiotics, it is unusual to see abscess formation. Recurrent episodes of lymphangitis are often associated with progressive lymphedema. After acute attacks, a graduated compression stocking should be worn on the affected extremity for several months to prevent long-term edema.

Lymphedema

Lymphedema may be primary (congenital malformations) or secondary (acquired obstructions). Tissue swelling occurs in the extremities because of an increased quantity of lymph that results from obstruction of lymphatic vessels. It is especially marked when the extremity is in a dependent position. Initially, the edema is soft and pitting. As the condition progresses, the edema becomes firm, nonpitting, and unresponsive to treatment. The most common type is congenital lymphedema, known as lymphedema praecox, which is caused by hypoplasia of the lymphatic system of the lower extremity. This disorder is usually seen in women and first appears before age 35 (Dayan, Ly, Kataru, et al., 2018).

The obstruction may be in the lymph nodes and the lymphatic vessels. Sometimes, it is seen in the arm after an axillary node dissection (e.g., for breast cancer) and in the leg in association with varicose veins or chronic thrombophlebitis. In the latter case, the lymphatic obstruction usually is caused by chronic lymphangitis. Lymphatic obstruction caused by a parasite (filaria) is most frequently seen in the tropics. When chronic swelling is present, there may be frequent bouts of acute infection characterized by high fever and chills and increased residual edema once the inflammation has resolved. These changes can lead to chronic fibrosis, thickening of the subcutaneous tissues, and hypertrophy of the skin. This specific type of lymphedema, in which chronic swelling of the extremity recedes only slightly with elevation, is referred to as elephantiasis. There are an estimated 120 million people in the world infected by lymph-dwelling filarial parasites; of these, 40 million have lymphedema and secondary infections, creating an enormous global burden (King, Suamani, Sanuku, et al., 2018).

Medical Management

The goal of therapy is to reduce and control the edema and prevent infection. Active and passive exercises assist in moving lymphatic fluid into the bloodstream. External compression devices milk the fluid proximally from the foot to the hip or from the hand to the axilla. When the patient is ambulatory, custom-fitted graduated compression stockings or sleeves are worn; those with the highest compression strength (exceeding 40 mm Hg) are suggested; however, many patients cannot tolerate these pressures. When the leg is affected, continuous bed rest with the leg elevated may aid in mobilizing the fluids but is not practical long term. Manual lymphatic drainage performed by specially trained therapists is designed to direct or shift the congested lymph through functioning lymphatics that have preserved drainage. Manual lymphatic drainage is performed with light touch (as opposed to deep massage) to the proximal then distal lymphatic channels. Manual lymphatic drainage is incorporated in a sequential treatment approach used in combination with multilayer compression bandages, stockings or wraps, exercises, skin care, pressure gradient sleeves, and pneumatic pumps, depending on the severity and stage of the lymphedema (Patullo & Rajagopalan, 2017).

Pharmacologic Therapy

As initial therapy, the diuretic furosemide may be prescribed to prevent fluid overload due to mobilization of extracellular fluid. Diuretics have also been used along with elevation of the leg and the use of graduated compression stockings or sleeves. The use of diuretics alone has little benefit because their main action is to limit capillary filtration by decreasing the circulating blood volume. If lymphangitis or cellulitis is present, antibiotic therapy is initiated. Lymphedema significantly increases the risk for cellulitis; therefore, the patient is taught to provide meticulous skin care and inspect the skin for evidence of infection.

Surgical Management

Surgery is performed if the edema is severe and uncontrolled by medical therapy, if mobility is severely compromised, or if infection persists. One surgical approach involves the excision of the affected subcutaneous tissue and fascia, with skin grafting to cover the defect. Another procedure involves the surgical relocation of superficial lymphatic vessels into the deep lymphatic system, also known as lymph node transfer, by means of a buried dermal flap to provide a conduit for lymphatic drainage (Pappalardo, Patel, & Cheng, 2018).

Lymphaticovenous bypasses also are performed with anastomosing the end of the lymphatic vessels to the side of veins to reduce lymphatic flow in the limbs (Gallagher, Marulanda, & Gray, 2018).

Nursing Management

After surgery, antibiotics may be prescribed for 3 to 7 days (Pappalardo et al., 2018). Constant elevation of the affected extremity and observation for complications are essential. Complications may include flap necrosis, hematoma or abscess under the flap, and cellulitis. The nurse instructs the patient or caregiver to inspect the dressing daily. Unusual drainage or any inflammation around the wound margin suggests infection and should be reported to the surgeon. The patient is informed that there may be a loss of sensation in the surgical area. The patient is also instructed to avoid the application of heating pads or exposure to sun to prevent burns or trauma to the area.

CELLULITIS

Cellulitis is the most common infectious cause of limb swelling. Cellulitis can occur as a single isolated event or a series of recurrent events. It is sometimes misdiagnosed as recurrent thrombophlebitis or chronic venous insufficiency.

Pathophysiology

Cellulitis occurs when an entry point through broken skin allows microbes to enter and release their toxins in the subcutaneous tissues. The etiologic pathogen of cellulitis is typically either *Streptococcus* species or *Staphylococcus aureus* (Bystritsky & Chambers, 2018).

Clinical Manifestations

The onset of swelling, localized redness, warmth, and pain is frequently associated with systemic signs of fever, chills, and sweating. The redness may not be uniform and often skips areas and eventually develops a pitting “orange peel” appearance. Regional lymph nodes may also be tender and enlarged (Bystritsky & Chambers, 2018).

Concept Mastery Alert

Cellulitis needs to be differentiated from lymphangitis. With cellulitis, the swelling and redness is localized and anatomically nonspecific. With lymphangitis, characteristic red streaks appear denoting the outline of the lymphatic vessels that are affected.

Medical Management

Mild cases of cellulitis can be treated on an outpatient basis with oral antibiotic therapy. If the cellulitis is severe, the patient is treated with IV antibiotics. The key to preventing recurrent episodes of cellulitis lies in adequate antibiotic therapy for the initial event and in identifying the site of microbial entry. Cracks and fissures that occur in the skin between the toes must be examined as potential sites of microbial entry. Other locations include drug use injection sites, contusions, abrasions, ulceration, ingrown toenails, and hangnails. Prophylactic compression therapy to reduce the risk of recurrence may be indicated in some cases (Webb, Neeman, Bowden, et al., 2020).

Nursing Management

The patient is instructed to elevate the affected area 3 to 6 inches above heart level and apply cool packs to the site every 2 to 4 hours until the inflammation has resolved, and then transition to warm packs. Patients with sensory and circulatory deficits, such as those caused by diabetes and paralysis, should use caution when applying warm packs because burns may occur; it is advisable to use a thermometer or have a caregiver ensure that the temperature is not more than lukewarm. Education should focus on preventing a recurrent episode. The patient with peripheral vascular disease or diabetes should receive education or reinforcement about skin and foot care.

CRITICAL THINKING EXERCISES

1 pq A 27-year-old male with Marfan syndrome presents to the emergency department where you work complaining of a sudden onset of chest pain with dyspnea and left leg weakness. You are unable to palpate pulses in his left foot. The patient's laboratory findings indicate a decline in renal function. How would you triage and prioritize your initial nursing care for this patient? The provider orders an urgent CT angiogram, which reveals a dissection of the aorta and obstructed flow to the left kidney and left leg. What are the ongoing priorities for managing this patient's care?

2 ebp A 32-year-old woman presents to the primary care clinic where you work with leg pain. She has recently been on a long airplane flight and has had some unilateral leg swelling with calf tightness and pain. Her only medication is an oral contraceptive agent; she is generally healthy. What are her risk factors for venous thromboembolism (VTE)? What further diagnostic studies should be considered and what evidence-based practice recommendations will guide the management of her care? What pharmacologic options might be considered for anticoagulation and what therapies are indicated to manage her leg edema?

3 ipc A 70-year-old male presents to a preadmission center where you work to prepare for surgical repair of an abdominal aortic aneurysm. His aneurysm is 5.8 cm which is an increase of 1 cm in the last 6 months. His hypertension is well controlled, and he has had no further angina since coronary artery bypass grafts (CABGs) 2 years ago. He has good exercise tolerance and his weight is within a normal range. What preoperative assessments are required? The patient asks what he should do if he experiences increasing abdominal, back, or flank pain before surgery. How will you respond? How will the interprofessional team manage his postoperative care and coordinate a safe discharge?

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*Asterisk indicates nursing research.

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Resources

American Heart Association (AHA), www.aha.org
American Venous Forum (AVF), www.veinforum.org
Society for Vascular Medicine (SVM), www.vascularmed.org
Society for Vascular Nursing (SVN), www.svnnet.org
Society for Vascular Surgery (SVS), www.vascularweb.org
Society for Vascular Ultrasound (SVU), www.svunet.org

27 Assessment and Management of Patients with Hypertension

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Compare and contrast normal blood pressure and various stages of hypertension.
2. Identify pathophysiologic processes implicated in the progression of hypertension.
3. Demonstrate the proper techniques to perform an assessment and discriminate between normal and abnormal findings identified in the patient with hypertension.
4. Discuss risk factors and treatment approaches for hypertension, including lifestyle modifications and medication therapy.
5. Use the nursing process as a framework for care of the patient with hypertension.
6. Describe hypertensive crises and their treatments.

NURSING CONCEPTS

Assessment
Perfusion

GLOSSARY

hypertensive emergency: an emergent situation in which blood pressure is severely elevated and there is evidence of actual or probable target organ damage

hypertensive urgency: an urgent situation in which blood pressure is severely elevated but there is no evidence of impending or progressive target organ damage

isolated systolic hypertension: a disorder most commonly seen in the older adult in which the systolic pressure is greater than 140 mm Hg and the diastolic pressure is less than 80 mm Hg

masked hypertension: blood pressure that is typically suggestive of a diagnosis of hypertension that is paradoxically normal in health care settings

primary hypertension: high blood pressure with no identifiable cause (*synonym:* essential hypertension)

rebound hypertension: blood pressure in a patient with hypertension that is controlled with medication and becomes abnormally high with the abrupt discontinuation of that medication

resistant hypertension: high blood pressure treated with three or more antihypertensive medications of different classes; one of these must be a diuretic agent

secondary hypertension: high blood pressure from an identified cause, such as chronic kidney disease

target organ damage: manifestations of pathophysiologic changes in various organs as a consequence of hypertension

white coat hypertension: blood pressure that increases to hypertensive readings in health care settings that is paradoxically within the normal ranges in other settings

Hypertension is the most common chronic disease among adults in the United States and in the world (Whelton, Carey, Aronow, et al., 2017*)*. It is identified as the leading risk factor for premature death, disability, and overall disease burden worldwide because it may lead to cardiovascular disease (CVD), stroke, and chronic kidney disease (CKD) when not appropriately treated (Caillon, Paradis, & Schiffrin, 2019; DePalma, Himmelfarb, MacLaughlin, et al., 2018). The overall risk of developing these CVDs, strokes, and renal disorders is low among patients with blood pressures that are consistently stable around 115/75 mm Hg; however, each increase of 20 mm Hg in the systolic blood pressure (SBP) or 10 mm Hg increase in the diastolic blood pressure (DBP) doubles the risk of death from stroke or heart disease (Lee, Kim, Kang, et al., 2018). And yet, most patients with hypertension could lower their blood pressure through lifestyle changes (e.g., diet, exercise, medication adherence, smoking cessation) and lower these associated morbid risks

(Whelton et al., 2017). This chapter presents an overview of hypertension and how it is defined and managed so that nurses may appropriately assess, monitor, educate, and intervene with patients with hypertension.

Hypertension

For many years, patients were diagnosed with hypertension if they had chronically elevated SBPs of 140 mm Hg or higher or DBPs of 90 mm Hg or higher. These parameters, which also specified that the diagnosis of hypertension must be based on an average of two or more accurate readings taken one to 4 weeks apart, were endorsed by the *Seventh Report of the Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure* (JNC 7) (Chobanian, Bakris, Black, et al., 2003), as well as the *Eighth Joint National Committee* (JNC 8) (James, Oparil, Carter, et al., 2014), and the *American Society of Hypertension* (ASH) and the *International Society of Hypertension* (ISH) (Weber, Schiffrin, White, et al., 2014). However, these parameters for diagnosing hypertension recently changed to less permissive parameters, and patients with average SBPs that are 130 mm Hg or higher or with average DBPs 80 mm Hg or higher may be diagnosed with hypertension, according to the *American College of Cardiology (ACC)/American Heart Association (AHA) Task Force* (Whelton et al., 2017).

The classification system for hypertension has been further revised by the ACC/AHA (Whelton et al., 2017) to include elevated, stage 1, and stage 2 categories, as displayed in Table 27-1. Table 27-1 compares this classification system to previous JNC 7 and JNC 8 guidelines classification systems, which are no longer followed (DePalma et al., 2018). The blood pressure categories emphasize the direct relationship between the SBP and DBP risks of morbidity, all-cause mortality, and specifically, cardiovascular mortality. Of particular note, the ACC/AHA guideline (Whelton et al., 2017) changed the previously labeled *prehypertension* category to *elevated blood pressure* category. The rationale for this change in terminology is to highlight the association between any elevated blood pressure and increased cardiovascular risk. The blood pressure readings should use the average of two or more valid, reproducible measurements obtained on more than two occasions, in most instances (see later discussion under Assessment and Diagnostic Findings).

The prevalence of hypertension among adults in the United States is substantially higher when the definition of the ACC/AHA guideline is used versus the JNC 7 or JNC 8 definition (46% vs. 32%) (Whelton et al., 2017). However, since nonpharmacologic treatment (i.e., lifestyle changes) is recommended for most adults whose blood pressures are within the elevated hypertension category, the newer guidelines that define hypertension have resulted in only a small increase in antihypertensive medication prescriptions,

overall. Indeed, it has been asserted that the greatest benefit of the ACC/AHA (2017) guideline is its greater emphasis on lifestyle interventions, which include weight loss, healthy diet, physical exercise, reduced sodium intake, increased potassium intake, and decreased alcohol intake (Ioannidis, 2018).

The prevalence of hypertension increases as people age or have other cardiovascular risk factors. Of all adults with hypertension, it is estimated that 35.3% do not know that they have this disorder. Furthermore, approximately 45.4% of people with hypertension do not have their blood pressure under control (Benjamin, Muntner, Alonso, et al., 2019). The prevalence of hypertension varies by ethnicity and gender, and is estimated at approximately 48.2% among Caucasian men, 41.3% among Caucasian women, 58.6% among African American men, 56% among African American women, 47.4% among Hispanic men, 40.8% among Hispanic women, 46.4% among Asian American men, and 36.4% among Asian American women. The prevalence of hypertension among African Americans is among the highest in the world (Benjamin et al., 2019). Moreover, African Americans tend to develop hypertension at younger ages than Caucasian Americans (Spikes, Higgins, Quyyumi, et al., 2019). Chart 27-1 displays risk factors for hypertension.

Findings from the National Health and Nutrition Examination Survey (NHANES) have shown better hypertension control rates in women, in Caucasians than in African Americans and Hispanics, and in older versus younger patients. Additionally, adults of higher socioeconomic status have better control of their blood pressures compared to adults of lower socioeconomic status. Hypertension is most prevalent among adults 75 years of age and older, affecting 80% of men and 85.6% of women (Benjamin et al., 2019).

TABLE 27-1 Comparing Blood Pressure Classifications by Key Guidelines for Adults Age 18 and Older

Systolic BP (mm Hg)		Diastolic BP (mm Hg)	ACC/AHA (2017) Guideline*	JNC 7* and JNC 8* Guidelines
<120	-and-	<80	Normal	Normal
120–129	-and-	<80	Elevated	Prehypertension
130–139	-or-	80–89	Stage 1 hypertension	Prehypertension
140–159	-or-	90–99	Stage 2 hypertension	Stage 1 hypertension
≥160	-or-	≥100	Stage 2 hypertension	Stage 2 hypertension

Note: For each guideline, if the patient's systolic and diastolic BPs fall into different categories, then the patient is classified according to the higher category.
BP, blood pressure.
Adapted from *Whelton, P. K., Carey, R. M., Aronow, W. S., et al. (2017). 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension, 71*(6), e13–e115; †Chobanian, A. V., Bakris, G. L., Black, H. R., et al; National High Blood Pressure Education Program Coordinating Committee (2003). Seventh Report of the Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure. The JNC 7 Report. *JAMA, 289*(19), 2560–2572; ‡James, P. A., Oparil, S., Carter, B. L., et al. (2014). 2014 evidence-based guideline for the management of high blood pressure in adults: Report from the panel members appointed to the Eighth Joint National Committee (JNC 8). *JAMA, 311*(5), 507–520.

Chart 27-1 **RISK FACTORS**

Hypertension

Risk Factors

- Advancing adult age
- African American
- Chronic kidney disease
- Diabetes
- Drinking too much alcohol (i.e., more than two drinks per day for men and more than one drink per day for women)
- Family history
- Gender-related:
  - Men have greater risk until 64 y of age
  - Women have greater risk at 65 y of age and later
- Hypercholesterolemia
- Overweight/obesity
- Poor diet habits, particularly if it includes too much salt, as well as limited intake of vegetables, fiber, fish fats, and potassium
- Sedentary lifestyle
- Use of tobacco and nicotine products (e.g., cigarettes, e-cigarettes) and exposure to secondhand smoke
- Stress
- Sleep apnea

Adapted from American Heart Association (AHA). (2019). Know your risk factors for high blood pressure. Retrieved on 10/17/2019 at: www.heart.org/en/health-topics/high-blood-pressure/why-high-blood-pressure-is-a-silent-killer/know-your-risk-factors-for-high-blood-pressure; Whelton, P. K., Carey, R. M., Aronow, W. S., et al. (2017). 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension, 71*(6), e13–e115.

Hypertension is categorized as either primary hypertension or secondary hypertension. **Primary hypertension** (also called *essential hypertension*) is diagnosed when there is no identifiable cause (Alexander, 2019). Approximately 90% to 95% of adults with hypertension have primary hypertension.

Secondary hypertension is defined as high blood pressure from an identifiable underlying cause. Between 5% and 10% of all adults with hypertension have secondary hypertension. Screening for secondary hypertension is indicated for new-onset, poorly controlled hypertension, in hypertension resistant to treatment with three or more drugs, with hypertension of an abrupt onset, or in patients younger than 30 years of age. In addition, a new diagnosis of hypertension with associated excessive target organ damage, such as cerebral vascular disease, retinopathy, left ventricular hypertrophy (LVH), heart failure with preserved ejection fraction, coronary artery disease, CKD, or peripheral arterial disease, could suggest secondary hypertension. Chart 27-2 displays some common underlying causes of secondary hypertension.

Pathophysiology

Blood pressure is the product of cardiac output multiplied by peripheral resistance. Cardiac output is the product of the heart rate multiplied by the stroke volume. Each time the heart contracts, pressure is transferred from the contraction of the myocardium to the blood and then pressure is exerted by the blood as it flows through the blood vessels. Hypertension can result from increases in cardiac output, increases in peripheral resistance (constriction of the blood vessels), or both. Increases in cardiac output are often related to an expansion in vascular volume. Although no precise cause can be identified for most cases of hypertension, it is understood that hypertension is a multifactorial condition. Because hypertension can be a sign, it is most likely to have many causes, just as fever has many causes (Norris, 2019). For hypertension to occur there must be a change in one or more factors affecting peripheral resistance or cardiac output. In addition, there must also be a problem with the body's control systems that monitor or regulate pressure (Fig. 27-1).

Chart 27-2

Common Causes of Secondary Hypertension

Chronic kidney disease
Coarctation of the aorta
Cushing's syndrome
Hyperaldosteronism (primary or secondary)
Hyperparathyroidism
Hypo- or hyperthyroidism
Medication abuse (nonsteroidal anti-inflammatory drugs [NSAIDs]) or substance abuse disorder (alcohol, cocaine, amphetamines)
Obstructive sleep apnea
Pheochromocytoma
Preeclampsia
Polycystic kidney disease
Prostatism
Renal artery stenosis

Adapted from Whelton, P. K., Carey, R. M., Aronow, W. S., et al. (2017). 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension, 71*(6), e13–e115.

Hypertension is thought to occur as a result of a complex interaction between behavioral–social–environmental risks and genetics (Zilbermint, Gaye, Berthon, et al., 2019). Behavioral–social–environmental risks may include dietary habits, including limited consumption of vegetables, fiber, fish fats, and potassium, and excessive intake of sodium; obesity; poor physical fitness; and excessive alcohol intake (Whelton et al., 2017).

Although single-gene mutations associated with hypertension have been identified, most types of hypertension are thought to be polygenic (i.e., mutations in more than one gene) (Whelton et al., 2017). The tendency to develop hypertension can be inherited; however, genetic profiles alone cannot predict who will and will not develop hypertension. The role of genetics in hypertension is complex and not fully understood at the present time.

To date, over 1000 genetic variants have been identified that may contribute to hypertension; however, collectively they explain only about 6% of the trait variance (Zilbermint et al., 2019).

Many physiologic precedents that can lead to hypertension have been identified (Caillon, Mian, Fraulob-Aquino, et al., 2017; Caillon et al., 2019; Norris, 2019):

- Increased sympathetic nervous system activity related to dysfunction of the autonomic nervous system

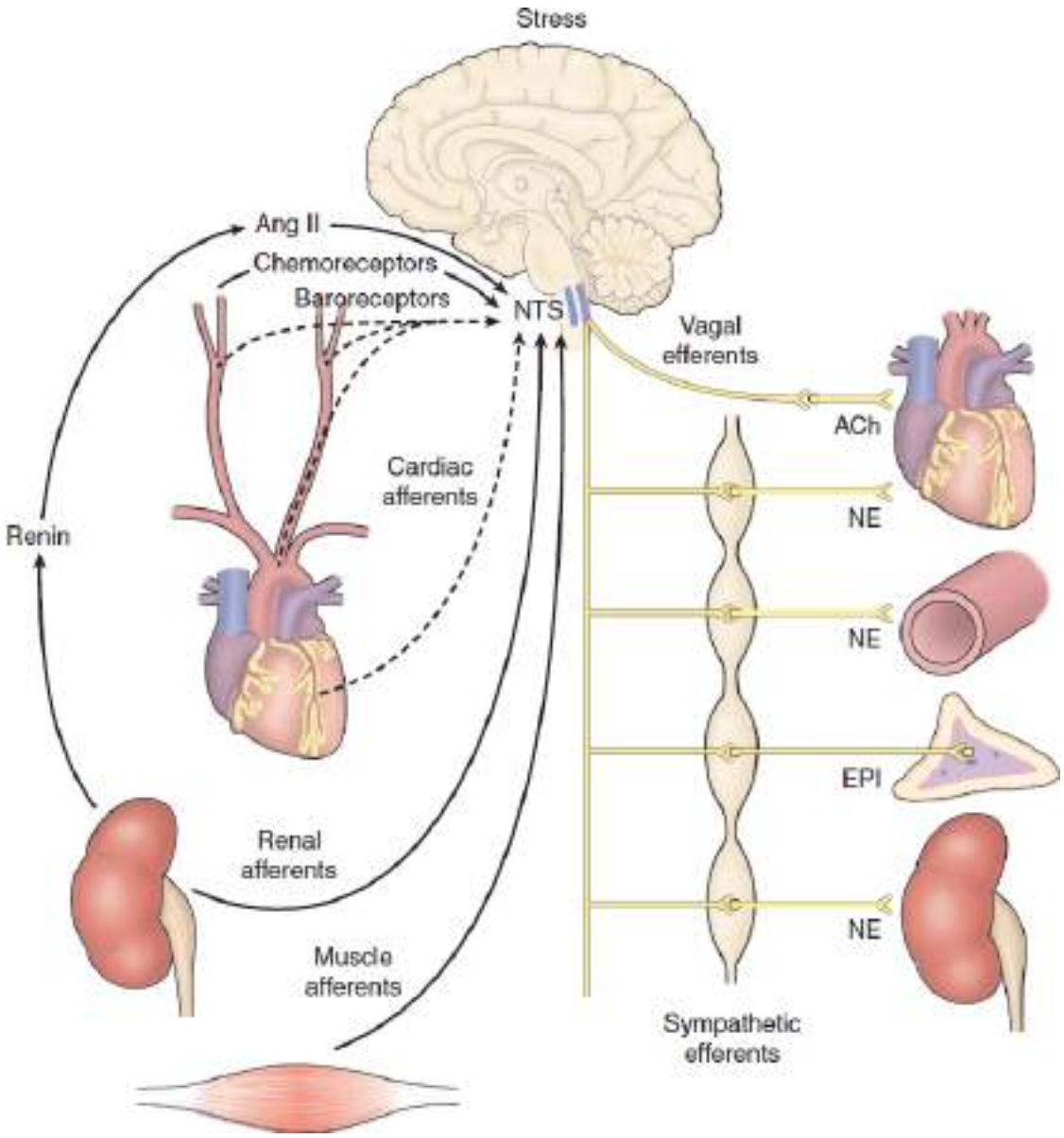

Figure 27-1 • Central and reflex mechanisms involved in the neural control of blood pressure. *Dotted arrows* represent inhibitory neural influences, and *solid arrows* represent excitatory neural influences on sympathetic outflow. ACH, acetylcholine; Ang II, angiotensin II; EPI, epinephrine; NE, norepinephrine; NTS, nucleus tractus solitarius. Adapted from Kaplan, N. M., & Victor, R. G. (2015). *Kaplan's clinical hypertension* (11th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

- Increased renal reabsorption of sodium, chloride, and water related to a genetic variation in the pathways by which the kidneys handle sodium
- Increased activity of the renin–angiotensin–aldosterone system, resulting in expansion of extracellular fluid volume and increased systemic vascular resistance

- Decreased vasodilation of the arterioles related to dysfunction of the vascular endothelium
- Resistance to insulin action, which may be a common factor linking hypertension, type 2 diabetes, hypertriglyceridemia, obesity, and glucose intolerance
- Activation of the innate and adaptive components of the immune response that contribute to vascular inflammation and dysfunction

Gerontologic Considerations

Structural and functional changes in the heart, blood vessels, and kidneys contribute to increases in blood pressure that occur with aging. These changes include accumulation of atherosclerotic plaque, fragmentation of arterial elastins, increased collagen deposits, impaired vasodilation, and renal dysfunction. The result of these changes is decreased elasticity or stiffening of the major blood vessels, particularly the aorta, and volume expansion (Eliopoulos, 2018; Fajemiroye, da Cunha, Saavedra-Rodríguez, et al., 2018). Hence, both SBP and DBP increase linearly up to the sixth decade of life. At that time, among most adults, DBP gradually decreases while SBP continues to rise. Thus, **isolated systolic hypertension** is the predominant form of hypertension in older people (Whelton et al., 2017). Results from randomized controlled studies have demonstrated that lowering blood pressure in older adults with isolated systolic hypertension is effective in reducing the incidence of adverse cardiovascular events and death (Whelton et al., 2017).

Clinical Manifestations

Physical examination may reveal no abnormalities other than elevated blood pressure. People with hypertension may be asymptomatic and remain so for many years. Hypertension is known as the “silent killer” because it typically has no warning signs or symptoms, and many people do not know they have it. However, when specific signs and symptoms appear, they usually indicate vascular damage, with specific manifestations related to the organs served by the involved vessels. These specific manifestations of pathophysiologic changes in various organs as a consequence of hypertension are referred to as **target organ damage**. Retinal changes such as hemorrhages, exudates (fluid accumulation), arteriolar narrowing, and cotton-wool spots (small infarctions) may occur. In severe hypertension, papilledema (swelling of the optic disc) may be seen (Weber & Kelley, 2018). Coronary artery disease with angina and myocardial infarction (MI) are common consequences of hypertension. LVH occurs in response to the increased workload placed on the ventricle as it contracts against higher systemic pressure. When heart damage is extensive, heart failure follows. Pathologic changes in the kidneys (indicated by

increased blood urea nitrogen [BUN] and serum creatinine levels) may manifest as nocturia. Cerebrovascular involvement may lead to a transient ischemic attack (TIA) or stroke, manifested by alterations in vision or speech, dizziness, weakness, a sudden fall, or transient or permanent hemiplegia (paralysis on one side). Cerebral infarctions account for most of the strokes in patients with hypertension (Norris, 2019).

Assessment and Diagnostic Findings

The first step of diagnosis is an accurate blood pressure measurement (see Chart 27-3 for an overview of appropriate BP measurement equipment, instructions, and interpretation for both the patient and the clinician). It is important to use an average of at least two blood pressure readings on at least two occasions to confirm the diagnosis of hypertension for most patients. The notable exception is when a patient's average BP is greater than or equal to 160/100 mm Hg, confirmed by at least two accurate readings on one occasion (see later discussion) (Muntner, Shimbo, Carey, et al., 2019; Whelton et al., 2017).

Blood pressure measurement within a clinical setting is often not an accurate reading; therefore, home blood pressure measurement (HBPM) or ambulatory blood pressure measurement (ABPM) are considered more accurate reflections of the blood pressure status. HBPM and ABPM are used not only to confirm the diagnosis of hypertension in most cases, but also to evaluate whether success has been achieved with treatments, such as lifestyle modifications and prescription medications (see later discussion) (Whelton et al., 2017).

Utilizing HBPM and ABPM measurements have led to recognizing other manifestations of blood pressure. Examples of these alternative manifestations of hypertension include masked hypertension and white coat hypertension. Patients with **masked hypertension** exhibit elevated blood pressure at levels typically consistent with hypertension in settings outside the hospital or clinic, while their blood pressure is seemingly normal in health care settings. In contrast, patients with **white coat hypertension** have blood pressure readings that would suggest a diagnosis of hypertension when they are in health care settings (e.g., clinics), but are within the normal ranges in other settings. If untreated, the patient with masked hypertension can go on to experience adverse cardiovascular events (e.g., MI, strokes) and mortality. On the other hand, the patient with white coat hypertension may receive treatment that is not warranted (Cohen, Lotito, Trivedi, et al., 2019).

Chart 27-3

Measuring Blood Pressure

Equipment

For the Patient at Home

- Automatic or semiautomatic upper-arm electronic device with digital display of readings

For the Practitioner

- Preferably, a validated electronic oscillometric device; if not available, a recently calibrated aneroid sphygmomanometer
- Appropriately sized arm cuff

Instructions for the Patient

- Avoid eating, smoking, drinking caffeinated beverages, and physical activity for 30 min before blood pressure (BP) is measured.
- Empty bladder.
- Sit quietly for 5 min before the measurement.
- Sit comfortably, with back supported, with the forearm supported at heart level on a firm surface, with both feet on the ground; avoid talking while the measurement is being taken.

Instructions for the Practitioner

- Select the size of the cuff based on the size of the patient. (The cuff size should have a bladder width of at least 40% of limb circumference and length 80–100% of limb circumference.) Small adult cuffs are 12 cm wide and 22 cm long, average adult cuffs are 16 cm wide and 30 cm long, large adult cuffs are 16 cm wide and 36 cm long, and extra-large adult cuffs are 16 cm wide and 42 cm long. Using a cuff that is too small will give a higher BP measurement, and using a cuff that is too large results in a lower BP measurement compared to one taken with a properly sized cuff.
- Wrap the cuff firmly around the arm. Center the cuff bladder directly over the brachial artery.
- Position the patient's arm at the level of the heart.
- If an aneroid sphygmomanometer is used, palpate the systolic pressure before auscultating. This technique helps to detect the presence of an auscultatory gap more readily.
- Ask the patient to sit quietly while the BP is measured, because the BP can increase when the patient is engaged in conversation.
- Initially, record BP results of both arms and take subsequent measurements from the arm with the higher BP. Normally, the BP should vary by no more than 5 mm Hg between arms.
- Take two readings 1–2 min apart and use the average of these measurements.

- Record the site where the BP was measured and the position of the patient (i.e., right arm).
- Inform the patient of their BP value and what it means. Emphasize the need for periodic reassessment, and encourage patients who measure BP at home to keep a written record of readings.

Interpretation

Assessment is based on the average of at least two readings. (If two readings differ by more than 5 mm Hg, additional readings are taken and an average reading is calculated from the results.)

Adapted from Muntner, P., Shimbo, D., Carey, R. M., et al. (2019). Measurement of blood pressure in humans: A scientific statement from the American Heart Association. *Hypertension, 73(*5), e35–e66; Padwal, R., Campbell, N. R. C., Schutte, A. E., et al. (2019). Optimizing observer performance of clinic blood pressure measurement: A position statement from the Lancet Commission on Hypertension Group. *Journal of Hypertension, 37*(9), 1737–1745.

A thorough health history and physical examination are necessary to ensure successful diagnosis and treatment. The onset of high blood pressure and the patient's health history can be used to determine whether the patient might have primary hypertension or secondary hypertension (see Chart 27-2).

Abnormal findings from the physical examination could suggest either target organ damage or secondary hypertension. The physical examination should include palpation of all peripheral pulses. Absent, weak, or delayed femoral pulses could suggest coarctation of the aorta or severe peripheral vascular disease. The neck should be examined for carotid bruits, distended veins, or an enlarged thyroid gland. The upper abdomen should be auscultated for the presence of a renal artery bruit that could be suggestive of renal artery stenosis. A careful cardiac examination is also needed to evaluate for signs of LVH. LVH signs include displacement of the apex, a sustained and enlarged apical impulse, and the presence of an S_4 cardiac sound (see Chapter 21) (Weber & Kelley, 2018).

Occasionally, signs of hypertension can be discovered during a fundoscopic eye examination manifested as hypertensive retinopathy (e.g., retinal hemorrhages, microaneurysms, cotton-wool spots, papilledema); these findings are associated with an increased cardiovascular risk (e.g., stroke). Acute or chronic ocular changes can be the initial finding in asymptomatic patients and typically require a referral to an ophthalmologist. Long-standing, untreated hypertension can cause heart failure, CKD (elevated BUN and creatinine), and increased risk for cerebrovascular disease (e.g., TIAs, strokes) (Weber & Kelley, 2018).

Laboratory tests are also performed to assess for possible target organ damage and to screen for primary hypertension or secondary hypertension.

These typically include urinalysis, blood chemistry (i.e., analysis of sodium, potassium, creatinine, fasting glucose, cholesterol levels), and a 12-lead electrocardiogram. LVH can be assessed by echocardiography. Renal damage may be suggested by elevations in BUN and creatinine levels or by microalbuminuria or macroalbuminuria. Additional studies, such as creatinine clearance, renin level, urine tests, and 24-hour urine protein, may be performed. Optional testing may include uric acid and urine albumin to creatinine ratio (Whelton et al., 2017).

Medical Management

The goal of hypertension treatment is to prevent complications (i.e., target organ damage) and death by maintaining a blood pressure lower than 130/80 mm Hg. Findings from a systematic review and meta-analysis demonstrated that hypertension treatment that effectively achieves the aim of BP control to normal levels is associated with lower mortality and lower rates of CVD (Brunstrom & Carlberg, 2018). The optimal treatment plan is one that is inexpensive, simple, and causes the least possible disruption in the patient's life.

The ACC/AHA Guidelines (Whelton et al., 2017) have developed a series of recommendations for prevention, treatment, and management of hypertension. In addition, these guidelines specify that a diagnosis of hypertension must be made based on accurate blood pressure measurements (see Chart 27-3). As noted previously, an average of at least two blood pressure readings on at least two occasions should be used to confirm the diagnosis of hypertension for most patients. After having the BP measured to screen for hypertension, a patient not previously diagnosed with hypertension and with a normal BP (i.e., SBP less than 120 mm Hg and DBP less than 80 mm Hg) can be advised to have the BP reevaluated in 1 year. A patient without a prior diagnosis of hypertension with an elevated BP (i.e., SBP 120 to 129 mm Hg and DBP less than 80 mm Hg) should be advised to follow up with additional BP readings within 3 to 6 months. A patient with a BP that could be consistent with hypertension; that is, with an SBP greater than or equal to 130 mm Hg or a DBP greater than or equal to 80 mm Hg should follow-up with additional BP readings within 1 month's time to either confirm or rule out the diagnosis (Muntner et al., 2019; Whelton et al., 2017). So that patients with suspected white coat hypertension or masked hypertension may be accurately diagnosed, blood pressure readings should be based on HBPM or ABPM. Patients not instructed to follow up with additional BP readings to confirm a diagnosis of hypertension are patients with average BP readings greater than or equal to 160/100 mm Hg on one occasion; these patients are diagnosed with hypertension and begin treatment with antihypertensive medications (Muntner et al., 2019; Whelton et al., 2017).

All patients who report lifestyle choices that may put them at risk for hypertension should be counseled to adopt lifestyle changes, as appropriate. These lifestyle changes could include weight loss, dietary changes, physical activity modifications, decreased alcohol consumption, and smoking cessation (Table 27-2). In particular, the *Dietary Approach to Stop Hypertension* (DASH) diet has been one of the most effective diets in lowering BP; if used in conjunction with weight loss, this diet can lower SBP by 11 to 16 mm Hg (Campbell, 2017) (Table 27-3). In addition to this dietary advice, patients should be counseled to incorporate a low sodium (less than 2 g/day), high potassium (3500 to 5000 mg/day) diet; this dietary combination is more effective than following either a lone low sodium or high potassium diet (Perez & Chang, 2014). A high potassium diet must be avoided in patients with CKD, however.

Patients suspected to have secondary hypertension must be accurately screened and the disorder that caused the high blood pressure must be properly treated in order to bring the patient's blood pressure into normal parameters (see Chart 27-2). The recommended treatment for patients with elevated blood pressure but who are not diagnosed with hypertension is lifestyle changes, not antihypertensive medications, with follow-up in 3 to 6 months, as noted previously, to not only reevaluate the blood pressure but to see if it has responded positively to lifestyle modifications (Whelton et al., 2017).

The primary provider is advised by the ACC/AHA Guidelines (Whelton et al., 2017) to screen the patient diagnosed with Stage 1 hypertension for risk of having adverse cardiac events (e.g., stroke, MI) within the next 10 years by using the online *ASCVD Risk Estimator Plus.* This tool is published by the ACC and is free to use (links to this tool are provided in the Resources section at the end of this chapter). This tool screens patients based on factors that include blood pressure readings, age, gender, lipid panel results, use of medications, smoking status, and whether or not they have concomitant diabetes. The risk of having an adverse cardiac event is then determined as low, borderline, or high. Those patients with a score of 10 or higher (consistent with mid-borderline risk) should be prescribed an antihypertensive medication, as should any patient diagnosed with stage 2 hypertension. All patients should be advised to institute relevant lifestyle changes, regardless of stage and use of antihypertensive medications.

TABLE 27-2 Lifestyle Modifications to Prevent and Manage Hypertension[a]

Modification	Recommendation	Impact on SBP Reduction[b] Patients without Hypertension	Impact on SBP Reduction[b] Patients with Hypertension
Weight reduction	Maintain normal body weight (body mass index 18.5–24.9 kg/m^2). Ideal body weight is best goal; but aim for at least 1 kg (2.2 lb) weight loss. Expect ~ 1 mm Hg SBP decrease per 1 kg reduction in weight.	−2–3 mm Hg	−5 mm Hg
Adopt DASH eating plan	Consume a diet rich in fruits, vegetables, and low-fat dairy products with a reduced content of saturated and total fat.	−3 mm Hg	−11 mm Hg
Dietary sodium reduction	Sodium <2 g/day is optimal goal; but aim for at least 1000 mg/day reduction. Check sodium amount on food labels.	−2–3 mm Hg	−5–6 mm Hg
Dietary potassium increase	Preferred potassium intake is 3500–5000 mg/day. Choose high potassium foods; check potassium amount on food labels.	−2 mm Hg	−4–5 mm Hg
Physical activity	Engage in: Regular aerobic physical activity such as brisk walking 90–150 min weekly Regular dynamic resistance training 90–150 min weekly Regular isometric resistance training at least three times weekly	−2–4 mm Hg −2 mm Hg −4 mm Hg	−5–8 mm Hg −4 mm Hg −5 mm Hg
Moderation of alcohol consumption	Limit consumption to ≤2 drinks (e.g., 24-oz beer, 10-oz wine, or 3-oz 80-proof whiskey) per day in most men and to ≤1 drink per day in women.	−3 mm Hg	−4 mm Hg

[a]For overall cardiovascular risk reduction, stop smoking.

[b]The effects of implementing these modifications are dose and time dependent and could be greater for some individuals.

DASH, dietary approaches to stop hypertension; SBP, systolic blood pressure.

Adapted from Whelton, P. K., Carey, R. M., Aronow, W. S., et al. (2017). 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: A

report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension*, *71*(6), e13–e115.

Pharmacologic Therapy

Research findings have demonstrated that appropriately prescribing antihypertensive pharmacologic agents lowers BP, and reduces the risk of CVD, cerebrovascular disease, and death (Whelton et al., 2017). Many classes of medications are available for hypertension management (Table 27-4). The medications that have been shown to prevent CVD are recommended as first-line agents for most patients. This first-line group includes thiazide or thiazide-type diuretics, angiotensin-converting enzyme (ACE) inhibitors, angiotensin receptor blockers (ARBs), and calcium channel blockers (CCBs). African American patients with hypertension and without heart failure or CKD should be prescribed either a thiazide diuretic or a CCB as a first-line agent (not an ACE inhibitor or an ARB). The recommended first-line antihypertensive agents for patients with select comorbid disorders or who are pregnant are displayed in Table 27-5.

TABLE 27-3 The DASH (Dietary Approaches to Stop Hypertension) Diet

Food Group	Number of Servings Daily
Grains and grain products	7 or 8
Vegetables	4 or 5
Fruits	4 or 5
Low-fat or fat-free dairy foods	2 or 3
Lean meat, fish, and poultry	≤2
Nuts, seeds, and dry beans	4 or 5 servings weekly

Note: The diet is based on 2000 calories/day.

Adapted from U.S. Department of Health and Human Services. (2003). Your guide to lowering your blood pressure with DASH: DASH eating plan. Retrieved on 9/27//2019 at: www.nhlbi.nih.gov/health/public/heart/hbp/dash/new_dash/pdf

Patients are first prescribed low doses of medication. If blood pressure does not fall to less than 130/80 mm Hg, the dose is increased gradually and additional medications are included as necessary to achieve control. The simplest treatment schedule possible is ideal as it promotes adherence to the regimen (e.g., one pill once each day, two or more agents combined into a single pill).

Resistant hypertension is diagnosed when a patient takes at least three antihypertensive medications from different classes (including a diuretic) and the blood pressure is still not controlled (i.e., not less than 130/80 mm Hg). A patient with controlled blood pressure but who requires at least four antihypertensive medications in order to maintain that control is also

considered to have resistant hypertension (Whelton et al., 2017). Risk factors for resistant hypertension include older age, being African American, and having obesity, CKD, or diabetes. Treatment of patients with suspected resistant hypertension first revolves around ensuring that they are indeed adhering to their prescribed medication regimen, including ensuring that their finances do not preclude them from purchasing their prescriptions, that they understand the purpose of the medications, and that medication side effects are tolerable. Patients with suspected resistant hypertension should also be evaluated for possible secondary hypertension (Whelton et al., 2017).

TABLE 27-4 Oral Medication Therapy for Hypertension

Medications	Major Actions	Advantages and Contraindications	Effects and Nursing Considerations
First-Line Antihypertensive Agents			
Thiazide or Thiazide-Type Diuretics			
chlorthalidone[a] hydrochlorothiazide indapamide metolazone [a]*preferred agent for its long half-life.*	Decrease of blood volume, renal blood flow, and cardiac output. Depletion of extracellular fluid. Negative sodium balance (from natriuresis), mild hypokalemia. Directly affect vascular smooth muscle.	Relatively inexpensive. Effective orally. Effective during long-term administration. Mild side effects. Enhance other antihypertensive medications. Counter sodium retention effects of other antihypertensive medications. *Contraindications:* Gout, known sensitivity to sulfonamide-derived medications, severely impaired kidney function, and history of hyponatremia.	Side effects include dry mouth, thirst, weakness, drowsiness, lethargy, muscle aches, muscular fatigue, tachycardia, GI disturbance. Orthostatic hypotension may be potentiated by alcohol, barbiturates, opioids, or hot weather. Because thiazides cause loss of sodium, potassium, and magnesium, and increase in uric acid and calcium, monitor for signs of electrolyte imbalance. Encourage intake of potassium-rich foods. *Gerontologic considerations:* Risk of orthostatic hypotension.
ACE Inhibitors			
benazepril captopril enalapril fosinopril lisinopril moexipril perindopril quinapril	Inhibit conversion of angiotensin I to angiotensin II. Lower total peripheral resistance.	Angioedema is a rare but potentially life-threatening complication. *Contraindications:* Concomitant use of an ARB or a renin inhibitor or a	Can cause hyperkalemia. Side effect can include cough. *Gerontologic considerations:* Require reduced dosages and the

ramipril trandolapril		potassium-sparing diuretic or potassium supplements; bilateral renal artery stenosis, pregnancy; history of angioedema with prior use of an ACE inhibitor.	addition of loop diuretics when there is renal dysfunction. May cause upregulation of ACE2 receptors, making patients more susceptible to infection with SARS-CoV-2; however, may also mitigate deleterious effects of COVID-19.
Angiotensin Receptor Blockers			
azilsartan candesartan eprosartan irbesartan losartan olmesartan telmisartan valsartan	Block the effects of angiotensin II at the receptor. Reduce peripheral resistance.	Minimal side effects. *Contraindications:* Concomitant use of an ACE inhibitor or a renin inhibitor or a potassium-sparing diuretic or potassium supplements; bilateral renal artery stenosis; history of angioedema with prior use of an ARB; pregnancy, lactation, renovascular disease.	Monitor for hyperkalemia. Can be prescribed for patients with a history of angioedema from ACE inhibitor; however, must wait 6 wks to take after ACE inhibitor stopped. May cause upregulation of ACE2 receptors, making patients more susceptible to infection with SARS-CoV-2; however, may also mitigate deleterious effects of COVID-19.
Calcium Channel Blockers—Dihydropyridines			
amlodipine felodipine isradipine nicardipine SR nifedipine LA nisoldipine	Inhibit calcium ion influx across membranes. Vasodilatory effects on coronary arteries and	Rapid action. Effective by oral or sublingual route. No tendency to slow SA nodal activity or prolong AV node conduction.	Can cause pedal edema, which is more common in women. Administer on empty stomach; recommend

	peripheral arterioles. Decrease cardiac work and energy consumption, increase delivery of oxygen to myocardium.	Useful drug in treating isolated systolic hypertension. *Contraindication:* HFrEF (but can use amlodipine or felodipine, if necessary).	eating small, frequent meals if complaint of nausea. Use with caution in patients with diabetes. Muscle cramps, joint stiffness, sexual dysfunction may disappear if dose decreased. Report irregular heartbeat, constipation, shortness of breath, edema. May cause dizziness.
Calcium Channel Blockers—Nondihydropyridines			
diltiazem ER verapamil IR verapamil SR verapamil—delayed-onset ER	Inhibit calcium ion influx. Reduce cardiac afterload. Slow velocity of conduction of cardiac impulse.	Avoid concomitant dosing with beta-blockers. *Contraindications:* HFrEF; sinus node dysfunction, AV block.	Do not discontinue suddenly. Observe for hypotension. Report irregular heartbeat, dizziness, edema. Instruct on regular dental care because of potential gingivitis. Metabolized via cytochrome p450 system; therefore, many potential drug interactions.
Second-Line Antihypertensive Agents			
Diuretics—Loop			
bumetanide furosemide torsemide	Volume depletion. Block reabsorption of sodium, chloride, and water in renal tubules.	Preferred diuretics for patients with symptomatic HF and for patients with moderate to severe CKD.	Risk of volume and electrolyte depletion; monitor for hypokalemia. *Gerontologic considerations:*

		Contraindications: Same as for thiazide diuretics.	Risk for orthostatic hypotension.
Diuretics—Potassium-Sparing			
amiloride triamterene	Block sodium reabsorption. Act on distal tubule independently of aldosterone.	Not particularly effective antihypertensive drugs when prescribed as lone agents; can be effective when prescribed with a thiazide diuretic in patients with hypokalemia; causes potassium retention. *Contraindications:* Significant CKD, severe hepatic disease, hyperkalemia.	Drowsiness, lethargy, headache. Monitor for hyperkalemia if given with ACE inhibitor or ARB. Diarrhea and other GI symptoms—administer medication after meals.
Diuretics—Aldosterone Antagonists			
eplerenone spironolactone	Competitive inhibitors of aldosterone binding.	Indicated for patients with primary aldosteronism and resistant hypertension. *Contraindications:* Hyperkalemia and impaired renal function.	Drowsiness, lethargy, headache. Monitor for hyperkalemia if given with ACE inhibitor or ARB. Diarrhea and other GI symptoms—administer medication after meals. Avoid the use of potassium supplements or salt substitutes. Spironolactone may cause gynecomastia.
Beta-Blockers—Cardioselective			
atenolol betaxolol bisoprolol metoprolol tartrate metoprolol succinate	Selectively block the beta-1 adrenergic receptors of the sympathetic nervous system, slowing the heart rate and lowering	Not recommended as first-line antihypertensive agents unless the patient has HF or CAD. Bisoprolol or metoprolol succinate preferred	Avoid sudden discontinuation. Side effects may include insomnia, lassitude, weakness, fatigue and

	the blood pressure.	agents for patients with HFrEF. These agents are preferred over noncardioselective beta-blockers if patient has asthma, reactive airway disease, or COPD. *Contraindications:* Heart block, symptomatic bradycardia.	occasionally nausea, vomiting, and epigastric distress.
Beta-Blockers—Cardioselective and Vasodilatory			
nebivolol	Blocks beta-1 adrenergic receptors and induces nitric oxide vasodilation.	Similar to other beta-blockers with additional capacity for vasodilation. *Contraindications:* Similar to beta-blockers but with greater risk of severe bradycardia, heart block, cardiogenic shock, decompensated cardiac failure, sinus node dysfunction.	Avoid sudden discontinuation. Side-effect profile similar to other beta-blockers.
Beta-Blockers—Noncardioselective			
nadolol propranolol propranolol LA timolol	Nonselectively block the beta-adrenergic receptors of the sympathetic nervous system with intended effects of slowing the heart rate and lowering the blood pressure.	*Contraindications:* Asthma, reactive airway disease, COPD, heart block, symptomatic bradycardia.	Avoid sudden discontinuation. Side effects may include insomnia, lassitude, weakness, fatigue and occasionally nausea, vomiting, and epigastric distress.
Beta-Blockers—Intrinsic Sympathomimetic Activity			
acebutolol penbutolol pindolol	Block both beta-1 and beta-2 receptors. Also has antiarrhythmic activity by slowing	*Contraindications:* Avoid use in patients with HFrEF.	Avoid sudden discontinuation. Side-effect profile similar to other beta-blockers.

	atrioventricular conduction.		
Beta-Blockers—Combined Alpha- and Beta-Receptor Blockers			
carvedilol carvedilol phosphate CR labetalol	Block alpha- and beta-adrenergic receptors. Cause peripheral dilation and decrease peripheral vascular resistance.	Carvedilol is a preferred agent for patient with HFrEF. *Contraindications:* Asthma, reactive airway disease, COPD, heart block, symptomatic bradycardia, cardiogenic shock, severe tachycardia.	Avoid sudden discontinuation. Side-effect profile similar to other beta-blockers.
Direct Renin Inhibitor			
Aliskiren	Blocks the conversion of angiotensinogen to angiotensin I by inhibiting the activity of the enzyme renin.	Cannot be given in combination with ACE inhibitors or ARBs. Very long acting. Contraindicated in pregnancy.	Monitor for hyperkalemia, especially for patients with CKD, or patients taking potassium supplements.
Alpha-1 Blockers			
doxazosin prazosin terazosin	Peripheral vasodilator acting directly on the blood vessel; action similar to direct vasodilators.	May be second-line agent in men with BPH. *Contraindication:* CAD.	Associated with orthostasis, especially in older adults.
Central Alpha$_2$-Agonists and Other Centrally Acting Drugs			
clonidine clonidine patch guanfacine methyldopa	clonidine: Exact mode of action is not understood, but acts through the central nervous system, apparently through centrally mediated alpha-adrenergic stimulation in the brain, producing blood pressure reduction. guanfacine:	Generally last-line agents—sometimes can be effective when other medications fail to lower blood pressure. Methyldopa may be drug of choice during pregnancy. *Contraindication:* Severe coronary artery disease.	Dry mouth, drowsiness, sedation, and occasional headaches and fatigue. Anorexia, malaise, and vomiting with mild disturbance of liver function have been reported. Rebound hypertension or hypertensive

	Stimulates central alpha$_2$-adrenergic receptors. methyldopa: Dopa decarboxylase inhibitor; displaces norepinephrine from storage sites.		crisis is relatively common with withdrawal of clonidine; medication dosage should be tapered down when discontinuing clonidine and BP monitored carefully.
Direct Vasodilators			
hydralazine minoxidil	Direct vasodilatory action on smooth muscle of blood vessels, causing decreased peripheral vascular resistance.	Typically used in combination with other medications (diuretics, beta-blockers). Used also in pregnancy-induced hypertension. *Contraindications:* Angina or coronary disease, heart failure, hypersensitivity.	Sodium and fluid retention and reflex tachycardia are common effects; headache, flushing, and dyspnea may occur. Hydralazine may produce lupus erythematosus–like syndrome. Minoxidil may cause hirsutism.

ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; AV, atrioventricular; BP, blood pressure; BPH, benign prostatic hyperplasia; CAD, coronary artery disease; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; COVID-19, coronavirus disease 2019; CR, controlled release; ER, extended release; GI, gastrointestinal; HF, heart failure; HFrEF, heart failure with reduced ejection fraction; IR, intermediate release; LA, long acting; SA, sinoatrial; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; SR, sustained release.

Adapted from Comerford, K. C., & Durkin, M. T. (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer; Guo, J., Huang, Z., Lin, L., et al. (2020). Coronavirus disease 2019 (COVID-19) and cardiovascular disease: A viewpoint on the potential influence of angiotensin-converting enzyme inhibitors/angiotensin receptor blockers on onset and severity of severe acute respiratory syndrome coronavirus 2 infection. *Journal of the American Heart Association*, *9*, e016219. doi:10.1161/JAHA.120.016219; Sommerstein, R., Kochen, M. M., Messerli, F. H., et al. (2020). Coronavirus disease 2019 (COVID-19): Do angiotensin-converting enzyme inhibitors/angiotensin receptor blockers have a biphasic effect? *Journal of the American Heart Association*, *9*, e016509. doi:10.1161/JAHA.120.016509; Vaduganathan, M., Vardeny, O., Michel, T., et al. (2020). Renin-angiotensin-aldosterone system inhibitors in patients with COVID-19. *The New England Journal of Medicine*, *382*(17), 1653–1659; Whelton, P. K., Carey, R. M., Aronow, W. S., et al. (2017). 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: A report of the American College of Cardiology/American

Heart Association Task Force on Clinical Practice Guidelines. *Hypertension*, *71*(6), e13–e115.

TABLE 27-5 Oral Antihypertensive Medications for Patients with Select Comorbid Diseases or Who Are Pregnant

Comorbid Disease or Special Patient Group	First-Line Antihypertensive Agents	Second-Line Antihypertensive Agents Comments
Stable coronary artery disease (e.g., myocardial infarction, angina) without heart failure	Beta-blockers, specifically carvedilol, metoprolol tartrate, metoprolol succinate, nadolol, bisoprolol, propranolol, or timolol; or ACE inhibitors; or ARBs.	Dihydropyridine calcium channel blockers may be prescribed if BP goal is not met and patient has continued angina. Dihydropyridine calcium channel blockers, thiazide diuretics, or aldosterone receptor antagonist diuretics may be prescribed if BP goal is not met.
Heart failure with reduced ejection fraction (HFrEF)	ACE inhibitors; ARBs; angiotensin receptor-neprilysin inhibitor (i.e., sacubitril-valsartan); aldosterone receptor antagonist diuretics; other diuretics; or beta-blockers, specifically carvedilol, metoprolol succinate, or bisoprolol.	Nondihydropyridine calcium channel blockers are NOT recommended. ACE inhibitors and ARBs should not be prescribed concomitantly.
Heart failure with preserved ejection fraction (HFpEF)	Diuretics should be prescribed to control hypertension when volume overload is present.	Nondihydropyridine calcium channel blockers are NOT recommended.
Chronic kidney disease (CKD) or kidney transplant	ACE inhibitors.	ARBs may be prescribed if patient is intolerant of ACE inhibitors. ACE inhibitors and ARBs should not be prescribed concomitantly.
Diabetes	Diuretics, calcium channel blockers, ACE inhibitors, or ARBs.	ACE inhibitors or ARBs are preferred if albuminuria is present.
History of atrial fibrillation	ARBs can prevent recurrence of atrial fibrillation and achieve BP control.	
Metabolic syndrome	The best first-line antihypertensive agent is not clear.	Caution with prescriptions of thiazide diuretics because they are associated with increased insulin resistance, dyslipidemia, increased uric

		acid and progression to diabetes.
Pregnancy	Stop ACE inhibitors, ARBs, and/or direct renin inhibitors due to teratogenic effects. Transition to methyldopa, nifedipine, and/or labetalol.	Beta-blockers or calcium channel blockers appear superior to other options for preventing preeclampsia.

ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; BP, blood pressure.

Adapted from DePalma, S. M., Himmelfarb, C. D., MacLaughlin, E. J., et al. (2018). Hypertension guideline update: A new guideline for a new era. *Journal of the American Academy of Physician Assistants*, *31*(6), 16–22; Whelton, P. K., Carey, R. M., Aronow, W. S., et al. (2017). 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension*, *71*(6), e13–e115.

COVID-19 Considerations

The coronavirus disease 2019 (COVID-19) pandemic began in Wuhan, China, in late 2019. Since that time, several risks for both severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and pathogenesis to coronavirus disease (COVID-19) have been posed. Epidemiologic findings from early data in China suggest that having a history of hypertension could be an important risk factor for becoming infected with SARS-CoV-2 as well as for being hospitalized to manage COVID-19 (Guo, Huang, Lin, et al., 2020; Sommerstein, Kochen, Messerli, et al., 2020; Vaduganathan, Vardeny, Michel, et al., 2020; Yang, Tan, Zhou, et al., 2020).

Because it is a virus, the SARS-CoV-2 pathogen must replicate within host cells. SARS-CoV-2 gains entry into host cells through the ACE2 cellular surface receptors, which are key to regulating the renin–angiotensin–aldosterone system (Fig. 27-2). ACE2 converts angiotensin II to angiotensin 1–7. ACE2 receptors are particularly abundant in type II alveolar cells (also called type II pneumocytes), vascular endothelial cells, and central nervous system tissue cells.

Patients who take ACE inhibitors or ARBs to manage hypertension tend to have an upregulation of ACE2 receptors (i.e., an increase in numbers of ACE2 receptors). Therefore, it is hypothesized that having an abundance of ACE2 receptors makes individuals with hypertension who take these medications more susceptible to SARS-CoV-2 infection; this hypothesis seems to explain the prevalence of patients with hypertension who also have COVID-19. However, it has also been found that, once infected with SARS-CoV-2, host cells will then downregulate ACE2 receptors, interfering with conversion of angiotensin II to angiotensin 1–7 (Vaduganathan et al., 2020). Angiotensin II

and angiotensin 1–7 have opposing effects. While angiotensin II causes vasoconstriction, high blood pressure, thrombosis, fibrosis, and inflammation, angiotensin 1–7 causes vasodilation, lower blood pressure, antithrombosis, and anti-apoptosis, and has anti-inflammatory effects (Guo et al., 2020). Thus, once infected with SARS-CoV-2, patients who take ACE inhibitors or ARBs might have a protective advantage over patients who do not take these medications, as patients who take ACE inhibitors or ARBs theoretically should have more ACE2 receptors (Sommerstein et al., 2020).

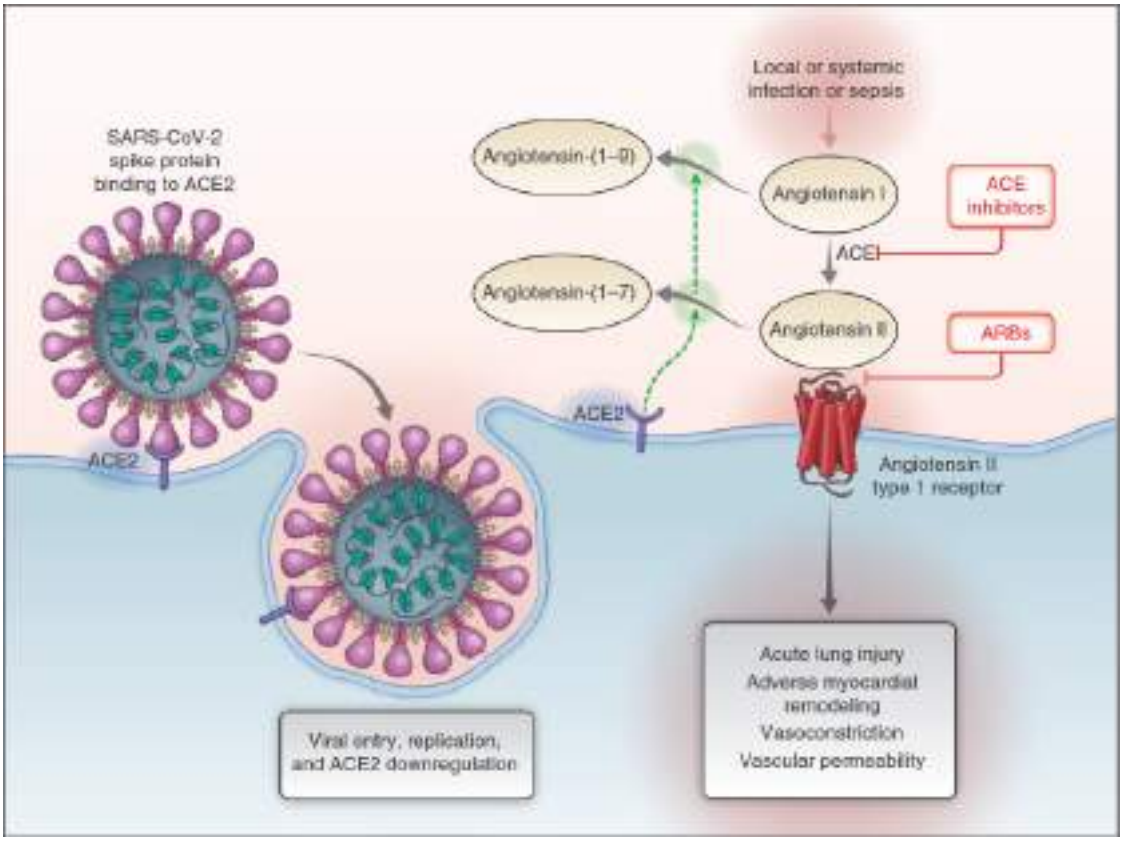

Figure 27-2 • Interaction between SARS-CoV-2 and the renin–angiotensin–aldosterone system. Shown is the initial entry of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) into cells, primarily type II pneumocytes, after binding to its functional receptor, angiotensin-converting enzyme 2 (ACE2). After endocytosis of the viral complex, surface ACE2 is further downregulated, resulting in unopposed angiotensin II accumulation. Local activation of the renin–angiotensin–aldosterone system may mediate lung injury responses to viral insults. ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker. Reprinted with permission from Vaduganathan, M., Vardeny, O., Michel, T., et al. (2020). Renin-angiotensin-aldosterone system inhibitors in patients with COVID-19. *The New England Journal of Medicine, 382*(17), 1653–1659.

Findings from a retrospective, single center study of patients hospitalized with COVID-19 in Wuhan, China, support the hypothesis that the use of ACE inhibitors or ARBs has a protective effect on patients with hypertension. In particular, patients with COVID-19 and hypertension who took these medications had significantly lower concentrations of C-reactive protein and procalcitonin (i.e., both are measures of inflammation) than patients with COVID-19 and hypertension who did not take these medications. In addition, fewer patients who took ACE inhibitors or ARBs were critically ill, and they had a lower mortality rate (Yang et al., 2020). Data to date supports continued use of both ACE inhibitors and ARBs in patients with hypertension during the COVID-19 pandemic (Guo et al., 2020; Sommerstein et al., 2020; Vaduganathan et al., 2020).

Gerontologic Considerations

The target blood pressure for all adults with hypertension is less than 130/80 mm Hg, regardless of age, including older adults (Whelton et al., 2017). There is a caveat, however, that community-dwelling, ambulatory older adults should be carefully monitored for adverse effects of prescribed antihypertensive medications, which can include falls, orthostatic hypotension, and reduced renal function. The usual adage for older adults commencing antihypertensive medications is to *start low and go slow;* that is, the medication regimen starts with a low medication dosage that is slowly increased over time as needed. For older adults with multiple comorbidities and limited life expectancy, advanced cognitive impairment, or who have had frequent falls, a less aggressive blood pressure target may be reasonable based on clinical judgment and patient preference (DePalma et al., 2018). Nonetheless, the *American College of Physicians (ACP)* and *American Academy of Family Physicians (AAFP)* recommend antihypertensive pharmacologic treatment of patients 60 years and older with a history of having had a stroke or a TIA to target SBP less than 140 mm Hg to reduce the risk of recurrent stroke (Qaseem, Wilt, Rich, et al., 2017).

NURSING PROCESS

The Patient with Hypertension

Assessment

Nurse-led hypertension management has demonstrated greater rates of blood pressure control than when nurses are not leading these management efforts (Himmelfarb, Commodore-Mensah, & Hill, 2016). In many health care settings, nurses provide the BP assessment, the education, and the counseling while actively engaging the patient to promote adherence to the treatment plan (Himmelfarb et al., 2016). Assessment includes BP assessment using the equipment, instructions, and interpretive guidelines displayed in Chart 27-3, and reviewing the patient's ambulatory or home blood pressure measurement technique and verifying its accuracy.

A complete history is obtained to assess for other cardiovascular risk factors and for signs and symptoms that indicate target organ damage (i.e., whether specific tissues are damaged by the elevated blood pressure). Manifestations of target organ damage may include angina; shortness of breath; alterations in speech, vision, or balance; nosebleeds; headaches; dizziness; or nocturia. The patient's partner may be helpful in identifying whether the patient may be experiencing obstructive sleep apnea (OSA), if the patient does not report being diagnosed or treated for OSA.

During the physical examination, the nurse must also pay specific attention to the rate, rhythm, and character of the apical and peripheral pulses to detect the effects of hypertension on the heart and blood vessels. A thorough assessment can yield valuable information about the extent to which the hypertension has affected the body and any other personal, social, or financial factors. For example, a patient's ability to adhere to an antihypertensive medication regimen may be influenced by the patient's financial resources to buy the medication and also by limited health insurance. Findings from research suggest that health beliefs, the presence of depressive symptoms, social support, and the presence of concomitant comorbidities might be associated with adherence to antihypertensive medication prescriptions (Spikes et al., 2019) (see the Nursing Research Profile in Chart 27-4).

Diagnosis

NURSING DIAGNOSES

Based on the assessment data, nursing diagnoses may include the following:

- Lack of knowledge regarding the relation between the treatment regimen and control of the disease process

- Impaired ability to manage regime as evidenced by difficulty adhering to prescribed regimen (e.g., lifestyle changes, antihypertensive medication prescriptions)

COLLABORATIVE PROBLEMS/POTENTIAL COMPLICATIONS

Potential complications may include the following:

- Left ventricular hypertrophy
- Myocardial infarction

Chart 27-4 NURSING RESEARCH PROFILE

Medication Adherence among African Americans with Hypertension

Spikes, T., Higgins, M., Quyyumi, A., et al. (2019). The relationship among health beliefs, depressive symptoms, medication adherence, and social support in African Americans with hypertension. *Journal of Cardiovascular Nursing*, *34*(1), 44–51.

Purpose

African American adults are disproportionately affected by hypertension. Not only is the prevalence of hypertension greater among African Americans than among Americans of other ethnic groups, African Americans tend to become hypertensive at earlier ages. They also tend to be at higher risk of having complications from hypertension earlier in life, including cardiovascular diseases such as strokes and heart failure, and chronic kidney disease. Evidence from previous research suggests that many African Americans hold different beliefs about the causes and consequences of hypertension than do patients with hypertension from other ethnic groups. These health beliefs are thought to affect adherence to prescribed antihypertensive medications. Furthermore, previous research suggests that depressive symptoms and social support may also affect adherence to prescribed medications. Therefore, the purpose of this study was to find associations between hypertension beliefs, depressive symptoms, social support, and medication adherence among African Americans with hypertension.

Design

This was a cross-sectional study that sampled African Americans with metabolic syndrome and hypertension managed with prescription antihypertensive medications (N = 120). Participants completed a series of surveys, including the medication taking subscale of the Hill-Bone Compliance to High Blood Pressure Therapy Scale, three select subscales of the Beliefs related to High Blood Pressure in African Americans Scale, the Beck Depression Index, and the Enhancing Recovery in Coronary Heart Disease Social Support Inventory.

Findings

Participants were mostly female (77%), with a mean age of 49.9 (±8.6) y. Slightly more than half of participants (54%) reported another comorbid condition in addition to having hypertension and metabolic syndrome. Approximately 37.5% of participants (n = 45) were deemed nonadherent to their prescribed antihypertensive regimen. Beliefs about high blood pressure, depressive symptoms, and social support were not found to correlate with antihypertensive medication adherence. However, participants with other comorbidities were found to have 2.63 times greater odds of adhering to their prescribed antihypertensive medications.

Nursing Implications

Findings from this study suggest that African Americans with hypertension may be more likely to adhere to their prescribed therapy if they have other comorbidities. The role of comorbidities among patients with hypertension needs to be further explored to determine how and why it might affect medication adherence. Nurses who manage the care of patients with hypertension should be cognizant that those without comorbidities might be at greater risk for nonadherence than those with multiple concomitant health disorders.

- Heart failure
- Cerebrovascular disease (TIA or stroke)
- Chronic kidney disease/end-stage renal disease
- Retinal hemorrhage

Planning and Goals

The major goals for the patient include understanding of the disease process and its treatment, participation in a self-care health management program, and absence of complications.

Nursing Interventions

The objective of nursing care for patients with hypertension focuses on lowering and controlling the blood pressure without adverse effects or undue cost. To achieve these goals, the nurse's role is to support and educate the patient about the treatment regimen, including making lifestyle changes, taking medications as prescribed, and scheduling regular follow-up appointments with the patient's primary provider to monitor progress or identify and treat any complications of disease or therapy.

Increasing Knowledge

The patient needs to understand the disease process and how lifestyle changes and medications can control hypertension. The nurse needs to emphasize the concept of controlling hypertension rather than curing it. The nurse can encourage the patient to consult a dietitian to help develop a plan for improving nutrient intake or for weight loss. Explaining that it takes 2–3 mo for the taste buds to adapt to changes in salt intake may help the patient adjust to reduced salt intake and consider herbs and seasonings that add flavor without adding salt. The patient should be advised to limit alcohol intake, and tobacco and nicotine should be avoided because anyone with high blood pressure is already at risk for heart disease, and use of cigarettes and electronic nicotine delivery systems (ENDS) including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars, amplifies this risk.

Promoting Effective Health Management

Deviating from the therapeutic health management program is a significant problem for people with hypertension and other chronic conditions requiring lifetime management. Blood pressure control is achieved by only 54% of patients (Whelton et al., 2017). Rates of blood pressure control are lowest among Mexican American men, at only 39% overall (Himmelfarb et al., 2016). Effective health management is more likely, however, when patients actively participate in self-care, including self-monitoring of blood pressure and diet, possibly because patients receive immediate feedback and have a greater sense of control. Nurse-led wellness programs that are tailored to the patients' behaviors and eating and exercise practices are more effective than generic programs. Patients with hypertension must make considerable effort to adhere to recommended lifestyle modifications (see Table 27-2) and to take regularly prescribed medications. The effort needed to follow the therapeutic plan may seem unreasonable to some, particularly when they have no symptoms without medications but do have side effects with medications. Continued education and encouragement are usually needed to enable patients to formulate an acceptable plan that helps them live with their hypertension and adhere to the treatment plans. Compromises may have to be made about some aspects of therapy to achieve higher-priority goals.

The nurse can assist with behavior change by supporting patients in making small changes with each visit that moves them toward their goals. Another important factor is following up at each visit to see how the patient has progressed with the plans made at the prior visit. If the patient has had difficulty with the plan, the patient and nurse should work together to develop an alternative or modification that the patient believes will be more successful. Support groups for weight control, smoking cessation, and stress reduction may be beneficial for some patients; others can benefit from the support of family and friends. The nurse assists the patient to develop and adhere to an appropriate exercise regimen, because regular activity is a significant factor in reducing blood pressure (Himmelfarb et al., 2016).

Promoting Home, Community-Based, and Transitional Care

If asked to participate in a blood pressure screening program, the nurse should ensure that proper blood pressure measurement technique is being used (see Chart 27-3), that validated electronic devices are used or, if aneroid sphygmomanometers are used, that they are properly calibrated, and that provision has been made to provide follow-up for any person identified as having an elevated blood pressure level. Adequate time should also be allowed to educate each person screened about what the blood pressure numbers mean. Each person should be given a written record of their blood pressure at the screening.

Educating Patients About Self-Care. The therapeutic regimen is the responsibility of the patient in collaboration with the primary provider. The nurse can help the patient achieve blood pressure control through education about managing blood pressure (see earlier discussion), setting goal blood pressures, and providing assistance with social support. Involving family members in education programs enables them to support the patient's efforts to control hypertension. The American Heart Association and the National Heart, Lung, and Blood Institute both provide printed and electronic patient education materials (see Resources section).

Providing written information about the expected effects and side effects of medications is important. When side effects occur, patients need to understand the importance of reporting them and to whom they should be reported. Patients need to be informed that **rebound hypertension** can occur. This phenomenon is characterized by a pathologically high blood pressure exhibited by patients who suddenly stop taking prescribed antihypertensive medications. Thus, patients should be advised to have an adequate supply of medication, particularly when traveling and in case of emergencies such as natural disasters. If traveling by airplane, patients should pack the medication in their carry-on luggage. All patients should be informed that some medications, such as beta-blockers, might cause sexual dysfunction and that other medications are available if problems with sexual function or satisfaction occur. The nurse can encourage and educate patients to measure their blood pressure at home. This practice involves patients in their own care and emphasizes that failing to take medications may result in an identifiable rise in blood pressure. Patients need to know that blood pressure varies continuously and that the range within which their pressure varies should be monitored.

Gerontologic Considerations. Adherence to the therapeutic program may be more difficult for the older adult. The medication regimen may be difficult to remember, and the expense can be a challenge. Simplification of the medication regimen to treatment with a single antihypertensive medication, if possible, is helpful. Many older adults are taking other prescription and over-the-counter medications, and verifying that there are no medication interactions is important. As noted previously, community-dwelling, ambulatory older adults should be carefully monitored for adverse effects of prescribed antihypertensive medications, which can include falls, orthostatic hypotension, and reduced renal function (e.g., the nurse should assess patient's urinary output and weight for changes from baseline). Special care must be taken to ensure the older patient understands the medication regimen, can see and read the instructions, open the medication container, and can get the prescription

refilled. The older adult's family or caregivers should be included in the educational program so that they understand the patient's needs, can encourage adherence to the treatment plan, and know when and whom to call if problems arise or further information is needed.

Continuing and Transitional Care. Regular follow-up care is imperative so that blood pressure control can be achieved. A history and physical examination should be completed at each clinic visit. The history should include all data pertaining to any potential problem, specifically medication-related problems such as orthostatic hypotension (experienced as dizziness or lightheadedness on standing). The patient should also bring a home blood pressure log and their own home blood pressure machine to verify accuracy and technique of home blood pressure monitor use. Patients and caregivers should also be given updated information at each visit on blood pressure medication, side effects, and important side effects to report immediately, such as low blood pressure or orthostatic hypotension. Low blood pressure readings can be due to impaired cardiovascular reflexes brought on by diuretics and other medication interactions.

Quality and Safety Nursing Alert

The patient and caregivers should be cautioned that antihypertensive medications might cause hypotension. Low blood pressure or orthostatic hypotension should be reported immediately. Older adults have impaired cardiovascular reflexes and thus are more sensitive to the extracellular volume depletion caused by diuretics and to the sympathetic inhibition caused by adrenergic antagonists. The nurse educates patients to change positions slowly when moving from a lying or sitting position to a standing position. The nurse also counsels older adult patients to use supportive devices such as hand rails and walkers as necessary to prevent falls that could result from dizziness.

Monitoring and Managing Potential Complications

Target organ damage is a potential adverse effect of long standing or poorly controlled hypertension. When the patient returns for follow-up care, all body systems must be assessed to detect any evidence of vascular damage. An eye examination with an ophthalmoscope is particularly important because retinal blood vessel damage indicates similar damage elsewhere in the vascular system. The patient is questioned about blurred vision, spots in front of the eyes, and diminished visual acuity. The heart, nervous system, and kidneys are also carefully assessed. Any significant findings are promptly reported to determine whether additional diagnostic studies are

required. Based on the findings, medications may be changed to improve blood pressure control.

Evaluation

Expected patient outcomes may include:

1. Reports knowledge of disease management sufficient to maintain adequate tissue perfusion
   a. Maintains blood pressure at less than 130/80 mm Hg with lifestyle modifications, medications, or both
   b. Demonstrates no symptoms of angina, palpitations, or vision changes
   c. Has stable BUN and serum creatinine levels
   d. Has palpable peripheral pulses
2. Effectively manages health program
   a. Adheres to the dietary regimen as prescribed: reduces calorie, sodium, and fat intake; increases fruit and vegetable intake
   b. Exercises regularly
   c. Takes medications as prescribed and reports any side effects
   d. Measures blood pressure routinely
   e. Abstains from tobacco, nicotine, and excessive alcohol intake
   f. Keeps follow-up appointments
3. Has no complications
   a. Reports no changes in vision
   b. Exhibits no retinal damage on vision testing
   c. Maintains pulse rate and rhythm and respiratory rate within normal ranges
   d. Reports no dyspnea or edema
   e. Maintains urine output consistent with intake
   f. Has renal function test results within normal range
   g. Demonstrates no motor, speech, or sensory deficits
   h. Reports no headaches, dizziness, weakness, changes in gait, or falls

Hypertensive Crises

Two classes of hypertensive crisis that require immediate intervention include hypertensive emergency and hypertensive urgency, which occur when the SBP exceeds 180 mm Hg or the DBP exceeds 120 mm Hg. Hypertensive emergencies and urgencies may occur in patients with secondary hypertension, and in those whose hypertension has been poorly controlled, whose hypertension has been undiagnosed, or in those who have abruptly

discontinued their medications (i.e., rebound hypertension). Once the hypertensive crisis has been managed, a complete evaluation is performed to review the patient's ongoing treatment plan, and strategies to prevent the occurrence of subsequent hypertensive crises are implemented (Whelton et al., 2017).

Hypertensive Emergency

Hypertensive emergency is severe BP elevation (SBP greater than 180 mm Hg or DBP greater than 120 mm Hg) with new or worsening target organ damage. Some examples of target organ damage that may occur include hypertensive encephalopathy, ischemic stroke, MI, heart failure with pulmonary edema, dissecting aortic aneurysm, and renal failure. The 1-year mortality rate is more than 79% and median survival is 10.4 months if left untreated (Whelton et al., 2017). The patient needs to be admitted to the intensive care unit for continuous monitoring of BP and parenteral administration of an appropriate antihypertensive medication (Whelton et al., 2017).

A rapid and focused assessment is necessary to determine possible causes and target organ involvement. For patients with suspected aortic dissection, the management goal is to reduce the SBP to less than 120 mm Hg within the first hour of treatment (Fukui, 2018; Whelton et al., 2017). For those patients with suspected severe preeclampsia/eclampsia or pheochromocytoma crises, the management goal is to reduce the SBP to less than 140 mm Hg within the first hour of treatment (Lim, 2018; Whelton et al., 2017). The treatment management goal for other patients with hypertensive emergencies is to reduce the SBP by no more than 25% within the first hour of treatment, and then, if the patient is stable, to 160/100 mm Hg within the next 2 to 6 hours with an eventual goal of a normal, controlled blood pressure within 24 to 48 hours of when treatment commenced (Whelton et al., 2017). The antihypertensive medications of choice are those that have immediate onsets of action, and can include intravenous drugs such as nicardipine, clevidipine, labetalol, esmolol, nitroglycerin, and nitroprusside (Whelton et al., 2017). To date, there is a dearth of research findings that demonstrate the superiority of any antihypertensive medications in treating hypertensive emergencies (Whelton et al., 2017).

Hypertensive Urgency

Hypertensive urgency is severe BP elevation (SBP greater than 180 mm Hg or DBP greater than 120 mm Hg) in stable patients without target organ damage as evidenced based on clinical examination and results of laboratory

studies. Many times, patients with a hypertensive urgency are nonadherent with antihypertensive therapy, resulting in rebound hypertension. The underlying reason for nonadherence should be explored (e.g., finances, anxiety, misunderstandings, miscommunication, drug side effects, or recreational drug use) and the team approach used and resources mobilized to prevent nonadherence from continuing or recurring. Restarting antihypertensive medication therapy or increasing dosages are indicated in treating these patients (Whelton et al., 2017).

Extremely close monitoring of the patient's blood pressure and cardiovascular status is required during treatment of hypertensive emergencies and urgencies (see Chapter 21 for discussion of cardiovascular assessment). The exact frequency of monitoring is a matter of clinical judgment and varies with the patient's condition. Taking vital signs every 5 minutes is appropriate if the blood pressure is changing rapidly; taking vital signs at 15- or 30-minute intervals in a more stable situation may be sufficient. A precipitous drop in blood pressure can occur that would require immediate action to restore blood pressure to an acceptable level.

CRITICAL THINKING EXERCISES

1 pq You are working as a nurse in a clinic that serves both an assisted living and a skilled nursing facility. One of your patients is an 80-year-old woman who is a new resident at the assisted living facility. When you take her blood pressure, you note that it is 110/70 mm Hg. While talking with her, you find that she reports episodes of dizziness and has fallen twice in the past 2 weeks. She tells you that she takes her medications as prescribed and has had no other concerns. What additional assessment data do you need to obtain? What is your priority plan of action?

2 ipc You are employed as an occupational health nurse in a manufacturing facility. A 32-year-old man who operates a forklift presents to be treated after injuring his forearm at work. During your assessment, he reports that he takes a beta-blocker for his hypertension and his blood pressure is 108/77 mm Hg. He also tells you that he is dedicated to staying healthy, has no underlying cardiac disease, and routinely exercises at the gym. He has noted that he cannot get his heart rate up no matter how long he works out and feels tired all the time. What further follow-up would you recommend and with whom?

3 ebp You are working in a clinic and a 50-year-old man presents for his annual examination. He takes no medications at present but reports that last year he was told that his blood pressure was elevated and that he needed to start taking an antihypertensive medication. He never filled that prescription because he had no symptoms and thought that if he had high blood pressure, he would feel bad. His blood pressure is 140/90 mm Hg and the rest of his examination is unremarkable. What education would you provide for him? What is the strength of the evidence that supports your education plan and follow-up with this patient?

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

ACC *ASCVD Risk Estimator Plus* online application, www.tools.acc.org/ASCVD-Risk-Estimator-Plus/#!/calculate/estimate
American Heart Association, www.heart.org
International Society of Hypertension, www.ish-world.com/index.htm
National Heart, Lung, and Blood Institute, www.nhlbi.nih.gov
National Heart, Lung, and Blood Institute, In Brief: Your Guide to Lowering Your Blood Pressure with DASH, www.nhlbi.nih.gov/files/docs/public/heart/dash_brief.pdf
STRIDE BP, www.stridebp.org
World Health Organization (WHO), Cardiovascular Disease Information, www.who.int/health-topics/cardiovascular-diseases

UNIT 6

Hematologic Function

Case Study

EVALUATING COMPLICATIONS OF CHEMOTHERAPY

A 66-year-old woman is receiving a course of chemotherapy for non-Hodgkin lymphoma in the infusion center where you work. You note that upon arrival the patient is short of breath, her SpO_2 is 88% on room air, and her heart rate is regular at 104 bpm. Her chemotherapy infusion is placed on hold and laboratory tests reveal she has anemia. Upon initiation of chemotherapy, all patients receive education about strategies to help avoid complications such as anemia, bleeding, and infection. Earlier in the week another patient had their chemotherapy held due to an infection. You wonder if you should consider a different type of intervention aimed at decreasing complications of chemotherapy.

QSEN Competency Focus: **Quality Improvement**

The complexities inherent in today's health care system challenge nurses to demonstrate integration of specific interdisciplinary core competencies. These competencies are aimed at ensuring the delivery of safe, quality patient care (Institute of Medicine, 2003). The Quality and Safety Education for Nurses project (Cronenwett, Sherwood, Barnsteiner, et al., 2007; QSEN, 2020) provides a framework for the knowledge, skills, and attitudes (KSAs) required for nurses to demonstrate competency in these key areas, which include ***patient-centered care***, ***interdisciplinary teamwork and collaboration***, ***evidence-based practice***, ***quality improvement***, ***safety***, and ***informatics.***

Quality Improvement Definition: Use data to monitor the outcomes of care processes and use improvement methods to design and test changes to continuously improve the quality and safety of health care systems.

SELECT PRE-LICENSURE KSAs	APPLICATION AND REFLECTION
Knowledge	
Explain the importance of variation and measurement in assessing quality of care	How can you verify the observations made about increased complication rates among patients receiving chemotherapy? Identify the sources of data that could be accessed to demonstrate the need for a change in the processes of care.
Skills	
Use quality measures to understand performance	Specify the main objective that you hope to achieve with this population of patients receiving chemotherapy. Specify measurable, time-oriented expected outcomes. Might there be an opportunity for you to do a pilot test of change in the infusion center? If so, how would you go about designing this type of project? Who else from the infusion center team might you need to be involved in this type of project?
Attitudes	
Value measurement and its role in good patient care	Reflect on your attitudes toward patients with cancer receiving chemotherapy. Do you tend to think that anemia and infection are unavoidable in patients with cancer receiving treatment?

Cronenwett, L., Sherwood, G., Barnsteiner, J., et al. (2007). Quality and safety education for nurses. *Nursing Outlook*, *55*(3), 122–131; Institute of Medicine. (2003). *Health professions education: A bridge to quality*. Washington, DC: National Academies Press; QSEN Institute. (2020). *QSEN competencies: Definitions and pre-licensure KSAs; Quality improvement*. Retrieved on 8/15/2020 at: qsen.org/competencies/pre-licensure-ksas/#quality_improvement

28 Assessment of Hematologic Function and Treatment Modalities

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe hematopoiesis and the processes involved in maintaining hemostasis.
2. Discuss the significance of the health history to the assessment of hematologic health and specify the appropriate techniques utilized to perform a comprehensive physical assessment of hematologic function.
3. Explain the diagnostic tests and related nursing implications used to evaluate hematologic function.
4. Identify therapies for blood disorders, including nursing implications for the administration of blood components.

NURSING CONCEPTS

Assessment
Clotting

GLOSSARY

anemia: decreased red blood cell (RBC) count

band cell: slightly immature neutrophil

blast cell: primitive white blood cell (WBC)

cytokines: proteins produced by leukocytes that are vital to regulation of hematopoiesis, apoptosis, and immune responses

differentiation: development of functions and characteristics that are different from those of the parent stem cell

erythrocyte: a cellular component of blood involved in the transport of oxygen and carbon dioxide (*synonym:* red blood cell [RBC])

erythropoiesis: process of the formation of RBCs

erythropoietin: hormone produced primarily by the kidney; necessary for erythropoiesis

fibrin: filamentous protein; basis of thrombus and blood clot

fibrinogen: protein converted into fibrin to form thrombus and clot

fibrinolysis: process of breakdown of fibrin clot

granulocyte: granulated WBC (i.e., neutrophil, eosinophil, basophil)

hematocrit: percentage of total blood volume consisting of RBCs

hematopoiesis: complex process of the formation and maturation of blood cells

hemoglobin: iron-containing protein of RBCs; delivers oxygen to tissues

hemostasis: intricate balance between clot formation and clot dissolution

leukocyte: one of several cellular components of blood involved in defense of the body; subtypes include neutrophils, eosinophils, basophils, monocytes, and lymphocytes (*synonym:* white blood cell [WBC])

leukopenia: less-than-normal amount of WBCs in circulation

lymphocyte: form of WBC involved in immune functions

lymphoid: pertaining to lymphocytes

macrophage: reticuloendothelial cells capable of phagocytosis

monocyte: large WBC that becomes a macrophage when it leaves the circulation and moves into body tissues

myeloid: pertaining to nonlymphoid blood cells that differentiate into RBCs, platelets, macrophages, mast cells, and various WBCs

myelopoiesis: formation and maturation of cells derived from myeloid stem cell

natural killer (NK) cells: lymphocytes that defend against microorganisms and malignant cells

neutrophil: fully mature WBC capable of phagocytosis; primary defense against bacterial infection

oxyhemoglobin: combined form of oxygen and hemoglobin; primarily found in arterial blood

phagocytosis: process of cellular ingestion and digestion of foreign bodies

plasma: liquid portion of blood

plasminogen: protein converted to plasmin to dissolve thrombi and clots

platelet: a cellular component of blood involved in blood coagulation (*synonym:* thrombocyte)

red blood cell (RBC): a cellular component of blood involved in the transport of oxygen and carbon dioxide (*synonym:* erythrocyte)

reticulocytes: slightly immature RBCs, usually only 1% of total circulating RBCs

reticuloendothelial system: complex system of cells throughout the body capable of phagocytosis

serum: portion of blood remaining after coagulation occurs

stem cell: primitive cell, capable of self-replication and differentiation into myeloid or lymphoid stem cell

stroma: component of the bone marrow not directly related to hematopoiesis but serves important supportive roles in this process

thrombocyte: a cellular component of blood involved in blood coagulation (*synonym:* platelet)

white blood cell (WBC): one of several cellular components of blood involved in defense of the body; subtypes include neutrophils, eosinophils, basophils, monocytes, and lymphocytes (*synonym:* leukocyte)

Unlike many other body systems, the hematologic system encompasses the entire human body. Patients with hematologic disorders often have significant abnormalities in blood tests but few or no symptoms. Therefore, the nurse must have a good understanding of the pathophysiology of the patient's condition and the ability to make a thorough assessment that relies heavily on the interpretation of laboratory tests. It is equally important for the nurse to anticipate potential patient needs and to target nursing interventions accordingly. Because it is so important to the understanding of most hematologic diseases, a basic appreciation of blood cells and bone marrow function is necessary.

Anatomic and Physiologic Overview

The hematologic system consists of the blood and the sites where blood is produced, including the bone marrow and the reticuloendothelial system (RES). Blood is a specialized organ that differs from other organs in that it exists in a fluid state. Blood is composed of plasma and various types of cells which account for 7% to 9% of total blood volume (Jouria, 2018). **Plasma** is the fluid portion of blood; it contains various proteins, such as albumin, globulin, **fibrinogen**, and other factors necessary for clotting, as well as electrolytes, waste products, and nutrients. About 55% of whole blood volume is plasma (American Society of Hematology, 2020).

Bone Marrow

The bone marrow is the site of hematopoiesis, or blood cell formation. In adults, blood cell formation is usually limited to the pelvis, ribs, vertebrae, and sternum. Marrow is one of the largest organs of the body, making up 4% to 5% of total body weight. It consists of islands of cellular components (red marrow) separated by fat (yellow marrow). As people age, the proportion of active marrow is gradually replaced by fat; however, in healthy adults, the fat can again be replaced by active marrow when more blood cell production is required. In adults with disease that causes marrow destruction, fibrosis, or scarring, the liver and spleen can also resume production of blood cells by a process known as extramedullary hematopoiesis.

The marrow is vascular. Within it are primitive cells called **stem cells**. The stem cells have the ability to self-replicate, thereby ensuring a continuous supply of stem cells throughout the life cycle. When stimulated to do so, stem cells can begin a process called **differentiation**, and develop into either **myeloid** or **lymphoid** stem cells (see Fig. 28-1). These stem cells are committed to produce specific types of blood cells. Lymphoid stem cells produce either T or B **lymphocytes**, cells that have specific immune functions that will be described in more detail later. Myeloid stem cells differentiate into three broad cell types: erythrocytes, leukocytes, and platelets. Thus, with the exception of lymphocytes, all blood cells are derived from myeloid stem cells. A defect in a myeloid stem cell can cause problems with erythrocyte, leukocyte, and platelet production. In contrast, a defect in the lymphoid stem cell can cause problems with T or B lymphocytes, plasma cells (a more differentiated form of B lymphocyte), or natural killer (NK) (see Chapter 31 for additional information) (Wimberly, 2019).

The **stroma** of the marrow refers to all tissue within the marrow that is not directly involved in hematopoiesis. However, the stroma is important in an indirect manner, in that it produces the colony-stimulating factors needed for hematopoiesis. The yellow marrow is the largest component of the stroma.

Other cells comprising the stroma include fibroblasts (reticular connective tissue), osteoclasts, osteoblasts (both needed for remodeling of skeletal bone), and endothelial cells.

Blood

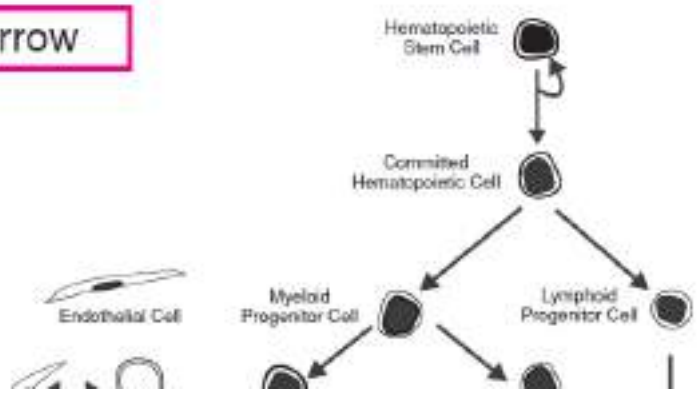
The cellular component of blood consists of three primary cell types (see Table 28-1): **erythrocytes (red blood cells [RBCs], red cells), leukocytes (white blood cells [WBCs]**), and **thrombocytes (platelets)**. These cellular components of blood normally make up 40% to 45% of the blood volume (American Society of Hematology, 2020). Because most blood cells have a short lifespan, the need for the body to replenish its supply of cells is continuous; this process is termed **hematopoiesis**. The primary site for hematopoiesis is the bone marrow. During embryonic development and in other conditions, the liver and spleen may also be involved.

Under normal conditions, the adult bone marrow produces about 175 billion erythrocytes, 70 billion **neutrophils** (a mature type of WBC), and 175 billion platelets each day. When the body needs more blood cells, as in infection (when neutrophils are needed to fight the invading pathogen) or in bleeding (when more RBCs are required), the marrow increases its production of the cells required. Thus, under normal conditions, the marrow responds to increased demand and releases adequate numbers of cells into the circulation.

Blood makes up approximately 7% to 9% of the normal body weight and amounts to 5 to 6 L of volume for men and 4 to 5 L of volume for women (Nair, 2017). Circulating through the vascular system and serving as a link between body organs, blood carries oxygen absorbed from the lungs and nutrients absorbed from the gastrointestinal (GI) tract to the body cells for cellular metabolism. Blood also carries hormones, antibodies, and other substances to their sites of action or use. In addition, blood carries waste products produced by cellular metabolism to the lungs, skin, liver, and kidneys, where they are transformed and eliminated from the body.

Physiology/Pathophysiology

Bone Marrow



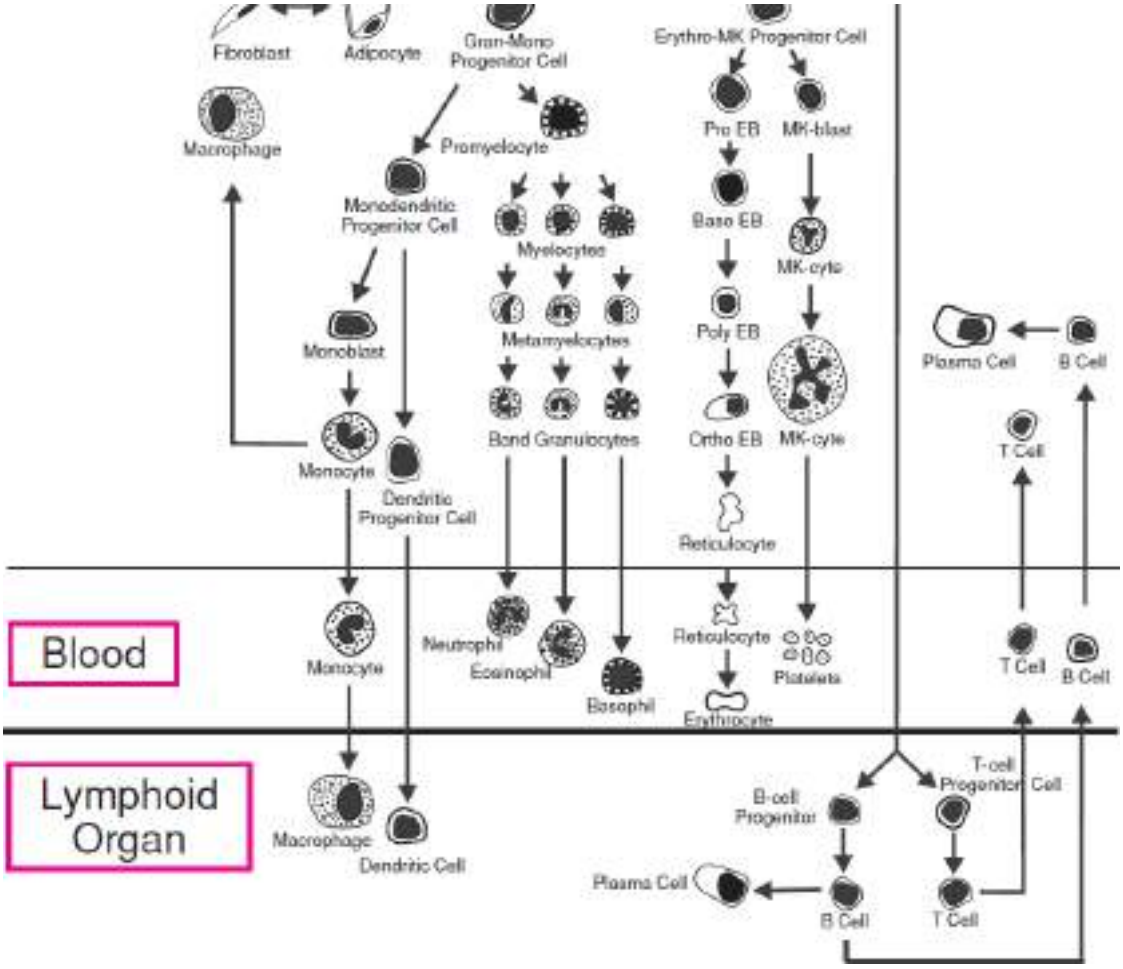


Figure 28-1 • Hematopoiesis and stromal stem cell differentiation. Uncommitted (pluripotent) stem cells can differentiate into myeloid or lymphoid stem cells. These stem cells then undergo a complex process of differentiation and maturation into normal cells that are released into the circulation. The myeloid stem cell is responsible not only for all nonlymphoid white blood cells but also for the production of red blood cells (RBCs) and platelets. Each step of the differentiation process depends in part on the presence of specific growth factors for each cell type. When the stem cells are dysfunctional, they may respond inadequately to the need for more cells, or they may respond excessively, and sometimes uncontrollably, as in leukemia. Reprinted with permission from Koury, M., Mahmud, N., & Rhodes, M. (2009). Origin and development of blood cells. In J. P. Greer, J. Foerster, G. M. Rodgers (Eds.). *Wintrobe's clinical hematology* (12th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

TABLE 28-1 Blood Cells

Cell Type	Major Function
WBC (Leukocyte)	Fights infection
Neutrophil	Essential in preventing or limiting bacterial infection via phagocytosis
Monocyte	Enters tissue as macrophage; highly phagocytic, especially against fungus; immune surveillance
Eosinophil	Involved in allergic reactions (neutralizes histamine); digests foreign proteins
Basophil	Contains histamine; integral part of hypersensitivity reactions
Lymphocyte	Integral component of immune system
T lymphocyte	Responsible for cell-mediated immunity; recognizes material as "foreign" (surveillance system)
B lymphocyte	Responsible for humoral immunity; many mature into plasma cells to form antibodies
Plasma cell	Secretes immunoglobulin (antibody); most mature form of B lymphocyte
RBC (Erythrocyte)	Carries hemoglobin to provide oxygen to tissues; average lifespan is 120 days
Platelet (Thrombocyte)	Fragment of megakaryocyte; provides basis for coagulation to occur; maintains hemostasis; average lifespan is 10 days

WBC, white blood cell; RBC, red blood cell.

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health state* (10th ed.). Philadelphia, PA: Wolters Kluwer.

The danger that trauma can lead to excess blood loss always exists. To prevent this, an intricate clotting mechanism is activated when necessary to seal any leak in the blood vessels. Excessive clotting is equally dangerous, because it can obstruct blood flow to vital tissues. To prevent this, the body has a fibrinolytic mechanism that eventually dissolves clots (thrombi) formed within blood vessels. The balance between these two systems—clot (thrombus) formation and clot dissolution or **fibrinolysis**—is called **hemostasis**.

Erythrocytes (Red Blood Cells)

The normal erythrocyte is a biconcave disc that resembles a soft ball compressed between two fingers (see Fig. 28-2). It has a diameter of about 8 μm and is so flexible that it can pass easily through capillaries that may be as small as 2.8 μm in diameter. The membrane of the red cell is very thin so that gases, such as oxygen and carbon dioxide, can easily diffuse across it; the disc

shape provides a large surface area that facilitates the absorption and release of oxygen molecules.

Mature erythrocytes consist primarily of **hemoglobin**, which contains iron and protein and makes up 95% of the cell mass. Mature erythrocytes have no nuclei, and they have many fewer metabolic enzymes than do most other cells. The presence of a large amount of hemoglobin enables the red cell to perform its principal function, which is the transport of oxygen between the lungs and tissues. Occasionally, the marrow releases slightly immature forms of erythrocytes, called **reticulocytes**, into the circulation. This occurs as a normal response to an increased demand for erythrocytes (as in bleeding) or in some disease states.

The oxygen-carrying hemoglobin molecule is made up of four subunits, each containing a heme portion attached to a globin chain. Iron is present in the heme component of the molecule. An important property of heme is its ability to bind to oxygen loosely and reversibly. Oxygen readily binds to hemoglobin in the lungs and is carried as **oxyhemoglobin** in arterial blood. Oxyhemoglobin is a brighter red than hemoglobin that does not contain oxygen (reduced hemoglobin); thus, arterial blood is a brighter red than venous blood. The oxygen readily dissociates (detaches) from hemoglobin in the tissues, where the oxygen is needed for cellular metabolism. In venous blood, hemoglobin combines with hydrogen ions produced by cellular metabolism and thus buffers excessive acid. Whole blood normally contains about 15 g of hemoglobin per 100 mL of blood (Fischbach & Fischbach, 2018).

Erythropoiesis

Erythroblasts arise from the primitive myeloid stem cells in bone marrow. The erythroblast is an immature nucleated cell that gradually loses its nucleus. At this stage, the cell is known as a reticulocyte. Further maturation into an erythrocyte entails the loss of the dark-staining material within the cell and slight shrinkage. The mature erythrocyte is then released into the circulation. Under conditions of rapid **erythropoiesis** (i.e., erythrocyte production), reticulocytes and other immature cells may be released prematurely into the circulation. This is often seen when the liver or spleen takes over as the site of erythropoiesis and more nucleated red cells appear within the circulation.

Differentiation of the primitive myeloid stem cell into an erythroblast is stimulated by **erythropoietin**, a hormone produced primarily by the kidney. If the kidney detects low levels of oxygen, as occurs when fewer red cells are available to bind oxygen (i.e., **anemia**), or with people living at high altitudes with lower atmospheric oxygen concentrations, erythropoietin levels increase. The increased erythropoietin then stimulates the marrow to increase the production of erythrocytes. The entire process of erythropoiesis occurs over 1 week (Wimberly, 2019). For normal erythrocyte production, the bone marrow also requires iron, vitamin B_{12}, folate, pyridoxine (vitamin B_6), protein, and

other factors. A deficiency of these factors during erythropoiesis can result in decreased red cell production and anemia.

Iron Stores and Metabolism

The rate of iron absorption is regulated by the amount of iron already stored in the body and by the rate of erythrocyte production. Daily dietary iron requirements vary based on age, gender, and health status. For example, pregnant women require up to 30 mg of iron daily, while adult men require up to 12 mg and children up to 10 mg of iron daily (Trevithick, 2019). Additional amounts of iron, up to 2 mg daily, must be absorbed by women of childbearing age to replace that lost during menstruation. Total body iron content in the average adult is approximately 3 g, most of which is present in hemoglobin or in one of its breakdown products. Iron is stored as ferritin and when required, the iron is released into the plasma, binds to transferrin, and is transported into the membranes of the normoblasts (erythrocyte precursor cells) within the marrow, where it is incorporated into hemoglobin. Iron is lost in the feces, either in bile, blood, or mucosal cells from the intestine.

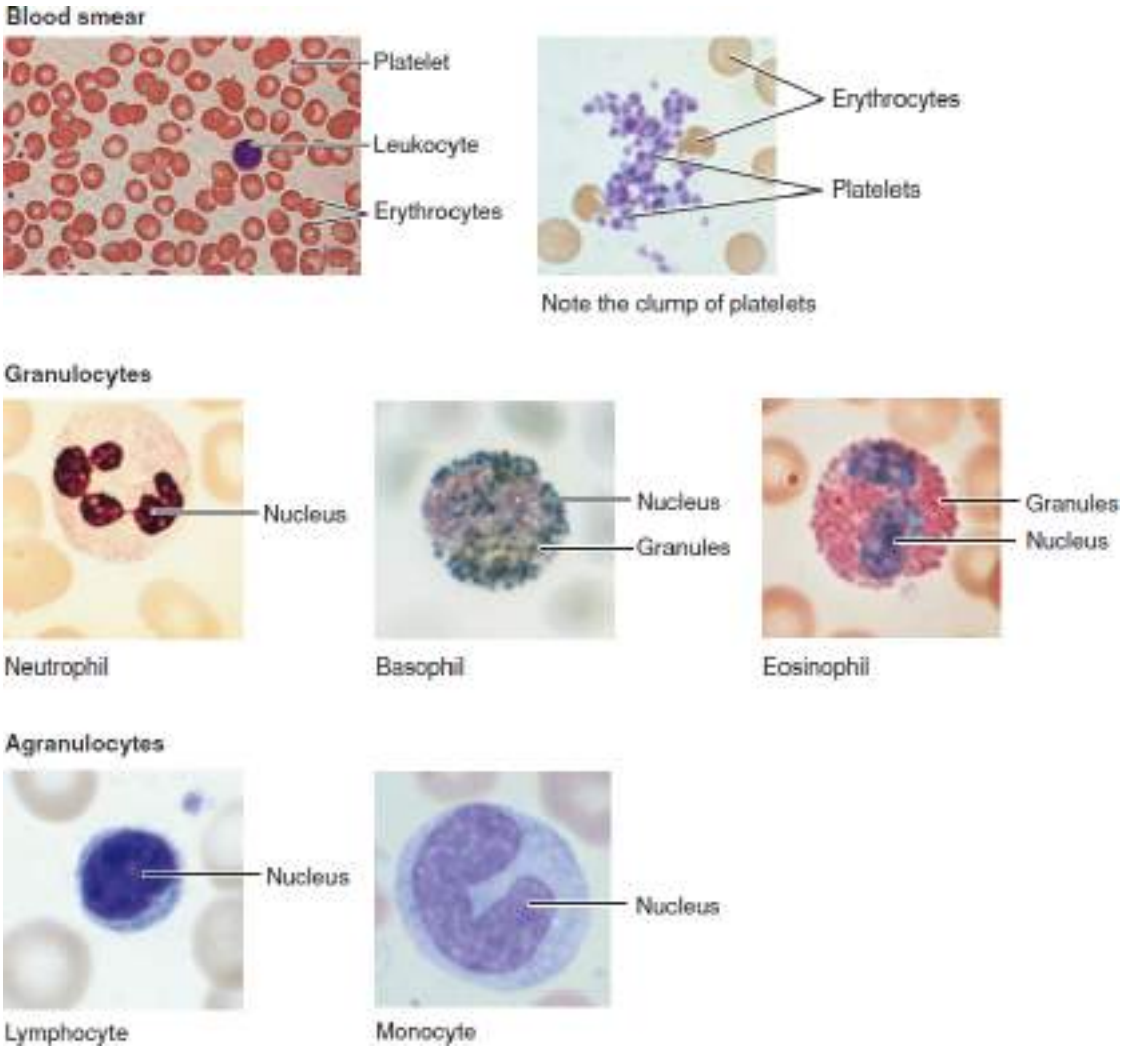


Figure 28-2 • Normal types of blood cells. Reprinted with permission from Cohen, B. J. (2005). *Memmler's the human body in health and disease* (10th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

The normal findings for concentration of iron in blood can range from 50 to 250 µg/dL depending on age and gender (Fischbach & Fischbach, 2018). With iron deficiency, bone marrow iron stores are rapidly depleted; hemoglobin synthesis is depressed, and the erythrocytes produced by the marrow are small and low in hemoglobin. Iron deficiency in the adult generally indicates blood loss (e.g., from bleeding in the GI tract or heavy menstrual flow). Lack of dietary iron is rarely the sole cause of iron deficiency anemia in adults. The source of iron deficiency should be investigated promptly, because iron deficiency in an adult may be a sign of bleeding in the GI tract or colon cancer.

Vitamin B_{12} and Folate Metabolism

Vitamin B_{12} and folate are required for the synthesis of deoxyribonucleic acid (DNA) in RBCs. Both vitamin B_{12} and folate are derived from the diet. Folate

is absorbed in the proximal small intestine, but only small amounts are stored within the body. If the diet is deficient in folate, stores within the body quickly become depleted. Because vitamin B_{12} is found only in foods of animal origin, strict vegetarians may ingest little vitamin B_{12}. Vitamin B_{12} combines with intrinsic factor produced in the stomach. The vitamin B_{12}–intrinsic factor complex is absorbed in the distal ileum. People who have had a partial or total gastrectomy may have limited amounts of intrinsic factor, and therefore the absorption of vitamin B_{12} may be diminished. The effects of either decreased absorption or decreased intake of vitamin B_{12} are not apparent for 2 to 4 years.

Vitamin B_{12} and folate deficiencies are characterized by the production of abnormally large erythrocytes called *megaloblasts*. Because these cells are abnormal, many are sequestered (trapped) while still in the bone marrow, and their rate of release is decreased. Some of these cells actually die in the marrow before they can be released into the circulation. This results in megaloblastic anemia.

Red Blood Cell Destruction

The average lifespan of a normal circulating erythrocyte is 120 days. Often, older erythrocytes lose elasticity and become trapped in small blood vessels and the spleen. These older erythrocytes are removed from the blood by the reticuloendothelial cells, particularly in the liver and the spleen. As the erythrocytes are destroyed, most of their hemoglobin is recycled. Some hemoglobin also breaks down to form bilirubin and is secreted in the bile. Most of the iron is recycled to form new hemoglobin molecules within the bone marrow; small amounts are lost daily in the feces and urine and monthly in menstrual flow.

Leukocytes (White Blood Cells)

Leukocytes are divided into two general categories: granulocytes and lymphocytes. In normal blood, the total leukocyte count is 4000 to 11,000 cells/mm^3. Of these, approximately 60% to 80% are granulocytes and 20% to 40% are lymphocytes. Both of these types of leukocytes primarily protect the body against infection and tissue injury.

Granulocytes

Granulocytes are defined by the presence of granules in the cytoplasm of the cell. Granulocytes are divided into three main subgroups—eosinophils, basophils, and neutrophils—that are characterized by the staining properties of these granules (see Fig. 28-2). Eosinophils have bright-red granules in their cytoplasm, whereas the granules in basophils stain deep blue. The third and most numerous cell in this class is the neutrophil, with granules that stain a

pink to violet hue. Neutrophils are also called *polymorphonuclear neutrophils* (PMNs, or polys) or *segmented neutrophils* (segs).

The nucleus of the mature neutrophil has multiple lobes (usually two to five) that are connected by thin filaments of nuclear material, or a "segmented" nucleus; it is usually two times the size of an erythrocyte. The somewhat less mature granulocyte has a single-lobed, elongated nucleus and is called a **band cell**. Ordinarily, band cells account for only a small percentage of circulating granulocytes, although their percentage can increase greatly under conditions in which neutrophil production increases, such as infection. The increased number of band cells is sometimes called a left shift or shift to the left. (Traditionally, the diagram of neutrophil maturation showed the myeloid stem cell on the left with progressive maturation stages toward the right, ending with a fully mature neutrophil on the far right side. A shift to the left indicates that more immature cells are present in the blood than normal.)

Fully mature neutrophils result from the gradual differentiation of myeloid stem cells, specifically myeloid **blast cells** (i.e., immature white blood cells). The process, called **myelopoiesis**, is highly complex and depends on many factors. These factors, including specific **cytokines** (i.e., regulatory proteins produced by leukocytes) such as growth factors, are normally present within the marrow itself. As the blast cell matures, the cytoplasm of the cell changes in color (from blue to violet) and granules begin to form with the cytoplasm. The shape of the nucleus also changes. The entire process of maturation and differentiation takes about 10 days (see Fig. 28-1). Once the neutrophil is released into the circulation from the marrow, it stays there for only about 6 hours before it migrates into the body tissues to perform its function of **phagocytosis** (ingestion and digestion of foreign bodies, such as bacteria). Neutrophils die here within 1 to 2 days. The number of circulating granulocytes found in the healthy person is relatively constant; however, in infection, large numbers of these cells are rapidly released into the circulation.

Agranulocytes

Monocytes

Monocytes (also called *mononuclear leukocytes*) are leukocytes with a single-lobed nucleus and a granule-free cytoplasm—hence the term *agranulocyte* (see Fig. 28-2). In normal adult blood, monocytes account for approximately 5% of the total leukocytes. Monocytes are the largest of the leukocytes. Produced by the bone marrow, they remain in the circulation for a short time before entering the tissues and transforming into **macrophages**. Macrophages are particularly active in the spleen, liver, peritoneum, and alveoli; they remove debris from these areas and phagocytize bacteria within the tissues.

Lymphocytes

Mature **lymphocytes** are small cells with scanty cytoplasm (see Fig. 28-2). Immature lymphocytes are produced in the marrow from the lymphoid stem cells. A second major source of production for lymphocytes is the thymus. Cells derived from the thymus are known as T lymphocytes (or T cells); those derived from the marrow can also be T cells but are more commonly B lymphocytes (or B cells). Lymphocytes complete their differentiation and maturation primarily in the lymph nodes and in the lymphoid tissue of the intestine and spleen after exposure to a specific antigen. Mature lymphocytes are the principal cells of the immune system, producing antibodies and identifying other cells and organisms as "foreign." **Natural killer (NK) cells** serve an important role in the body's immune defense system. Like other lymphocytes, NK cells accumulate in the lymphoid tissues (especially spleen, lymph nodes, and tonsils), where they mature. When activated, they serve as potent killers of virus-infected and cancer cells. They also secrete cytokines to mobilize the T and B cells into action.

Function of Leukocytes

Leukocytes protect the body from invasion by bacteria and other foreign entities. The major function of neutrophils is phagocytosis. Neutrophils arrive at a given site within 1 hour after the onset of an inflammatory reaction and initiate phagocytosis, but they are short-lived. An influx of monocytes follows; these cells continue their phagocytic activities for long periods as macrophages. This process constitutes a second line of defense for the body against inflammation and infection. Although neutrophils can often work adequately against bacteria without the help of macrophages, macrophages are particularly effective against fungi and viruses. Macrophages also digest senescent (aging or aged) blood cells, primarily within the spleen.

The primary function of lymphocytes is to attack foreign material. One group of lymphocytes (T lymphocytes) kills foreign cells directly or releases lymphokines, substances that enhance the activity of phagocytic cells. T lymphocytes are responsible for delayed allergic reactions, rejection of foreign tissue (e.g., transplanted organs), and destruction of tumor cells. This process is known as *cellular immunity.* The other group of lymphocytes (B lymphocytes) is capable of differentiating into plasma cells. Plasma cells, in turn, produce antibodies called *immunoglobulins* (Igs), which are protein molecules that destroy foreign material by several mechanisms. This process is known as humoral immunity.

Eosinophils and basophils function in hypersensitivity reactions. Eosinophils are important in the phagocytosis of parasites. The increase in eosinophil levels in allergic states indicates that these cells are involved in the hypersensitivity reaction; they neutralize histamine. Basophils produce and store histamine as well as other substances involved in hypersensitivity

reactions. The release of these substances provokes allergic reactions. See Chapter 31 for further information on the immune response.

Platelets (Thrombocytes)

Platelets, or thrombocytes, are not technically cells; rather, they are granular fragments of giant cells in the bone marrow called *megakaryocytes* (see Fig. 28-2). Platelet production in the marrow is regulated in part by the hormone thrombopoietin, which stimulates the production and differentiation of megakaryocytes from the myeloid stem cell. Each megakaryocyte has the capacity to produce approximately 2000 platelets; 80% of these platelets are active in the circulation and 20% are stored in the spleen (Ciesla, 2019a).

Platelets play an essential role in the control of bleeding. They circulate freely in the blood in an inactive state, where they nurture the endothelium of the blood vessels, maintaining the integrity of the vessel. When vascular injury occurs, platelets collect at the site and are activated. They adhere to the site of injury and to each other, forming a platelet plug that temporarily stops bleeding. Substances released from platelet granules activate coagulation factors in the blood plasma and initiate the formation of a stable clot composed of **fibrin**, a filamentous protein. Platelets have a normal lifespan of 7 to 10 days (Ciesla, 2019b).

Plasma and Plasma Proteins

After cellular elements are removed from blood, the remaining liquid portion is called *plasma.* More than 90% of plasma is water. The remainder consists primarily of plasma proteins; clotting factors (particularly fibrinogen); and small amounts of other substances, such as nutrients, enzymes, waste products, and gases. If plasma is allowed to clot, the remaining fluid is called **serum**. Serum has essentially the same composition as plasma, except that fibrinogen and several clotting factors have been removed during the clotting process.

Plasma proteins consist primarily of albumin and globulins. The globulins can be separated into three main fractions (alpha, beta, and gamma), each of which consists of distinct proteins that have different functions. Important proteins in the alpha and beta fractions are the transport globulins and the clotting factors that are made in the liver. The transport globulins carry various substances in bound form in the circulation. For example, thyroid-binding globulin carries thyroxin, and transferrin carries iron. The clotting factors, including fibrinogen, remain in an inactive form in the blood plasma until activated by the clotting cascade. The gamma-globulin fraction refers to the Igs, or antibodies. These proteins are produced by well-differentiated B lymphocytes and plasma cells. The actual fractionation of the globulins can be seen on a specific laboratory test (serum protein electrophoresis).

Albumin is particularly important for the maintenance of fluid balance within the vascular system. Capillary walls are impermeable to albumin, so its presence in the plasma creates an osmotic force that keeps fluid within the vascular space. Albumin, which is produced by the liver, has the capacity to bind to several substances that are transported in plasma (e.g., certain medications, bilirubin, and some hormones). People with impaired hepatic function may have low concentrations of albumin, with a resultant decrease in osmotic pressure and the development of edema.

Reticuloendothelial System (RES)

The **reticuloendothelial system (RES)** is composed of special tissue macrophages. When released from the marrow, monocytes spend a short time in the circulation (about 24 hours) and then enter the body tissues. Within the tissues, the monocytes continue to differentiate into macrophages, which can survive for months or years. Macrophages have a variety of important functions. They defend the body against foreign invaders (i.e., bacteria and other pathogens) via phagocytosis. They remove old or damaged cells from the circulation. They stimulate the inflammatory process and present antigens to the immune system (Banaski, 2019). Macrophages give rise to tissue histiocytes, phagocytic cells that are present in loose connective tissue. These include Kupffer cells of the liver, peritoneal macrophages, alveolar macrophages, and other components of the RES. Thus, the RES is a component of many other organs within the body, particularly the spleen, lymph nodes, lungs, and liver.

The spleen is the site of activity for most macrophages. Most of the spleen (75%) is made of red pulp; here, the blood enters the venous sinuses through capillaries that are surrounded by macrophages. Within the red pulp are tiny aggregates of white pulp, consisting of B and T lymphocytes. The spleen sequesters newly formed reticulocytes from the marrow, removing nuclear fragments and other materials (e.g., damaged or defective hemoglobin, iron) before the now fully mature erythrocyte returns to the circulation. If the spleen is enlarged, a greater number of red cells and platelets can be sequestered. The spleen is a major source of hematopoiesis in fetal life. It can resume hematopoiesis later in adulthood if necessary, particularly when marrow function is compromised (e.g., in bone marrow fibrosis). The spleen has important immunologic functions as well. It forms substances called *opsonins* that promote the phagocytosis of neutrophils; it also forms the antibody immunoglobulin M (IgM) after exposure to an antigen.

Hemostasis

Hemostasis is the process of preventing blood loss from intact vessels and of stopping bleeding from a severed vessel, which requires adequate numbers of functional platelets. Platelets nurture the endothelium and thereby maintain the structural integrity of the vessel wall. Two processes are involved in arresting bleeding: primary and secondary hemostasis (see Fig. 28-3).

In primary hemostasis, the severed blood vessel constricts. Circulating platelets aggregate at the site and adhere to the vessel and to one another. An unstable hemostatic plug is formed. For the coagulation process to be correctly activated, circulating inactive coagulation factors must be converted to active forms. This process occurs on the surface of the aggregated platelets at the site of vessel injury.

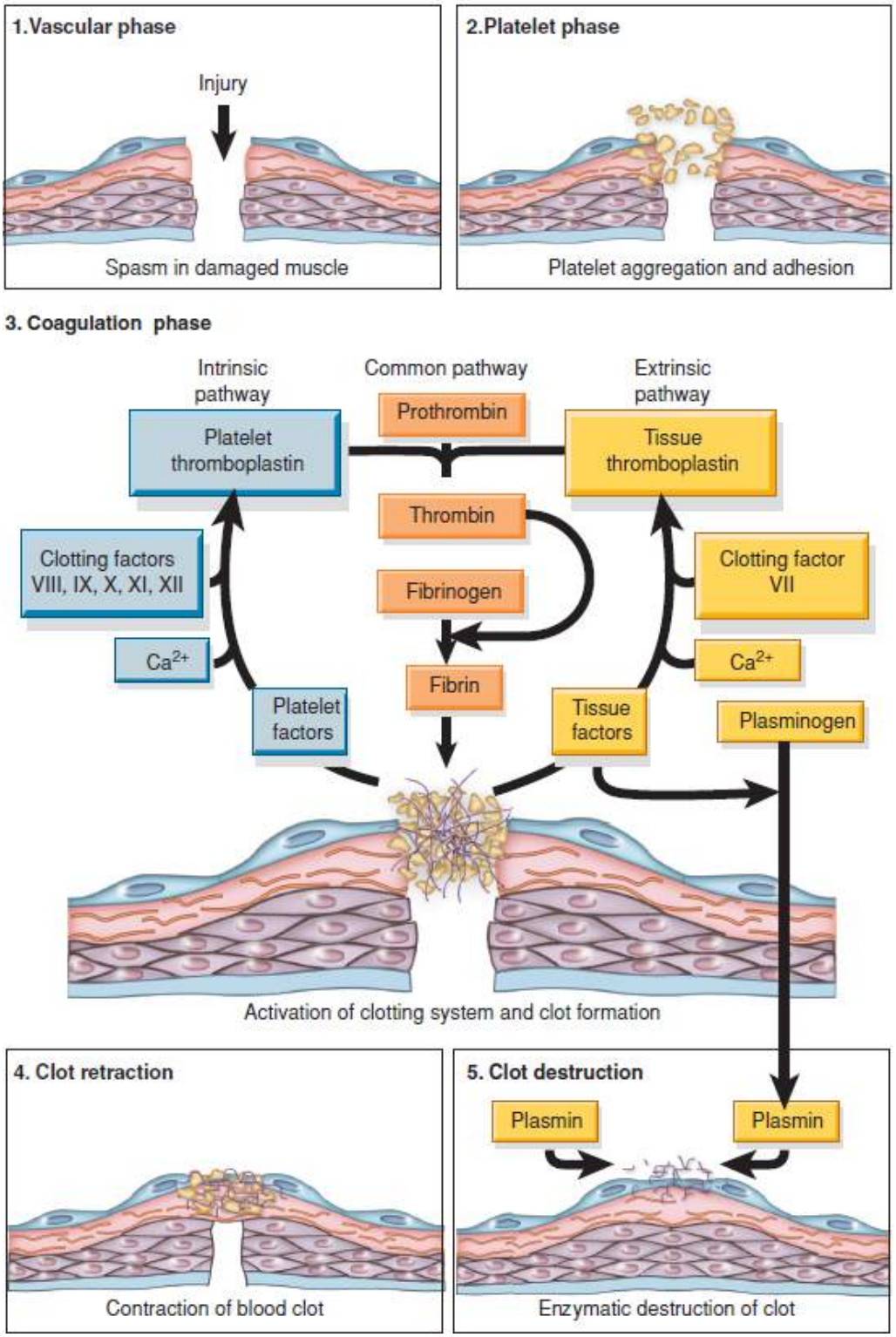


Figure 28-3 • Hemostasis. When the endothelial surface of a blood vessel is injured, several processes occur. In primary hemostasis, platelets within the circulation are attracted to the exposed layer of collagen at the site of injury. They adhere to the site of injury, releasing factors that stimulate other platelets to aggregate at the

site, forming an unstable platelet plug. In secondary hemostasis, based on the type of stimulus, one of two clotting pathways is initiated—the intrinsic or extrinsic pathway—and the clotting factors within that pathway are activated. The end result from either pathway is the conversion of prothrombin to thrombin. Thrombin is necessary for fibrinogen to be converted into fibrin, the stabilizing protein that anchors the fragile platelet plug to the site of injury to prevent further bleeding and permit the injured vessel or site to heal. Modified from www.irvingcrowley.com/cls/clotting.gif

The end result is the formation of fibrin, which reinforces the platelet plug and anchors it to the injury site. This process is referred to as secondary hemostasis. Blood coagulation is highly complex. It can be activated by the extrinsic pathway (also known as the tissue factor pathway) or the intrinsic pathway (also known as the contact activation pathway). Both pathways are needed for maintenance of normal hemostasis. Many factors are involved in the reaction cascade that forms fibrin. When tissue is injured, the extrinsic pathway is activated by the release of thromboplastin from the tissue. As the result of a series of reactions, prothrombin is converted to thrombin, which in turn catalyzes the conversion of fibrinogen to fibrin. Clotting by the intrinsic or contact activation pathway is activated when the collagen that lines blood vessels is exposed. Clotting factors are activated sequentially until, as with the extrinsic pathway, fibrin is ultimately formed (Rockwell, 2019). The intrinsic pathway is slower, and this sequence is less often responsible for clotting in response to tissue injury. However, it is important if a noninjured vessel wall comes into contact with lipoproteins (e.g., atherosclerosis) or with bacteria, resulting in a clot that is formed for purposes other than protection from trauma or bleeding.

As the injured vessel is repaired and again covered with endothelial cells, the fibrin clot is no longer needed. The fibrin is digested via two systems: the plasma fibrinolytic system and the cellular fibrinolytic system. The protein **plasminogen** is required to lyse (break down) the fibrin. Plasminogen, which is present in all body fluids, circulates with fibrinogen and is therefore incorporated into the fibrin clot as it forms. When the clot is no longer needed (e.g., after an injured blood vessel has healed), the plasminogen is activated to form plasmin. Plasmin digests the fibrinogen and fibrin. The breakdown particles of the clot, called *fibrin degradation products,* are released into the circulation. Through this system, clots are dissolved as tissue is repaired, and the vascular system returns to its normal baseline state.

Gerontologic Considerations

In older adults, the bone marrow's ability to respond to the body's need for blood cells (erythrocytes, leukocytes, and platelets) may be decreased, resulting in **leukopenia** (a decreased number of circulating leukocytes) or anemia. This decreased ability is a result of many factors, including diminished production of the growth factors necessary for hematopoiesis by stromal cells within the marrow or a diminished response to the growth factors (in the case of erythropoietin). Over time, stem cells within the marrow acquire damage to their DNA, which compromises their function. T- and B-cell development is also decreased. This age-related decrease in immune system response due to diminished production and function of blood cells designed to protect the body is called immunosenescence (Yeager, 2019).

Assessment

Health History

A careful health history and physical assessment can provide important information related to a patient's known or potential hematologic diagnosis. Because many hematologic disorders are more prevalent in certain ethnic groups, assessments of ethnicity and family history are useful (see Chart 28-1). Similarly, obtaining a nutritional history and assessing the use of prescription and over-the-counter medications, as well as herbal supplements, are important to note, because several conditions can result from nutritional deficiencies, or from the use of certain herbs or medications. Careful attention to the onset of a symptom or finding (e.g., rapid vs. gradual; persistent vs. intermittent), its severity, and any contributing factors can further differentiate potential causes. Of equal importance is assessing the impact of these findings on the patient's functional ability, manifestations of distress, and coping mechanisms.

Chart 28-1 **GENETICS IN NURSING PRACTICE**

Hematologic Disorders

Hematologic disorders are marked by aberrations in the structure or function of the blood cells or the blood clotting mechanism. Some examples of genetic hematologic disorders are:

Autosomal Dominant:

- Factor V Leiden
- Familial hypercholesterolemia
- Hereditary angioedema
- Hereditary spherocytosis
- von Willebrand disease

Autosomal Recessive:

- Hemochromatosis
- Sickle cell disease
- Thalassemia

X-Linked:

- Hemophilia

Nursing Assessments

Refer to Chapter 4, Chart 4-2: Genetics in Nursing Practice: Genetic Aspects of Health Assessment

Family History Assessment Specific to Hematologic Disorders

- Collect family history information on maternal and paternal relatives from three generations of the family.
- Assess family history for other family members with histories of blood disorders or episodes of abnormal bleeding.
- If a family history or personal risk is suspected, the person should be carefully screened for bleeding disorders prior to surgical procedures.

Patient Assessment Specific to Hematologic Disorders

- Assess for specific symptoms of hematologic diseases:
  - Extreme fatigue (the most common symptom of hematologic disorders)
  - Delayed clotting of blood
  - Easy or deep bruising

- Abnormal bleeding (e.g., frequent nosebleeds)
- Abdominal pain (hemochromatosis) or joint pain (sickle cell disease)

- Review blood cell counts for abnormalities.
- Assess for presence of illness despite low risk for the illness (e.g., a young adult with a blood clot)

Resources

Hemophilia Federation of America, www.hemophiliafed.org
Iron Disorders Institute: Hemochromatosis, www.hemochromatosis.org
Sickle Cell Association of America, www.sicklecelldisease.org
See Chapter 6, Chart 6-7, for components of genetic counseling.

Physical Assessment

The physical assessment should be comprehensive and include careful attention to the skin, oral cavity, lymph nodes, and spleen (see Fig. 28-4). Table 28-2 highlights a general approach to the physical assessment findings in hematologic disorders (more specific findings are presented in Chapters 29 and 30).

Diagnostic Evaluation

Most hematologic diseases reflect a defect in the hematopoietic, hemostatic, or reticuloendothelial systems. The defect can be quantitative (e.g., increased or decreased production of cells), qualitative (e.g., the cells that are produced are defective in their expected functional capacity), or both. Initially, many hematologic conditions cause few symptoms, and extensive laboratory tests are often required to establish a diagnosis. For most hematologic conditions, continued monitoring via specific blood tests is required because it is very important to assess for changes in test results over time. In general, it is important to assess trends in test results because these trends help the clinician decide whether the patient is responding appropriately to interventions.

Hematologic Studies

The most common tests used are the complete blood count (CBC) and the peripheral blood smear. The CBC identifies the total number of blood cells (leukocytes, erythrocytes, and platelets) as well as the hemoglobin, **hematocrit** (percentage of blood volume consisting of erythrocytes), and RBC indices. Because cellular morphology (shape and appearance of the cells) is

particularly important in accurately diagnosing most hematologic disorders, the blood cells involved must be examined. This process is referred to as the manual examination of the peripheral smear, which may be part of the CBC. In this test, a drop of blood is spread on a glass slide, stained, and examined under a microscope. The shape and size of the erythrocytes and platelets, as well as the actual appearance of the leukocytes, provide useful information in identifying hematologic conditions. Blood for the CBC is typically obtained by venipuncture (Fischbach & Fischbach, 2018).

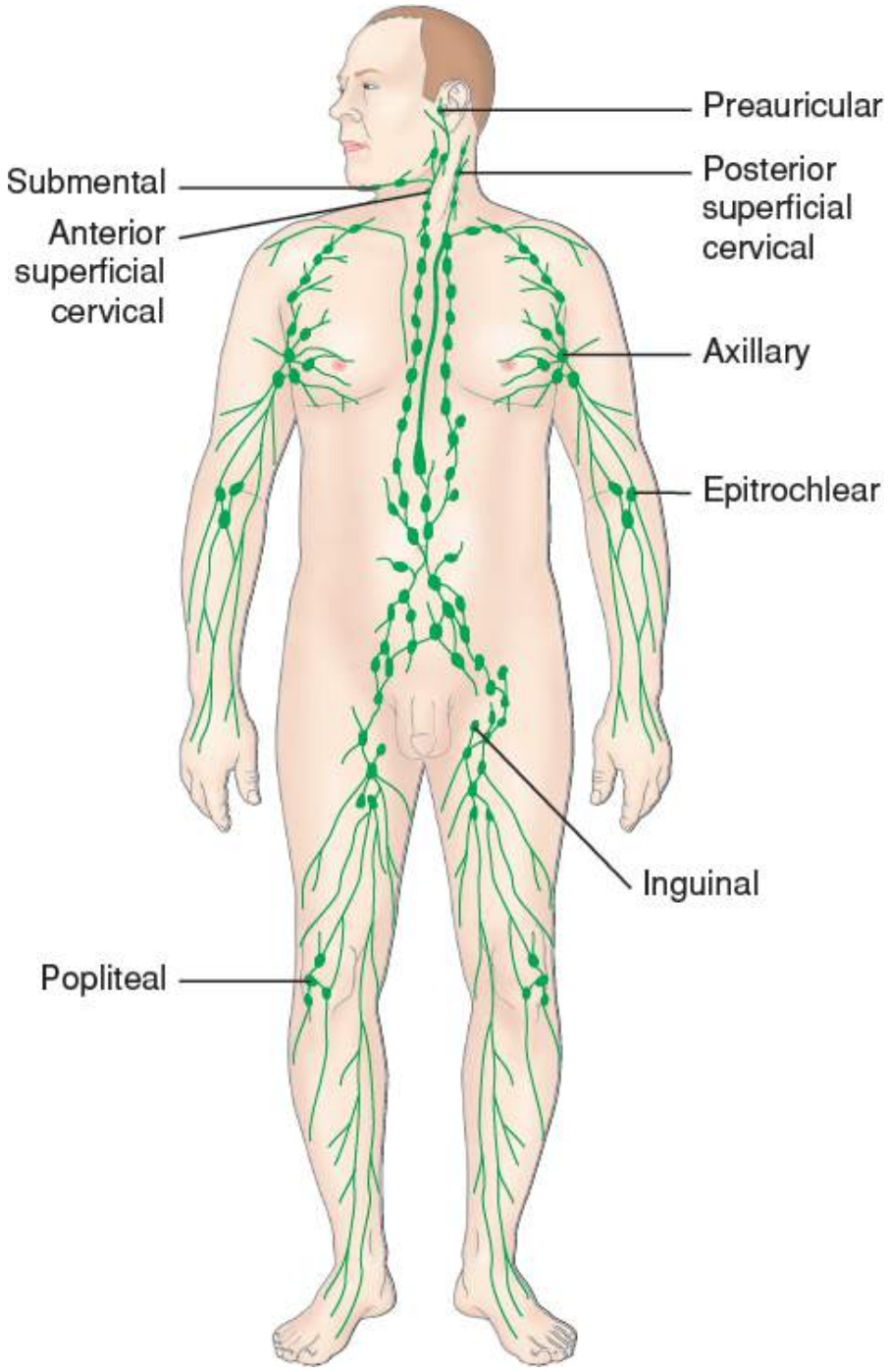


Figure 28-4 • Lymphatic system. Sites where lymph nodes are accessible for palpation. Developed by Thomas, M., & Morrow, K. (2011). Veterans Administration Palo Alto Health Care System.

TABLE 28-2 Health History and Physical Assessment in Hematologic Disorders[a]

	Findings	Potential Indications of Hematologic Disorder
Health History	Prior episodes of bleeding (epistaxis, tooth, gum, hematuria, menorrhagia, hematochezia, gastrointestinal bleeding and/or ulcers)	Thrombocytopenia, coagulopathy, anemia
	Prior blood clots, pulmonary emboli, miscarriages	Thrombotic disorder
	Fatigue and weakness	Anemia, infection, malignancy, clonal disorders
	Dyspnea, particularly dyspnea on exertion, orthopnea, shortness of breath	Anemia, infection
	Prior radiation therapy (especially pelvic irradiation)	Anemia, pancytopenia, myelodysplastic syndrome, leukemia
	Prior chemotherapy	Myelodysplastic syndrome, leukemia
	Hobbies/occupational/military exposure history (especially benzene, Agent Orange)	Myelodysplastic syndrome, leukemia, myeloma, lymphoma
	Diet history	Anemia (due to vitamin B_{12}, folate, iron deficiency)
	Alcohol consumption	Anemia (effect on hematopoiesis, nutritional deficiency)
	Use of herbal supplements	Platelet dysfunction
	Concurrent medications	Neutropenia, anemia, hemolysis, thrombocytopenia
	Family history/ethnicity	Some hematologic disorders have a higher prevalence in certain ethnic groups and families (see Chart 28-1)
Physical Assessment		
Skin	Gray-tan or bronze skin color (especially genitalia, scars, exposed areas)	Hemochromatosis (primary or secondary)
	Ruddy complexion (face, conjunctiva, hands, feet)	Polycythemia
	Ecchymoses (i.e., bruises)	Thrombocytopenia, coagulopathy
	Petechiae (i.e., pinpoint hemorrhagic	Severe thrombocytopenia

	lesions, usually more prominent on trunk or anterior aspects of lower extremities)	
	Rash	Variable; if pruritic, may indicate polycythemia, other non–hematologic-related disorders (see Chapter 56)
	Bleeding (including around vascular lines, tubes)	Thrombocytopenia, coagulopathy
	Conjunctival hemorrhage	Severe thrombocytopenia, coagulopathy
	Pallor, especially in mucous membranes (including conjunctiva), nail beds	Anemia
	Jaundice in mucous membranes (including conjunctiva), nail beds, palate	Hemolysis
Oral cavity	Petechiae in the buccal mucosa, gingiva, hard palate	Severe thrombocytopenia
	Ulceration of oral mucosa	Infection, leukemia
	Tongue: Smooth	Pernicious anemia
	Beefy red	Vitamin B_{12}/folate deficiency
	Enlarged	Amyloidosis
	Angular cheilosis (ulceration at corners of mouth)	Anemia
	Enlarged gums: hyperplasia	Leukemia
Lymph nodes	Enlarged size, firm and fixed vs. mobile and tender	Leukemia, lymphoma
Respiratory	Increased rate and depth of respirations; adventitious breath sounds	Anemia; infection
Cardiovascular	Distended neck veins, edema, chest pain on exertion, murmurs, gallops	Severe anemia
	Hypotension (below baseline)	Polycythemia
	Hypertension (above baseline)	
Genitourinary	Hematuria	Hemolysis, thrombocytopenia
	Proteinuria	Myeloma
Musculoskeletal	Rib/sternal tenderness to palpation	Leukemia, myeloma
	Back pain; tenderness to palpation over spine, loss of height, kyphosis	Myeloma
	Pain/swelling in knees, wrists, hands	Hemophilia, sickle cell disease
Abdominal	Enlarged spleen	Leukemia, myelofibrosis
	Enlarged liver	Myelofibrosis

	Stool positive for occult blood	Anemia, thrombocytopenia
Central nervous system	Cranial nerve dysfunction	Vitamin B_{12} deficiency
	Peripheral nerve dysfunction (especially sensory) Visual changes, headache, alteration in mental status	Vitamin B_{12} deficiency, amyloidosis, myeloma Severe thrombocytopenia
Gynecologic	Menorrhagia	Thrombocytopenia, coagulopathy
Constitutional	Fever, chills, sweats, asthenia	Leukemia, lymphoma; infection

[a]Common findings (obtained via health history and physical assessment) that occur in patients with hematologic disorders. Note that signs and symptoms are not disease specific but are useful in guiding the nurse to establishing an etiology for the findings noted.

Adapted from Bickley, L. S. (2016). *Bates' guide to physical examination and history taking* (12th ed.). Philadelphia, PA: Lippincott Williams & Wilkins; Weber, J. W., & Kelley, J. (2018). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Wolters Kluwer.

Other common tests of coagulation are the prothrombin time (PT), typically replaced by the standardized test, international normalized ratio (INR), and the activated partial thromboplastin time (aPTT). The INR and aPTT serve as useful screening tools for evaluating a patient's clotting ability and monitoring the therapeutic effectiveness of anticoagulant medications. In both tests, specific reagents are mixed into the plasma sample, and the time taken to form a clot is measured. For these tests to be accurate, the test tube must be filled with the correct amount of the patient's blood; either excess or inadequate blood volume within the tube can render the results inaccurate.

Bone Marrow Aspiration and Biopsy

Bone marrow aspiration and biopsy are crucial when additional information is needed to assess how a patient's blood cells are being formed and to assess the quantity and quality of each type of cell produced within the marrow. Also, results of these tests can be used to document infection or tumor within the marrow. Other specialized tests can be performed on the marrow aspirate, such as cytogenetic analysis or immunophenotyping (i.e., identifying specific proteins expressed by cells), and are useful to identify certain malignant conditions and form a prognosis.

Normal bone marrow is in a semifluid state and can be aspirated through a special large needle. In adults, bone marrow is usually aspirated from the iliac crest and occasionally from the sternum. The bone marrow aspirate provides a sample of cells from the more fluid part of the bone marrow and may not be adequate for evaluating certain conditions, such as anemia. When more

information is required, a bone marrow biopsy is performed, which examines a solid part of the bone marrow. Biopsy samples are taken from the posterior iliac crest; although occasionally, an anterior approach is required. A marrow biopsy shows the architecture of the bone marrow as well as its degree of cellularity.

Patient preparation includes a careful explanation of the procedure, which may be done at the patient's bedside (for a patient who is hospitalized) or in the outpatient setting. Some patients may be anxious, thus an anxiolytic agent may be prescribed. It is essential the physician or nurse explain the procedure, including risks, benefits and alternatives, and describe sensations the patient may experience. A signed informed consent is required for a bone marrow aspiration and biopsy.

Before aspiration, the skin is cleansed using aseptic technique. Next, a small area is anesthetized with a local anesthetic agent through the skin and subcutaneous tissue to the periosteum of the bone; it is not possible to anesthetize the bone itself. The bone marrow needle is introduced with a stylet in place. When the needle moves through the outer cortex of bone and enters the marrow cavity, the stylet is removed, and a syringe is attached. A small volume (5 mL) of blood and marrow is then aspirated. Patients typically feel a pressure sensation as the needle is advanced into position. The actual aspiration always causes sharp but brief pain, resulting from the suction exerted as the marrow is aspirated into the syringe. Taking deep breaths or using relaxation techniques often helps ease the discomfort (see Fig. 28-5).

A bone marrow biopsy is most often performed with a bone marrow aspiration and is called a bone marrow exam (Mayo Clinic, 2018a). The bone marrow aspirate is used to determine types and numbers of cells present in the bone marrow. The bone marrow biopsy consists of an actual tissue sample used to study the architecture of the bone marrow and confirm diagnoses (Wimberly, 2019). For a bone marrow biopsy, a special biopsy needle is used. Because these needles are large, the skin may be punctured first with a surgical blade to make a 3- to 4-mm incision. The biopsy needle is advanced well into the marrow cavity. When the needle is properly positioned, a portion of marrow is cored out. The patient feels a pressure sensation but should not feel actual pain. The nurse should assist the patient in maintaining a comfortable position and encourage relaxation and deep breathing throughout the procedure. The patient should be instructed to inform the physician if pain occurs so that an additional anesthetic agent can be given.

Potential complications of either bone marrow aspiration or biopsy include bleeding and infection. The risk of bleeding is somewhat increased if the patient's platelet count is low or if the patient has been taking a medication that alters platelet function (e.g., aspirin). After the marrow sample is obtained, pressure is applied to the site for several minutes. The site is then covered with a sterile dressing. Most patients have no discomfort after a bone marrow

aspiration, but the site of a biopsy may ache for 1 or 2 days. Warm tub baths and a mild analgesic agent (e.g., acetaminophen) may be useful. Aspirin-containing analgesic agents should be avoided in the immediate postprocedure period because they can aggravate or potentiate bleeding. Also, no rigorous activity or exercise for 1 to 2 days is recommended (Mayo Clinic, 2018a).

Unfolding Patient Stories: Lloyd Bennett • Part 1

Lloyd Bennett is a 76-year-old male who fell while working outdoors. He presents to the emergency department with a hip fracture. What physical assessment and laboratory data can assist the nurse in evaluation for possible internal blood loss from the fracture or indications that the patient is at higher risk of bleeding? (Lloyd Bennett's story continues in Chapter 47.)

Care for Lloyd and other patients in a realistic virtual environment: vSim(**thepoint.lww.com/vSimMedicalSurgical**). Practice documenting these patients' care in DocuCare (**thepoint.lww.com/DocuCareEHR**).

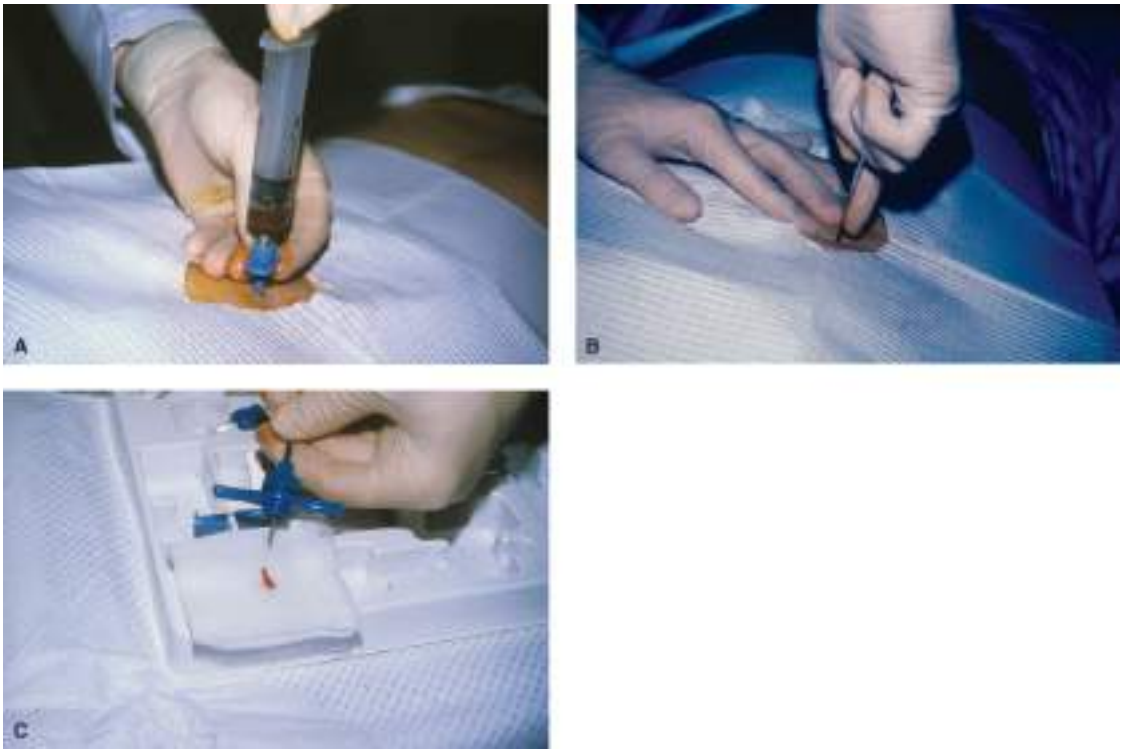


Figure 28-5 • Bone marrow aspiration procedure. The posterior superior iliac crest is the preferred site for bone marrow aspiration and biopsy because no vital organs or vessels are nearby. The patient is placed either in the lateral position with one leg flexed or in the prone position. The anterior iliac crest or sternum may also be used. Note that the sternum cannot be used for a marrow biopsy. **A.** Bone marrow aspiration. **B.** Inserting a Jamshidi biopsy needle. **C.** Dispensing the bone marrow core. Reprinted with permission from Farhi, D. C. (2009). *Pathology of bone marrow and blood cells* (2nd ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Therapeutic Approaches to Hematologic Disorders

Splenectomy

The surgical removal of the spleen, called splenectomy, is a possible treatment for some hematologic disorders. For example, an enlarged spleen may be the site of excessive destruction of blood cells. In addition, some patients with grossly enlarged spleens develop severe thrombocytopenia as a result of platelets being sequestered in the spleen. Splenectomy removes the "trap," and platelet counts may normalize over time.

Laparoscopic splenectomy is associated with decreased postoperative morbidity compared to open splenectomy. Acute risks associated with a splenectomy include hemorrhage, increased clotting, and injury to surrounding

organs and tissues. Long-term risks post splenectomy includes greater likelihood to develop life-threatening infections. Patients should be vaccinated for pneumonia before undergoing splenectomy, if possible. The patient is instructed to seek prompt medical attention for even minor symptoms of infection. The Centers for Disease Control and Prevention (CDC, 2020) recommends patients without spleens receive vaccines for influenza, pneumonia, and meningococci. Also, if a patient has other conditions that increase risk of serious infection in addition to a history of splenectomy, they may need antibiotic prophylaxis (Mayo Clinic, 2018b).

Therapeutic Apheresis

Apheresis is a Greek word meaning "separation." In therapeutic apheresis (or pheresis), blood is taken from the patient and passed through a centrifuge, where a specific component is separated from the blood, removed (see Table 28-3), and the remaining blood is returned to the patient. The entire system is closed, so the risk of bacterial contamination is low. When platelets or leukocytes are removed, the decrease in these cells within the circulation is temporary. Platelet donors can have their platelets apheresed as often as every 14 days. Leukocytes can be obtained similarly, typically after the donor has received growth factors (granulocyte colony-stimulating factor, granulocyte-macrophage colony-stimulating factor) to stimulate the formation of additional leukocytes and thereby increase the leukocyte count. The use of these growth factors also stimulates the release of stem cells within the circulation. Apheresis is used to harvest these stem cells (typically over a period of several days) for use in peripheral blood stem cell transplant (Padmanabhan, Smith, Aqui, et al., 2019). Sometimes plasma is removed rather than blood cells, and this process is called plasmapheresis. Indications for plasmapheresis include obtaining plasma for transfusion and removing dangerous substances such as immune complexes and autoantibodies (Sarode, 2018).

Hematopoietic Stem Cell Transplantation

Hematopoietic stem cell transplantation (HSCT) is a therapeutic modality that offers the possibility of cure for some patients with hematologic disorders such as severe aplastic anemia, some forms of leukemia, and thalassemia. It can also provide longer remission from disease even when cure is not possible, such as in multiple myeloma. Hematopoietic stem cells may be transplanted from either allogeneic or autologous donors. For most hematologic diseases, allogeneic transplant is more effective (Bazinet & Popradi, 2019); here, stem cells are obtained from a donor whose cells match those of the patient. In contrast, the patient's own stem cells are harvested and then used in autologous transplant. (See Chapter 12 for a detailed discussion of HSCT.)

TABLE 28-3 Types of Apheresis[a]

Procedure	Purpose	Examples of Clinical Use
Plateletpheresis	Remove platelets	Extreme thrombocytosis, essential thrombocythemia (temporary measure); single-donor platelet transfusion
Leukapheresis	Remove WBCs (can be specific to neutrophils or lymphocytes)	Extreme leukocytosis (e.g., AML, CML) (very temporary measure); harvest WBCs for transfusion
Erythrocytapheresis (RBC exchange)	Remove RBCs	RBC dyscrasias (e.g., sickle cell disease); RBCs replaced via transfusion
Plasmapheresis (plasma exchange)	Remove plasma proteins	Hyperviscosity syndromes; treatment for some renal and neurologic diseases (e.g., Goodpasture syndrome, TTP, Guillain–Barré, myasthenia gravis)
Stem cell harvest	Remove circulating stem cells	Transplantation (donor harvest or autologous)

[a]Therapeutic apheresis can be used to treat a wide variety of conditions. When it is used to treat a disease that causes an increase in a specific cell type with a short life in circulation (i.e., WBCs, platelets), the reduction in those cells is temporary. However, this temporary reduction permits a margin of safety while waiting for a longer-lasting treatment modality (e.g., chemotherapy) to take effect. Apheresis can also be used to obtain stem cells for transplantation, either from a matched donor (allogeneic) or from the patient (autologous).

AML, acute myeloid leukemia; CML, chronic myeloid leukemia; RBC, red blood cell; TTP, thrombotic thrombocytopenic purpura; WBCs, white blood cells.

Adapted from Padmanabhan, A., Smith, L., Aqui, N., et al. (2019). Guidelines on the use of therapeutic apheresis in clinical practice—evidence-based approach from the Writing Committee of the American Society for Apheresis: The eighth special issue. *Journal of Clinical Apheresis*, *34*(3), 171–354.

Therapeutic Phlebotomy

Therapeutic phlebotomy is the removal of a certain amount of blood under controlled conditions. Patients with elevated hematocrits (e.g., those with polycythemia vera) or excessive iron absorption (e.g., hemochromatosis) can usually be managed by periodically removing 1 unit (about 500 mL) of whole blood. Over time, this process can produce iron deficiency, leaving the patient unable to produce as many erythrocytes. The actual procedure for therapeutic phlebotomy is similar to that for blood donation (see later discussion).

Blood Component Therapy

A single unit of whole blood contains 450 mL of blood and 50 mL of an anticoagulant, which can be processed and dispensed for administration.

However, it is more appropriate, economical, and practical to separate that unit of whole blood into its primary components: erythrocytes, platelets, and plasma (leukocytes are rarely used; see later discussion).

Each component must be processed and stored differently to maximize the longevity of the viable cells and factors within it; thus, each individual blood component has a different storage life. Because the plasma is removed, a unit of packed red blood cells (PRBCs) is very concentrated (hematocrit approximately 70%) (Butterworth, Mackey, &Wasnick, 2018). PRBCs are stored at 4°C (39.2°F). With special preservatives, they can be stored safely for up to 42 days before they must be discarded (American Red Cross, 2020a).

In contrast, platelets must be stored at room temperature because they cannot withstand cold temperatures, and they last for only 5 days before they must be discarded. To prevent clumping, platelets are gently agitated while stored. Plasma is immediately frozen to maintain the activity of the clotting factors within; it lasts for 1 year if it remains frozen. Alternatively, plasma can be further pooled and processed into blood derivatives, such as albumin, immune globulin, factor VIII, and factor IX. Table 28-4 describes each blood component and how it is commonly used.

Special Preparations

Factor VIII concentrate (antihemophilic factor) is a lyophilized, freeze-dried concentrate of pooled fractionated human plasma used in treating hemophilia A. Factor IX concentrate (prothrombin complex) is similarly prepared and contains factors II, VII, IX, and X. It is used primarily for the treatment of factor IX deficiency (hemophilia B). Factor IX concentrate is also useful in treating congenital factor VII and factor X deficiencies. Recombinant forms of factor VIII, such as Humate-P or Alphanate, are also useful. Because they contain von Willebrand factor, these agents are used in von Willebrand disease as well as in hemophilia A, particularly when patients develop factor VIII inhibitors.

Plasma albumin is a large protein molecule that usually stays within vessels and is a major contributor to plasma oncotic pressure. This protein is used to expand the blood volume of patients in hypovolemic shock and, rarely, to increase the concentration of circulating albumin in patients with hypoalbuminemia.

Immune globulin is a concentrated solution of the antibody immunoglobulin G (IgG), prepared from large pools of plasma. It contains very little immunoglobulin A (IgA) or IgM. Intravenous immunoglobulin (IVIG) is used in various clinical situations to replace inadequate amounts of IgG in patients who are at risk for recurrent bacterial infection (e.g., those with chronic lymphocytic leukemia, those receiving HSCT). It is also used in certain autoimmune disorders, such as idiopathic thrombocytopenic purpura (ITP). Albumin, antihemophilic factors, and IVIG, in contrast to all other

fractions of human blood, cells, or plasma, can survive being subjected to heating at 60°C (140°F) for 10 hours to free them of the viral contaminants that may be present.

TABLE 28-4 Blood and Blood Components Commonly Used in Transfusion Therapy[a]

Component	Composition	Indications and Considerations
Whole blood	Cells and plasma, hematocrit about 40%	Volume replacement and oxygen-carrying capacity; usually used only in significant bleeding (>25% blood volume lost)
PRBCs	RBCs with little plasma (hematocrit about 75%); some platelets and WBCs remain	↑ RBC mass; symptomatic anemia: • Platelets within the unit are not functional • WBCs within the unit may cause reaction and are not functional
Platelets—random	Platelets (5.5×10^{10} platelets/unit), plasma; some RBCs, WBCs	Bleeding due to severe ↓ platelets Prevent bleeding when platelets <5,000–10,000/mm^3 Survival ↓ in presence of fever, chills, infection Repeated treatment leads to ↓ survival due to alloimmunization
Platelets—single donor	Platelets (3×10^{11} platelets/unit) 1 unit is equivalent to 6–8 units of random platelets	Used for repeated treatment: • darr; alloimmunization risk by limiting exposure to multiple donors
Plasma	Plasma; all coagulation factors Complement	Bleeding in patients with coagulation factor deficiencies; plasmapheresis
Granulocytes	Neutrophils (>1×10^{10}/unit); some lymphocytes, RBCs, and platelets will remain within the unit	Severe neutropenia in select patients; controversial
Lymphocytes	Lymphocytes (number varies)	Stimulate graft-vs.-host disease effect
Cryoprecipitate	Fibrinogen ≥150 mg/bag, AHF (VIII:C) 80–110 units/bag, von Willebrand factor; fibronectin	von Willebrand disease Hypofibrinogenemia Hemophilia A
AHF	Factor VIII	Hemophilia A
Factor IX concentrate	Factor IX	Hemophilia B (Christmas disease)
Factor IX complex	Factors II, VII, IX, X	Hereditary factor VII, IX, X deficiency; hemophilia A with factor VII inhibitors
Albumin	Albumin 5%, 25%	Hypoproteinemia; burns; volume expansion by 5% to ↑ blood volume; 25% leads to ↓ hematocrit
IV gamma-globulin	Immunoglobulin G antibodies	Hypogammaglobulinemia (in CLL, recurrent infections); ITP; primary

		immunodeficiency states
Antithrombin III concentrate (AT III)	AT III (trace amounts of other plasma proteins)	AT III deficiency with or at risk for thrombosis

[a]The composition of each type of blood component is described as well as the most common indications for using a given blood component. RBCs, platelets, and fresh-frozen plasma are the blood products most commonly used. When transfusing these blood products, it is important to realize that the individual product is always "contaminated" with very small amounts of other blood products (e.g., WBCs mixed in a unit of platelets). This contamination can cause some difficulties, particularly isosensitization, in certain patients.

↑, increased; ↓, decreased; AHF, antihemophilic factor; CLL, chronic lymphocytic leukemia; ITP, idiopathic thrombocytopenic purpura; IV, intravenous; PRBCs, packed red blood cells; RBCs, red blood cells; WBCs, white blood cells.

Adapted from American Red Cross. (2020b). How can one donation help multiple people? Retrieved on 1/15/2020 at: www.redcrossblood.org/faq.html#eligibility; Stowell, C. P. (2019). Transfusion medicine. In M. Laposata (Ed.). *Laboratory medicine: Diagnosis of disease in the clinical laboratory* (3rd ed., pp. 321–348). New York: McGraw-Hill.

Procuring Blood and Blood Products

The process of procuring blood and blood products includes donation and processing.

Blood Donation

To protect both the donor and the recipients, all prospective donors are examined and interviewed before they are allowed to donate their blood. The intent of the interview is to assess the general health status of the donor and to identify risk factors that might harm a recipient of the donor's blood. There is no upper age limit to donation. The American Red Cross (2020c) requires that donors be in good health and meet specific eligibility criteria related to medications and vaccinations, medical conditions and treatments, travel outside the United States, lifestyle and life events, and so on. Detailed information about these criteria is available on the American Red Cross Web site (see the Resources section). Examples of these minimal requirements include (American Red Cross, 2020a, 2020d):

- Body weight should be at least 50 kg (110 lb) for a standard 450-mL donation.
- Donors must wait at least 8 weeks between whole blood (standard) donations.
- People younger than 17 years require parental consent in some states.
- The oral temperature should not exceed 37.5°C (99.6°F).

- The systolic arterial blood pressure should be 80 to 180 mm Hg, and the diastolic pressure should be 50 to 100 mm Hg.
- The hemoglobin level should be at least 12.5 g/dL.
- The destinations of people who traveled outside the United States and Canada within the past 3 years are reviewed; a waiting period maybe required before a donation is accepted.
- Prospective donors who received a blood transfusion must wait 12 months before a donation is accepted.
- Men who have sexual relations with men must wait 3 months from their last sexual encounter before a donation is accepted.

The American Red Cross follows the U.S. Food and Drug Administration (FDA) policy for donors who are lesbian, gay, bisexual, transgender, or queer (LGBTQ) and provides support for these individuals through the American Red Cross LGBTQ+ Team Member Resource Group (see Resources section at the end of the chapter).

Directed Donation

At times, friends and family of a patient wish to donate blood for that person. These blood donations are referred to as directed donations. These donations are not any safer than those provided by random donors, because directed donors may not be as willing to identify themselves as having a history of any of the risk factors that disqualify a person from donating blood. Therefore, many blood centers no longer accept directed donations.

Standard Donation

Phlebotomy consists of venipuncture and blood withdrawal. Standard precautions are used. Donors are placed in a semirecumbent position. The skin over the antecubital fossa is carefully cleansed with an antiseptic preparation, a tourniquet is applied, and venipuncture is performed. Withdrawal of 450 mL of blood usually takes less than 15 minutes. After the needle is removed, donors are asked to hold the involved arm straight up, and firm pressure is applied with sterile gauze for 2 to 3 minutes. A firm bandage is then applied. The donor remains recumbent until they feel able to sit up, usually within a few minutes. Donors who experience weakness or faintness should rest for a longer period. The donor then receives food and fluids and is asked to remain another 15 minutes.

The donor is instructed to leave the dressing on and to avoid heavy lifting for several hours, to avoid smoking for 1 hour, to avoid drinking alcoholic beverages for 3 hours, to increase fluid intake for 2 days, and to eat healthy meals for at least 2 weeks. Specimens from the donated blood are tested to

detect infections and to identify the specific blood type (see later discussion under Blood Processing).

Autologous Donation

A patient's own blood may be collected for future transfusion; this method is useful for many elective surgeries where the potential need for transfusion is high (e.g., orthopedic surgery). Preoperative donations are ideally collected 4 to 6 weeks before surgery. Iron supplements are prescribed during this period to prevent depletion of iron stores. Typically, 1 unit of blood is drawn each week; the number of units obtained varies with the type of surgical procedure to be performed (i.e., the amount of blood anticipated to be transfused). Phlebotomies are not performed within 72 hours of surgery. Individual blood components can also be collected.

The primary advantage of autologous transfusions is the prevention of viral infections from another person's blood. Other advantages include safe transfusion for patients with a history of transfusion reactions, prevention of alloimmunization, and avoidance of complications in patients with alloantibodies. It is the policy of the American Red Cross that autologous blood is transfused only to the donor. If the blood is not required, it is discarded. The blood is never returned to the general donor supply of blood products to be used by another person (American Red Cross, 2020a).

Needless autologous donation (i.e., performed when the likelihood of transfusion is small) is discouraged because it is expensive, takes time, and uses resources inappropriately. Moreover, in an emergency situation, the autologous units available may be inadequate, and the patient may still require additional units from the general donor supply. Furthermore, although autologous transfusion can eliminate the risk of viral contamination, the risk of bacterial contamination is the same as that in transfusion from random donors (Stowell, 2019).

Contraindications to donation of blood for autologous transfusion are acute infection, severely debilitating chronic disease, hemoglobin level less than 11 g/dL, unstable angina, and acute cardiovascular or cerebrovascular disease. A history of poorly controlled epilepsy may be considered a contraindication in some centers.

Intraoperative Blood Salvage

This transfusion method provides replacement for patients who cannot donate blood before surgery and for those undergoing vascular, orthopedic, or thoracic surgery. During a surgical procedure, blood lost into a sterile cavity (e.g., hip joint) is suctioned into a cell-saver machine. The whole blood or PRBCs are washed, often with saline solution; filtered; and then returned to the patient as

an IV infusion. Salvaged blood cannot be stored, because bacteria cannot be completely removed from the blood and thus cannot be used when it is contaminated with bacteria. The use of intraoperative blood salvage has decreased the need for autologous blood donation but has not affected the need for allogeneic blood products (Sikorski, Rizkalla, Yang, et al., 2017).

Hemodilution

This transfusion method may be initiated before or after induction of anesthesia. About 1 to 2 units of blood are removed from the patient through a venous or arterial line and simultaneously replaced with a colloid or crystalloid solution. The blood obtained is then reinfused after surgery. The advantage of this method is that the patient loses fewer erythrocytes during surgery, because the added IV solutions dilute the concentration of erythrocytes and lower the hematocrit. However, patients who are at risk for myocardial injury should not be further stressed by hemodilution. Hemodilution has been associated with adverse outcomes in patients having cardiopulmonary bypass; it has also been linked to tissue ischemia, particularly in the kidneys (Hare, Han, Leshchyshyn, et al., 2018).

Complications of Blood Donation

Excessive bleeding at the donor's venipuncture site is sometimes caused by a bleeding disorder but more often results from a technique error: laceration of the vein, excessive tourniquet pressure, or failure to apply enough pressure after the needle is withdrawn.

Fainting may occur after blood donation and may be related to emotional factors, a vasovagal reaction, or prolonged fasting before donation. Because of the loss of blood volume, hypotension and syncope may occur when the donor assumes an erect position (John, Theodora, Gloria, et al., 2017). A donor who appears pale or complains of faintness should immediately lie down or sit with the head lowered below the knees. The donor should be observed for another 30 minutes.

Anginal chest pain may be precipitated in patients with unsuspected coronary artery disease. Seizures can occur in donors with epilepsy, although the incidence is very low. Both angina and seizures require further medical evaluation and treatment.

Blood Processing

Samples of the unit of blood are always taken immediately after donation so that the blood can be typed and tested. Each donation is tested for antibodies to human immune deficiency virus (HIV) types 1 and 2, hepatitis B core antibody

(anti-HBc), hepatitis C virus (HCV), human T-cell lymphotropic virus type I (anti-HTLV-I/II), hepatitis B surface antigen (HbsAG), and syphilis. Negative reactions are required for the blood to be used, and each unit of blood is labeled to certify the results. Nucleic acid amplification testing has increased the ability to detect the presence of HCV, HIV, and West Nile virus infections, because it directly tests for genomic nucleic acids of the viruses rather than for the presence of antibodies to the viruses. This testing significantly shortens the "window" of inability to detect HIV and HCV from a donated unit, further ensuring the safety of the blood; the risk of transmission of HIV or HCV is now estimated at 1 in 2 million units and 1 in 1.6 million units of blood donated, respectively (American Cancer Society, 2017). Blood is also screened for cytomegalovirus (CMV). If it tests positive for CMV, it can still be used, except in recipients who are negative for CMV and who are severely immunocompromised; any components are labeled as CMV positive.

Equally important is accurate determination of the blood type. More than 200 antigens have been identified on the surface of RBC membranes. Of these, the most important for safe transfusion are the ABO and Rh systems. The ABO system identifies which sugars are present on the membrane of a person's erythrocytes: A, B, both A and B, or neither A nor B (type O). To prevent a significant reaction, the same type of PRBCs should be transfused. Previously, it was thought that in an emergency situation in which the patient's blood type was not known, type O blood could be safely transfused. This practice is no longer recommended.

The Rh antigen (also referred to as D) is present on the surface of erythrocytes in 85% of the population (Rh positive). Those who lack the D antigen are referred to as being Rh negative. PRBCs are routinely tested for the D antigen as well as ABO. Patients should receive PRBCs with a compatible Rh type.

The majority of transfusion reactions are due to clerical errors, including mislabeling, inaccuracy transcribing orders and incorrect verification of product and patient. When these errors occur, the patient is transfused an incompatible unit of blood product (Stubbs, 2018). Reactions (other than those due to procedural error) are most frequently due to the presence of donor leukocytes within the blood component unit (PRBCs or platelets); the recipient may form antibodies to the antigens present on these leukocytes. PRBC components typically have 1 to 3×10^9 leukocytes remaining in each unit. Leukocytes from the blood product are frequently filtered to diminish the likelihood of developing reactions and refractoriness to transfusions, particularly in patients who have long-term transfusion needs. The process of leukocyte filtration renders the blood component "leukocyte poor" (i.e., leukopoor). Filtration can occur at the time the unit is collected from the donor and processed, which achieves better results but is more expensive, or at the time the blood component is transfused by attaching a leukocyte filter to the

blood administration tubing. Many centers advocate routinely using leukopoor filtered blood components for people who have or are likely to develop long-term transfusion requirements.

When a patient is immunocompromised, as in the case following stem cell transplant, any donor lymphocytes must be removed from the blood components. In this situation, the blood component is exposed to low amounts of radiation (25 Gy) that kill any lymphocytes within the blood component. Irradiated blood products are highly effective in preventing transfusion-associated graft-versus-host disease, which is fatal in most cases. Irradiated blood products have a shorter shelf life.

Transfusion

Administration of blood and blood components requires knowledge of correct administration techniques and possible complications. It is very important to be familiar with the agency's policies and procedures for transfusion therapy.

Most blood transfusions are performed in the acute care setting, and sometimes must be done emergently. Patients with long-term transfusion requirements (i.e., patients who require transfusions on an ongoing, periodic basis) often can receive transfusions in other settings. Freestanding infusion centers, ambulatory care clinics, physicians' offices, and even patients' homes may be appropriate settings for transfusion. Typically, patients who need long-term transfusions but are otherwise stable physically are appropriate candidates for outpatient therapy. Verification and administration of the blood product are performed as in a hospital setting. Although most blood products can be transfused in the outpatient setting, the home is typically limited to transfusions of PRBCs and factor components (e.g., factor VIII for patients with hemophilia).

Pretransfusion Assessment

Patient History

The patient history is an important component of the pretransfusion assessment to determine the history of previous transfusions as well as previous reactions to transfusion. The history should include the type of reaction, its manifestations, the interventions required, and whether any preventive interventions were used in subsequent transfusions. The nurse assesses the number of pregnancies a woman has had, because a high number can increase her risk of reaction due to antibodies developed from exposure to fetal circulation. Other concurrent health problems should be noted, with careful

attention to cardiac, pulmonary, and vascular disease. Informed consent must be obtained preprocedure (see Chart 28-2).

Physical Assessment

A systematic physical assessment and measurement of baseline vital signs and fluid status are important before transfusing any blood product. The respiratory system should be assessed, including careful auscultation of the lungs and the patient's use of accessory muscles. Cardiac system assessment should include careful inspection for any edema as well as other signs of heart failure (e.g., jugular venous distention; see Chapter 25). The skin should be observed for rashes, petechiae, and ecchymoses. The sclera should be examined for icterus. In the event of a transfusion reaction, a comparison of findings can help differentiate between types of reactions.

Chart 28-2 **ETHICAL DILEMMA**

Can Surrogates Refuse Life-Saving Treatment?

Case Scenario

L.C. is a 34-year-old woman who was an unrestrained front-seat passenger in a motor vehicle crash 2 days ago. She sustained multiple trauma, including a fractured skull, traumatic brain injury, several fractured ribs, a pulmonary contusion, and a fractured right femur. After stabilization in the emergency department, she was admitted to the intensive care unit (ICU) endotracheally intubated and mechanically ventilated. You are a staff nurse in the ICU and have been assigned as L.C.'s nurse since her admission. You have come to know her family members, including her parents and her boyfriend, whom she has lived with for the past 10 months. During interdisciplinary rounds, L.C.'s trauma surgeon notes that her hemoglobin continues to drop since admission, and is now 7.7 g/dL; he asserts that she must receive blood transfusions. L.C.'s parents and her boyfriend are present during these rounds. L.C.'s parents tell the trauma surgeon that they are Jehovah's Witnesses, and that receiving blood transfusions is against their religious beliefs. L.C.'s boyfriend notes that she no longer adheres to the tenets of Jehovah's Witnesses and does not attend any religious meetings or services. L.C.'s parents become angry and tell her boyfriend that they are the ones to make decisions on L.C.'s behalf. L.C. does not have an advance directive or a power-of-attorney for health care.

Discussion

Whenever a patient lacks capacity to make their own health care decisions, those decisions are made by a legally identified surrogate. Had L.C. identified who that surrogate should be in a power-of-attorney for health care document, that person would have the rights and responsibilities to make those decisions. Since that document does not exist, and since L.C. does not have a spouse, her parents are her legal surrogates and authorized to make those decisions on her behalf.

Had L.C. written an advance directive and specified whether or not she would wish to receive blood transfusions for life-threatening contingencies, that specification would be legally binding. For instance, had she noted in an advance directive that she would *not* wish to receive blood transfusions, even if that meant that she would die, that would be a legally binding decision, even if her parents wished for her to receive blood transfusions.

However, L.C.'s parents and her boyfriend disagree about what they believe L.C. would want to be done in this situation. Surrogates are charged with making decisions on behalf of patients who lack capacity. However, that charge is predicated on the belief that surrogates know which decision is consistent with what the patient would have wanted when the patient could have made a reasoned decision. It is noteworthy that L.C.'s parents insist that she not be transfused since it is against *their* religious beliefs. However, they do not note that their beliefs are also consistent with L.C.'s beliefs.

Analysis

- Describe the ethical principles that are in conflict in this case (see Chapter 1, Chart 1-7). Is it possible to preserve L.C.'s autonomy, given that she lacks capacity at this time, and given the conflict between her family members?
- There is a conflict between legal rights and moral decisions in this case. Are there situations where the decision that a legal surrogate makes for a patient who lacks capacity could and should be overturned?
- What if a family meeting is called to try to resolve the conflict between L.C.'s parents and her boyfriend, and her boyfriend is able to provide evidence that L.C. does not adhere to the tenets of the Jehovah's Witness faith? By contrast, what if her parents are able to provide evidence that L.C. has been faithfully attending Jehovah's Witnesses meetings for the past 10 months and that she has explicitly told her parents that she would not ever wish to have blood transfusions? Finally, what if L.C.'s parents and her boyfriend each express that none of them are certain what decision L.C. would make in this situation? Would the trauma surgeon be justified in then upholding the principle of beneficence and prescribe blood transfusions for L.C., despite her parents' objections? If those transfusions were prescribed, would you administer the blood transfusions or would you object?
- What resources might be mobilized to be of assistance to L.C.'s family and the health care team so that the decision that best respects L.C.'s wishes might be made?

References

Baumrucker, S. J., Stolick, M., Hutchinson, L., et al. (2019). Death or damnation: Surrogacy and religious beliefs. *American Journal of Hospice & Palliative Medicine, 36*(8), 740–745.

Resources

See Chapter 1, Chart 1-10, for Steps of an Ethical Analysis and Ethics Resources.

Patient Education

Reviewing the signs and symptoms of a transfusion reaction is crucial with all patients, including those who have and have not received a previous transfusion. Signs and symptoms of a reaction include fever, chills, respiratory distress, low back pain, nausea, pain at the IV site, or anything "unusual." Although a thorough review is very important, the nurse also reassures the patient that the blood is carefully tested against the patient's own blood (cross-

matched) to diminish the likelihood of any untoward reaction. Similarly, the patient can be reassured about the very low possibility of contracting HIV from the transfusion; this fear persists among many people.

Transfusion Procedures

Methods for transfusing blood components and the role of the nurse in assessing patients before, during, and after these procedures are described in Charts 28-3 and 28-4.

Complications

Any patient who receives a blood transfusion is at risk for developing complications from the transfusion. Nursing management is directed toward preventing complications, promptly recognizing complications if they develop, and promptly initiating measures to control complications. Nurses assess patients' vital signs before, during, and after a blood transfusion is complete to screen for any adverse reactions; however, the optimal frequency for assessing these vital signs during the transfusion is not well established (Cortez-Gann, Gilmore, Foley, et al., 2017) (see the Nursing Research Profile in Chart 28-5). The following sections describe the most common or potentially severe transfusion-related complications.

Febrile Nonhemolytic Reaction

A febrile nonhemolytic reaction is caused by antibodies to donor leukocytes that remain in the unit of blood or blood component; it is the most common type of transfusion reaction (Stubbs, 2018). It occurs more frequently in patients who have had previous transfusions (exposure to multiple antigens from previous blood products) and in Rh-negative women who have borne Rh-positive children (exposure to an Rh-positive fetus raises antibody levels in the untreated mother).

Chart 28-3

Transfusion of Packed Red Blood Cells

Preprocedure

1. Confirm that the transfusion has been prescribed.
2. Check that patient's blood has been typed and cross-matched.
3. Verify that patient has signed a written consent form per institution or agency policy and agrees to procedure.
4. Explain procedure to patient. Educate patient about signs and symptoms of transfusion reaction (itching, hives, swelling, shortness of breath, fever, chills).
5. Take patient's temperature, pulse, respiration, blood pressure, and assess fluid volume status (e.g., auscultate lungs, assess for jugular venous distention) to serve as a baseline for comparison during transfusion.
6. Note if signs of increased fluid overload present (e.g., heart failure, see Chapter 25), contact primary provider to discuss potential need for a prescription for diuretic, as warranted.
7. Use hand hygiene and wear gloves in accordance with standard precautions.
8. Use appropriately sized intravenous cannula for insertion in a peripheral vein.[a] Use special tubing that contains a blood filter to screen out fibrin clots and other particulate matter. Do not vent blood container.

Procedure

1. Obtain packed red blood cells (PRBCs) from the blood bank *after* the IV line is started. (Institution policy may limit release to only 1 unit at a time.)
2. Double-check labels with another nurse or physician to ensure that the ABO group and Rh type agree with the compatibility record. Check to see that number and type on donor blood label and on patient's medical record are correct. Confirm patient's identification by asking the patient's name and checking the identification wristband.
3. Check blood for gas bubbles and any unusual color or cloudiness. (Gas bubbles may indicate bacterial growth. Abnormal color or cloudiness may be a sign of hemolysis.)
4. Make sure that PRBC transfusion is initiated within 30 minutes after removal of PRBCs from blood bank refrigerator.
5. For the first 15 minutes, run the transfusion slowly—no faster than 5 mL/min. Observe patient carefully for adverse effects. If no adverse effects occur during the first 15 minutes, increase the flow rate unless patient is at high risk for circulatory overload.
6. Monitor closely for 15 to 30 minutes to detect signs of reaction. Monitor vital signs at regular intervals per institution or agency policy; compare results with baseline measurements. Increase frequency of measurements based on patient's condition. Observe patient frequently throughout the

transfusion for any signs of adverse reaction, including restlessness, hives, nausea, vomiting, torso or back pain, shortness of breath, flushing, hematuria, fever, or chills. Should any adverse reaction occur, stop infusion immediately, notify primary provider, and follow the agency's transfusion reaction standard.

7. Note that administration time does not exceed 4 hours because of increased risk of bacterial proliferation.
8. Be alert for signs of adverse reactions: circulatory overload, sepsis, febrile reaction, allergic reaction, and acute hemolytic reaction.
9. Change blood tubing after every 2 units transfused to decrease chance of bacterial contamination.

Postprocedure

1. Obtain vital signs and breath sounds; compare with baseline measurements. If signs of increased fluid overload present (e.g., heart failure), consider obtaining prescription for diuretic as warranted.
2. Dispose of used materials properly.
3. Document procedure in patient's medical record, including patient assessment findings and tolerance to procedure.
4. Monitor patient for response to and effectiveness of procedure. If patient is at risk, monitor for at least 6 hours for signs of transfusion-associated circulatory overload (TACO); also monitor for signs of delayed hemolytic reaction.

Note: Never add medications to blood or blood products; if blood is too thick to run freely, normal saline may be added to the unit. If blood must be warmed, use an in-line blood warmer with a monitoring system.

[a]The size of the peripheral cannula used in a blood transfusion depends on two factors, size and integrity of the vein and desired speed for transfusion.

Adapted from Robinson, S., New, H., Shackleton, T., et al. (2018). The administration of blood components: A British Society for Haematology Guideline. *Transfusion Medicine, 28*(1), 3–21.

Chart 28-4

Transfusion of Platelets or Fresh-Frozen Plasma

Preprocedure

1. Confirm that the transfusion has been prescribed.
2. Verify that patient has signed a written consent form per institution or agency policy and agrees to procedure.
3. Explain procedure to patient. Educate patient about signs and symptoms of transfusion reaction (itching, hives, swelling, shortness of breath, fever, chills).
4. Take patient's temperature, pulse, respiration, blood pressure, and assess fluid status, and auscultate breath sounds to establish a baseline for comparison during transfusion.
5. Note if signs of increased fluid overload present (e.g., heart failure, see Chapter 25), contact primary provider to discuss potential need for a prescription for diuretic, as warranted; this is particularly important when plasma is also infused.
6. Use hand hygiene and wear gloves in accordance with standard precautions.
7. Use a 22-gauge or larger needle or catheter for placement in a large vein, if possible. Use appropriate tubing per institution policy (platelets often require different tubing from that used for other blood products).

Procedure

1. Obtain platelets or fresh-frozen plasma (FFP) from the blood bank (only *after* the IV line is started.)
2. Double-check labels with another nurse or physician to ensure that the ABO group matches the compatibility record (not usually necessary for platelets; here only if compatible platelets are ordered). Check to see that the number and type on donor blood label and on patient's medical record are correct. Confirm patient's identification by asking the patient's name and checking the identification wristband.
3. Check blood product for any unusual color or clumps (excessive redness indicates contamination with larger amounts of red blood cells).
4. Make sure that platelets or FFP units are given immediately after they are obtained.
5. Infuse each unit of FFP over 30 to 60 minutes per patient tolerance; be prepared to infuse at a significantly lower rate in the context of fluid overload. Infuse each unit of platelets as fast as patient can tolerate to diminish platelet clumping during administration. Observe patient carefully for adverse effects, especially circulatory overload. Decrease rate of infusion if necessary.
6. Observe patient closely throughout transfusion for any signs of adverse reaction, including restlessness, hives, nausea, vomiting, torso or back pain, shortness of breath, flushing, hematuria, fever, or chills. Should any adverse reaction occur, stop infusion immediately, notify primary provider, and follow the agency's transfusion reaction standard.

7. Monitor vital signs at the end of transfusion per institution policy; compare results with baseline measurements.
8. Flush line with saline after transfusion to remove blood component from tubing.

Postprocedure

1. Obtain vital signs and auscultate breath sounds; compare with baseline measurements. If signs of increased fluid overload present, consider obtaining prescription for diuretic, as warranted.
2. Dispose of used materials properly.
3. Document procedure in patient's medical record, including patient assessment findings and tolerance to procedure.
4. Monitor patient for response to and effectiveness of procedure. A platelet count may be ordered 1 hour after platelet transfusion to facilitate this evaluation.
5. If patient is at risk for transfusion-associated circulatory overload (TACO), monitor closely for 6 hours after transfusion if possible.

Note: FFP requires ABO but not Rh compatibility. Platelets are not typically cross-matched for ABO compatibility. Never add medications to blood or blood products.

Adapted from Robinson, S., New, H., Shackleton, T., et al. (2018). The administration of blood components: A British Society for Haematology Guideline. *Transfusion Medicine, 28*(1), 3–21.

The diagnosis of a febrile nonhemolytic reaction is made by excluding other potential causes, such as a hemolytic reaction or bacterial contamination of the blood product. The signs and symptoms of a febrile nonhemolytic transfusion reaction are chills (minimal to severe) followed by fever (more than 1°C elevation). The fever typically begins within 2 hours after the transfusion has begun. Although the reaction is not life threatening, the fever, and particularly the chills and muscle stiffness, can be frightening to the patient.

This reaction can be diminished, even prevented, by further depleting the blood component of donor leukocytes; this is accomplished by a leukocyte reduction filter. Antipyretic agents can be given to prevent fever; however, routine premedication is not advised because it can mask the beginning of a more serious transfusion reaction.

Acute Hemolytic Reaction

The most dangerous, and potentially life-threatening, type of transfusion reaction occurs when the donor blood is incompatible with that of the recipient (i.e., type II hypersensitivity reaction). Antibodies already present in the recipient's plasma rapidly combine with antigens on donor erythrocytes, and the erythrocytes are destroyed in the circulation (i.e., intravascular hemolysis).

The most rapid hemolysis occurs in ABO incompatibility. Rh incompatibility often causes a less severe reaction. This reaction can occur after transfusion of as little as 10 mL of PRBCs. Although the overall incidence of such reactions is not high (1:20,000 to 1:40,000 units transfused) (Robinson, New, Shackleton, et al., 2018), they are largely preventable. The most common causes of acute hemolytic reaction are errors in blood component labeling, a type of clerical error, and errors in patient identification that result in the administration of an ABO-incompatible transfusion.

Symptoms consist of fever, chills, low back pain, nausea, chest tightness, dyspnea, and anxiety. As the erythrocytes are destroyed, the hemoglobin is released from the cells and excreted by the kidneys; therefore, hemoglobin appears in the urine (hemoglobinuria). Hypotension, bronchospasm, and vascular collapse may result. Diminished renal perfusion results in acute kidney injury, and disseminated intravascular coagulation may also occur. The reaction must be recognized promptly and the transfusion discontinued immediately (see the Nursing Management of Transfusion Reactions section).

Chart 28-5 **NURSING RESEARCH PROFILE**

Blood Transfusions and Vital Sign Frequency

Cortez-Gann, J., Gilmore, K. D., Foley, K. W., et al. (2017). Blood transfusion vital sign frequency: What does the evidence say? *MEDSURG Nursing, 26*(2), 89–92.

Purpose

Nurses are responsible for assuring patient safety during a blood transfusion through effective monitoring of vital signs. When and how often to take vital signs varies, based upon institutional protocols. There are no evidence-based research findings that provide direction regarding optimal timing and frequency of vital sign monitoring for patients who receive blood transfusions. Therefore, the purpose of this research was to discover the relationship between vital sign findings and blood transfusion-associated adverse events in order to find patterns suggestive of optimal vital sign timing and frequency for patients receiving blood transfusions.

Design

A retrospective descriptive study was conducted in a 921-bed hospital where approximately 77,800 units of blood products were transfused during 2008 through 2012. Of those patients transfused during this time, 116 experienced a blood transfusion reaction. Using a medical record data collection tool, information from these 116 patients was collected including demographics, type of blood product administered, transfusion start and stop times, vital signs before, during, and after transfusion, symptomatology and treatment protocol for the transfusion reaction, and patient outcomes.

Findings

Packed red blood cells were the most commonly transfused product. Of the 116 sampled patients who experienced a transfusion reaction, 67% were over 60 years of age. The most common changes among vital signs were an increase in temperature, blood pressure, and heart rate. Six of the 116 patients with transfusion reactions experienced severe life-threatening complications from the blood transfusion, but none died from them. The average time from the start of transfusion to an adverse reaction was approximately 92 minutes, with the quickest documented response occurring 5 minutes after initiation of the transfusion and the most delayed reaction taking place 2 hours and 30 minutes after the start of the transfusion.

Nursing Implications

Hospitals endorse different protocols that dictate when and how often nurses take vital signs for patients who receive blood products. While it is commonly believed that the most likely time for a patient to experience a transfusion reaction is within the first 15 minutes after the start of a transfusion, findings from this study established an average time to the reaction of 1.5 hours, with the most severe reaction occurring 2 hours after initiation of the transfusion. Only one severe reaction in this study occurred during the first 15 minutes of

the transfusion period. Findings from this study suggest that nurses should take vital signs of patients receiving blood transfusions at periodic intervals during the entire timeframe that a patient receives a blood transfusion.

Acute hemolytic transfusion reactions are preventable. Meticulous attention to detail in labeling blood samples and blood components and accurately identifying the recipient cannot be overemphasized. Bar coding methods can be useful safeguards in matching a patient's wristband with the label on the blood component; however, these methods are not fail proof and do not reduce the nurse's responsibility to ensure the correct blood component is transfused to the correct patient (Robinson et al., 2018).

Allergic Reaction

Some patients develop urticaria (hives) or generalized itching during a transfusion; the cause is thought to be a sensitivity reaction to a plasma protein within the blood component being transfused. Symptoms of an allergic reaction are urticaria, itching, and flushing. The reactions are usually mild and respond to antihistamines. If the symptoms resolve after administration of an antihistamine (e.g., diphenhydramine), the transfusion may be resumed. Rarely, the allergic reaction is severe, with bronchospasm, laryngeal edema, and shock. These reactions are managed with epinephrine, corticosteroids, and vasopressor support, if necessary.

Giving the patient antihistamines or corticosteroids before the transfusion may prevent future reactions. For severe reactions, future blood components are washed to remove any remaining plasma proteins. Leukocyte filters are not useful to prevent such reactions, because the offending plasma proteins can pass through the filter.

Transfusion-Associated Circulatory Overload (TACO)

If too much blood is infused too quickly, hypervolemia can occur. This condition, known as transfusion-associated circulatory overload (TACO), can be aggravated in patients who already have increased circulatory volume (e.g., those with heart failure, renal dysfunction, advanced age, acute myocardial infarction) (Carman, Uhlenbrock, & McClintock, 2018). A careful assessment for signs of circulatory overload or positive fluid status prior to initiating the transfusion is required, particularly in patients at risk for developing transfusion-related acute lung injury (TRALI) (see discussion below). PRBCs are safer to use than whole blood. If the administration rate is sufficiently slow, circulatory overload may be prevented. For patients who are at risk for, or already in, circulatory overload, diuretics are given prior to the transfusion or between units of PRBCs. Patients receiving fresh-frozen plasma or even platelets may also develop circulatory overload. The infusion rate of these blood components must also be titrated to the patient's tolerance. Rates of

transfusion may need to decrease to less than 100 to 120 mL/h (Henneman, 2017).

Signs of circulatory overload include dyspnea, orthopnea, tachycardia, an increase in blood pressure, and sudden anxiety. Jugular vein distention, crackles at the base of the lungs, and hypoxemia will also develop. Pulmonary edema can quickly develop, as manifested by severe dyspnea and coughing of pink, frothy sputum.

If fluid overload is mild, the transfusion can often be continued after slowing the rate of infusion and administering diuretics. However, if the overload is severe, the patient is placed upright with the feet in a dependent position, the transfusion is discontinued, and the primary provider is notified. The IV line is kept patent with a very slow infusion of normal saline solution or a saline lock device to maintain access to the vein in case IV medications are necessary. Oxygen and morphine may be needed to treat severe dyspnea (see Chapter 25).

TACO can develop as late as 6 hours after transfusion (Henneman, 2017). Therefore, patients need close monitoring after the transfusion is completed, particularly those who are at higher risk for developing this complication (e.g., older adults, those with a positive fluid balance prior to transfusion, patients with renal dysfunction, patients with left ventricular dysfunction). Monitoring vital signs, auscultating breath sounds, and assessing for jugular venous distention should be included in patient monitoring.

Bacterial Contamination

The incidence of bacterial contamination of blood components is very low; however, administration of contaminated products puts the patient at great risk. Contamination can occur at any point during procurement or processing but often results from organisms on the donor's skin. Many bacteria cannot survive in the cold temperatures used to store PRBCs, but some organisms can. Platelets are at greater risk of contamination because they are stored at room temperature. In response to this, blood centers have developed rapid methods of culturing platelet units, thereby diminishing the risk of using a contaminated platelet unit for transfusion (CDC, 2019).

Preventive measures include meticulous care in the procurement and processing of blood components. When PRBCs or whole blood is transfused, it should be given within a 4-hour period, because warm room temperatures promote bacterial growth. A contaminated unit of blood product may appear normal, or it may have an abnormal color.

The signs of bacterial contamination are fever, chills, and hypotension. These manifestations may not occur until the transfusion is complete, and occasionally not until several hours after the transfusion. As soon as the reaction is recognized, any remaining transfusion is discontinued (see the Nursing Management of Transfusion Reactions section). If the condition is not

treated immediately with fluids and broad-spectrum antibiotics, sepsis can occur. Sepsis is treated with IV fluids and antibiotics; corticosteroids and vasopressors are often also necessary (see Chapter 11).

Transfusion-Related Acute Lung Injury (TRALI)

TRALI is a potentially fatal, idiosyncratic reaction that is defined as the development of acute lung injury occurring within 6 hours after the blood transfusion. All blood components have been implicated in TRALI, including IVIG, cryoprecipitate, and stem cells. TRALI is the most common cause of transfusion-related death (Heering & Karakashian, 2017).

The underlying pathophysiologic mechanism for TRALI is unknown but is thought to involve specific human leukocyte antigen (HLA) or human neutrophil antigen (HNA) antibodies in the donor's plasma that react to the leukocytes in the recipient's blood. Occasionally, the reverse occurs, and antibodies present in the recipient's plasma agglutinate the antigens on the few remaining leukocytes in the blood component being transfused. Another theory suggests that an initial insult to the patient's vascular endothelium can predispose the neutrophils to aggregate at the injured endothelium. Various substances within the transfused blood component (lipids, cytokines) then activate these neutrophils. Each of these pathophysiologic mechanisms can contribute to the process. The end result of this process is interstitial and intra-alveolar edema, as well as extensive sequestration of WBCs within the pulmonary capillaries (Heering & Karakashian, 2017).

Onset is abrupt (usually within 6 hours of transfusion, often within 2 hours). Signs and symptoms include acute shortness of breath, hypoxia (arterial oxygen saturation [SaO_2] less than 90%; partial pressure of arterial oxygen [PaO_2] to fraction of inspired oxygen [FIO_2] ratio of less than 300), hypotension, fever, and eventual pulmonary edema. Diagnostic criteria include hypoxemia, bilateral pulmonary infiltrates (seen on chest x-ray), no evidence of cardiac cause for the pulmonary edema, and no other plausible alternative cause within 6 hours of completing transfusion. Aggressive supportive therapy (e.g., oxygen, intubation, fluid support) may prevent death. Immunologic therapy (e.g., corticosteroids) has not been shown to be effective in this setting; diuretics can worsen the situation (Raja, Rahul, Kumar, et al., 2019).

Although TRALI can occur with the transfusion of any blood component, it is more likely to occur when plasma and, to a lesser extent, platelets are transfused. One commonly used preventive strategy involves limiting the frequency and amount of blood products transfused. Another entails obtaining plasma and possibly platelets only from men because women who have been pregnant may have developed offending antibodies. A third strategy involves screening donors for the presence of these antibodies and discarding any plasma-containing blood products from those donors who screen positive. The

efficacy of these approaches in preventing TRALI remains unclear (Otrock, Liu, & Grossman, 2017).

Delayed Hemolytic Reaction

Delayed hemolytic reactions usually occur within 14 days after transfusion, when the level of antibody has been increased to the extent that a reaction can occur (Siddon, Kenney, Hendrickson, et al., 2018). The hemolysis of the erythrocytes is extravascular via the RES and occurs gradually.

Signs and symptoms of a delayed hemolytic reaction are fever, anemia, increased bilirubin level, decreased or absent haptoglobin, and possibly jaundice. Rarely, there is hemoglobinuria. Generally, these reactions are not dangerous, but it is important to recognize them because subsequent transfusions with blood products containing these antibodies may cause a more severe hemolytic reaction. However, recognition is also difficult because the patient may not be in a health care setting to be tested for this reaction, and even if the patient is hospitalized, the reaction may be too mild to be recognized clinically. Because the amount of antibody present can be too low to detect, it is difficult to prevent delayed hemolytic reactions. Fortunately, the reaction is usually mild and requires no intervention (Siddon et al., 2018).

Disease Acquisition

Despite advances in donor screening and blood testing, certain diseases can still be transmitted by transfusion of blood components (see Chart 28-6).

Chart 28-6

Diseases Potentially Transmitted by Blood Transfusion

Hepatitis (Viral Hepatitis B, C)

- There is greater risk from pooled blood products and blood of paid donors than from volunteer donors.
- A screening test detects most hepatitis B and C.
- Transmittal risk for Hepatitis B is estimated at 1:350,000 donated units.

AIDS (HIV and HTLV)

- Donated blood is screened for antibodies to HIV.
- Transmittal risk is estimated at 1:1.5 million donated units.
- People with high-risk behaviors (multiple sex partners, anal sex, IV/injection drug use) and people with signs and symptoms that suggest AIDS should not donate blood.

Cytomegalovirus (CMV)

- Transmittal risk is greater for premature newborns with CMV antibody–negative mothers and for immunocompromised recipients who are CMV negative (e.g., those with acute leukemia, organ or tissue transplant recipients).
- Blood products rendered "leukocyte reduced" help reduce transmission of virus.

Graft-Versus-Host Disease (GVHD)

- GVHD occurs only in recipients who are severely immunocompromised (e.g., Hodgkin disease, bone marrow transplantation).
- Transfused lymphocytes engraft in recipient and attack host lymphocytes or body tissues; signs and symptoms are fever, diffuse reddened skin rash, nausea, vomiting, and diarrhea.
- Preventive measures include irradiating blood products to inactivate donor lymphocytes (no known radiation risks to transfusion recipient) and processing donor blood with leukocyte reduction filters.

Creutzfeldt–Jakob Disease (CJD)

- CJD is a rare, fatal disease that causes irreversible brain damage.
- There is no evidence of transmittal by transfusion.
- All blood donors must be screened for positive family history of CJD.
- Potential donors who spent a cumulative time of 5 years or more (January 1980 to present) in certain areas of Europe cannot donate blood; blood products from a donor who develops CJD are recalled.

AIDS, acquired immunodeficiency syndrome; HIV, human immunodeficiency virus; HTLV, human T-lymphotropic virus.

Adapted from Katz, L. M., & Dodd, R. Y. (2018). Transfusion-transmitted diseases. In B. H. Shaz, C. D. Hillyer, & M. R. Gil (Eds.). *Transfusion medicine and hemostasis: Clinical and laboratory aspects* (3rd ed.). Cambridge, MA: Elsevier.

Complications of Long-Term Transfusion Therapy

The complications that have been described represent a real risk to any patient any time a blood component is given. However, patients with long-term transfusion requirements (e.g., those with myelodysplastic syndrome, thalassemia, aplastic anemia, sickle cell disease) are at greater risk for infection transmission and for becoming more sensitized to donor antigens, simply because they are exposed to more units of blood and, consequently, more donors. A summary of complications associated with long-term transfusion therapy is given in Table 28-5.

Iron overload is a complication unique to people who have had long-term PRBC transfusions. One unit of PRBCs contains 250 mg of iron. Patients with long-term transfusion requirements can quickly acquire more iron than they can use, leading to iron overload. Over time, the excess iron deposits in body tissues can cause organ damage, particularly in the liver, heart, testes, and pancreas. Promptly initiating a program of iron chelation therapy can prevent end-organ damage from iron toxicity (see Chapter 29, Hereditary Hemochromatosis, Nursing Management, and Chapter 30, Myelodysplastic Syndrome, Nursing Management).

Nursing Management of Transfusion Reactions

If a transfusion reaction is suspected, the transfusion must be stopped immediately, and the primary provider notified. A thorough patient assessment is crucial because many complications have similar signs and symptoms. The following steps are taken to determine the type and severity of the reaction:

TABLE 28-5 Common Complications Resulting from Long-Term Packed Red Blood Cell Transfusion Therapy[a]

Complication	Manifestation	Management
Infection	Hepatitis (B, C)	May immunize against hepatitis B; treat hepatitis C; monitor hepatic function
	CMV	WBC filters to protect against CMV
Iron overload	Heart failure Endocrine failure (diabetes, hypothyroidism, hypoparathyroidism, hypogonadism)	Prevent by chelation therapy
Transfusion reaction	Sensitization	Diminish by RBC phenotyping, using WBC-filtered products
	Febrile reactions	Diminish by using WBC-filtered products

[a]Patients with long-term transfusion therapy requirements are at risk not only for the transfusion reactions discussed in the text but also for the complications noted in the table. In many cases, the use of WBC-filtered (i.e., leukocyte-poor) blood products is standard for patients who receive long-term packed RBC transfusion therapy. An aggressive chelation program initiated early in the course of therapy can prevent problems with iron overload.

CMV, cytomegalovirus; RBC, red blood cell; WBC, white blood cell.

Adapted from Carman, M., Uhlenbrock, J. S., & McClintock, S. M. (2018). CE: A review of current practice in transfusion therapy. *The American Journal of Nursing*, *118*(5), 36–44.

- Stop the transfusion. Maintain the IV line with normal saline solution through new IV tubing, given at a slow rate.
- Assess the patient carefully. Compare the vital signs with baseline, including oxygen saturation. Assess the patient's respiratory status carefully. Note the presence of adventitious breath sounds; the use of accessory muscles; the extent of dyspnea; and changes in mental status, including anxiety and confusion. Note any chills, diaphoresis, jugular vein distention, and reports of back pain or urticaria.
- Notify the primary provider of the assessment findings and implement any treatments prescribed. Continue to monitor the patient's vital signs and respiratory, cardiovascular, and renal status.
- Notify the blood bank that a suspected transfusion reaction has occurred.
- Send the blood container and tubing to the blood bank for repeat typing and culture. The patient's identity and blood component identifying tags and numbers are verified.

If a hemolytic transfusion reaction or bacterial infection is suspected, the nurse does the following:

- Obtains appropriate blood specimens from the patient.
- Collects a urine sample as soon as possible to detect hemoglobin in the urine.
- Documents the reaction according to the institution's policy.

Pharmacologic Alternatives to Blood Transfusions

Pharmacologic agents that stimulate the production of one or more types of blood cells by the marrow are commonly used (see Chart 28-7). Researchers continue to seek a blood substitute that is practical and safe. Manufacturing artificial blood is problematic, given the myriad functions of blood components. Currently, there are two types of products in development: hemoglobin-based oxygen carriers and perfluorocarbons (which can dissolve gases and thus carry oxygen indirectly); none are approved for use in humans, to date (Adams, 2019).

Chart 28-7 **PHARMACOLOGY**

Pharmacologic Alternatives to Blood Transfusions

Growth Factors

Recombinant technology has provided a means to produce hematopoietic growth factors necessary for the production of blood cells within the bone marrow. By increasing the body's production of blood cells, transfusions and complications resulting from diminished blood cells (e.g., infection from neutropenia) may be avoided. However, the successful use of growth factors requires functional bone marrow. Moreover, the safety of these products has been questioned, and the U.S. Food and Drug Administration is limiting their use in some patient populations.

Erythropoietin

Erythropoietin (epoetin alfa; darbopoietin) is an effective alternative treatment for patients with chronic anemia secondary to diminished levels of erythropoietin, as in chronic kidney disease. This medication stimulates erythropoiesis. It also has been used for patients who are anemic from chemotherapy or zidovudine (AZT) therapy and for those who have diseases involving bone marrow suppression, such as myelodysplastic syndrome (MDS). The use of erythropoietin can also enable a patient to donate several units of blood for future use (e.g., preoperative autologous donation). The medication can be administered IV or subcutaneously, although plasma levels are better sustained with the subcutaneous route. Side effects are rare, but erythropoietin can cause or exacerbate hypertension. If the anemia is corrected too quickly or is overcorrected, the elevated hematocrit can cause headache and, potentially, seizures. Thrombosis has been noted in some patients whose hemoglobins were raised to a high level; thus, it is recommended that a target hemoglobin level of less than 12 g/dL be used. These adverse effects are rare except for patients with renal failure. Serial complete blood counts (CBCs) must be performed to evaluate the response to the medication. The dose and frequency of administration are titrated to the hemoglobin level.

Granulocyte Colony-Stimulating Factor (G-CSF)

G-CSF (filgrastim) is a cytokine that stimulates the proliferation and differentiation of myeloid stem cells; a rapid increase in neutrophils is seen within the circulation. G-CSF is effective in improving transient but severe neutropenia after chemotherapy or in some forms of MDS. It is particularly useful in preventing bacterial infections that would be likely to occur with neutropenia. G-CSF is given subcutaneously on a daily basis. The primary side effect is bone pain; this probably reflects the increase in hematopoiesis within the marrow. Serial CBCs should be performed to evaluate the response to the medication and to ensure that the rise in white blood cells is not excessive. The effect of G-CSF on myelopoiesis is short; the neutrophil count drops once the medication is stopped.

Granulocyte-Macrophage Colony-Stimulating Factor (GM-CSF)

GM-CSF (sargramostim) is a cytokine that is naturally produced by a variety of cells, including monocytes and endothelial cells. It works either directly or synergistically with other growth factors to stimulate myelopoiesis. GM-CSF is not as specific to neutrophils as is G-CSF; thus, an increase in erythroid (red blood cell) and megakaryocytic (platelet) production may also be seen. GM-CSF serves the same purpose as G-CSF. However, it may have a greater effect on macrophage function and therefore may be more useful against fungal infections, whereas G-CSF may be better used to fight bacterial infections. GM-CSF is also given subcutaneously. Side effects include bone pain, fevers, and myalgias.

Thrombopoietin

Thrombopoietin (TPO) is a cytokine that is necessary for the proliferation of megakaryocytes and subsequent platelet formation. Nonimmunogenic second-generation thrombopoietic growth factors (romiplostim; eltrombopag) are used for the treatment of idiopathic thrombocytopenic purpura. Eltrombopag is also approved for use in certain situations for patients with aplastic anemia and in patients requiring hepatitis C treatment that can cause significant thrombocytopenia.

Adapted from Hudgins, K., & Carter, E. (2019). Blood conservation: Exploring alternatives to blood transfusions. *Critical Care Nursing Quarterly, 42*(2), 187–191.

CRITICAL THINKING EXERCISES

1 pq A 40-year-old female is receiving one unit of packed red blood cells after admission for trauma as a result of an automobile injury. She is alert and responsive but lost a large amount of blood and presented with a hematocrit of 28% and a hemoglobin of 10 mg/dL. The blood has been transfusing for approximately 15 minutes when the patient complains of a headache and feeling "achy." Her pulse is 96 bpm, respirations 20 per minute, blood pressure 128/76, and temperature 37.8°C (100.2°F). A nursing co-worker tells you this is a transfusion reaction, and you should stop the transfusion immediately. How would you respond to the nursing co-worker? What would you prioritize as the first three nursing actions most appropriate for this patient?

2 ebp You are a nurse working in a community health clinic and today during a vaccination health fair a 70-year-old male patient presents for varicella and Td/Tdap vaccines. You notice on his health history that he had a blood transfusion 2 months prior during a total hip replacement procedure. Based on this history, would you advise this patient to accept both vaccinations, varicella only, Td/Tdap only, or no vaccines? What is the strength of the evidence supporting the role of vaccinations in patients who have received blood transfusions? Which interprofessional resources and team members would you consult to help determine the best decision for this patient?

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*Asterisk indicates nursing research.

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Resources

AABB (formerly known as the American Association of Blood Banks), www.aabb.org/Pages/default.aspx
American Cancer Society, www.cancer.org
American Red Cross, www.redcross.org
American Red Cross LGBTQ+ Team Member Resource Group, www.redcrossblood.org/donate-blood/how-to-donate/eligibility-requirements/lgbtq-donors.html
Blood and Marrow Transplant Information Network, www.bmtinfonet.org
Infusion Nurses Society, www.ins1.org
Myelodysplastic Syndromes Foundation, www.mds-foundation.org
National Cancer Institute, www.cancer.gov
National Hemophilia Foundation, www.hemophilia.org
National Marrow Donor Program, www.bethematch.org
Oncology Nursing Society (ONS), www.ons.org

29 Management of Patients with Nonmalignant Hematologic Disorders

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Differentiate between hypoproliferative and hemolytic anemias and compare the physiologic mechanisms, clinical manifestations, medical management, and nursing interventions for each.
2. Describe the processes involved in neutropenia and lymphopenia and the principles involved in medical and nursing management of patients with these disorders.
3. Specify the etiologies and the medical and nursing management of patients with secondary polycythemias and bleeding and thrombotic disorders.
4. Use the nursing process as a framework for care of the patient with anemia, with sickle cell disease, or with disseminated intravascular coagulation.

NURSING CONCEPTS

Cellular Regulation
Clotting
Perfusion

GLOSSARY

absolute neutrophil count (ANC): a calculation of the number of circulating neutrophils, derived from the total number of white blood cells (WBCs) and the percentage of neutrophils counted in a microscope's visual field

anemia: decreased red blood cell (RBC) count

aplasia: lack of cellular development (e.g., of cells within the bone marrow)

cytokines: proteins produced by leukocytes that are critical for regulation of hematopoiesis, apoptosis, and immune responses

erythrocyte: a cellular component of blood essential to the transport of oxygen and carbon dioxide (*synonym*: RBC)

erythroid cells: any cell that is or will become a mature RBC

erythropoietin: hormone produced primarily by the kidneys in response to cellular hypoxia that is necessary for erythropoiesis

haptoglobin: blood protein synthesized by the liver; binds free hemoglobin released from erythrocytes which is then removed by the reticuloendothelial system

hemolysis: destruction of RBCs with release of cellular components into the circulation; may occur within or outside the vasculature

hemosiderin: iron-containing pigment derived from the breakdown of hemoglobin

hypochromia: pallor within the RBCs caused by decreased hemoglobin content

leukemia: uncontrolled proliferation of WBCs

lymphopenia: a lymphocyte count less than 1500/mm^3

megaloblastic anemia: a type of anemia characterized by abnormally large, nucleated RBCs

microcytosis: smaller-than normal RBCs

neutropenia: lower-than-normal number of neutrophils

normochromic: normal RBC color, indicating normal amount of hemoglobin

normocytic: normal size of RBC

pancytopenia: abnormal decrease in WBCs, RBCs, and platelets

petechiae: tiny capillary hemorrhages

poikilocytosis: variation in shape of RBCs

polycythemia: excess RBCs

reticulocytes: slightly immature RBCs, usually 1% of total number of circulating RBCs

spherocytes: small, spherically shaped RBCs

thrombocytopenia: lower-than-normal platelet count

thrombocytosis: higher-than-normal platelet count

Hematologic disorders vary widely in their etiologies and manifestations. While some are malignant, most hematologic disorders are benign. Disease processes can be quite complex, so a comprehensive understanding of the processes involved is important so that nurses may effectively assess, intervene, monitor, and educate patients about their conditions.

Anemia

Anemia is a condition characterized by a lower-than-normal hemoglobin concentration. Fewer than the normal number of red blood cells (RBCs), also called **erythrocytes**, are present in the circulation. Subsequently, less oxygen reaches the tissues, causing a variety of signs and symptoms. Rather than a disease state, anemia is a sign of an underlying disorder. It is the most common of all hematologic conditions and is prevalent throughout the world (Bunn, 2017a; Nair, 2018).

Pathophysiology

Anemia is classified in several ways (see Table 29-1). Most often it is classified according to whether the decreased number of erythrocytes is associated with hypoproliferation (decreased production), hemolysis (increased destruction), or loss of cells through bleeding.

Hypoproliferative anemias occur when the bone marrow produces an inadequate number of erythrocytes. Decreased erythrocyte production results in a low or inappropriately normal **reticulocyte** (i.e., immature RBC) count. Causes of hypoproliferative anemia may include bone marrow damage from chemicals (e.g., benzene) or medication (e.g., chloramphenicol), lack of important factors that promote erythrocyte production such as **erythropoietin**, or lack of nutrients, including iron, vitamin B_{12} and folic acid.

In hemolytic anemias, premature destruction of erythrocytes results in the liberation of hemoglobin from the erythrocytes into the plasma; the released hemoglobin is converted in large part to bilirubin and, therefore, the bilirubin concentration rises. The increased erythrocyte destruction leads to tissue hypoxia, which in turn stimulates erythropoietin production. This increased production is reflected in an increased reticulocyte count as the bone marrow responds to the loss of erythrocytes. **Hemolysis** (destruction of RBCs with release of cellular components into the circulation) can result from an abnormality within the erythrocyte itself (e.g., sickle cell disease [SCD], glucose-6-phosphate dehydrogenase [G-6-PD] deficiency), within the plasma

(e.g., immune hemolytic anemias), or from direct injury to the erythrocyte within the circulation (e.g., hemolysis caused by a mechanical heart valve). Chart 29-1 identifies causes of hemolytic anemias.

It is often possible to determine the cause of anemia in each patient based on the following factors:

- The ability of the bone marrow to respond to the decrease in erythrocytes by producing reticulocytes.
- The degree to which immature erythrocytes proliferate in the bone marrow and their ability to mature (as seen in a bone marrow biopsy).

TABLE 29-1 Classification of Anemias

Type of Anemia	Laboratory Findings	
	CBC	Other
Hypoproliferative (Resulting from Defective RBC Production)		
Iron deficiency (microcytic)	↓ MCV, ↓ reticulocytes	↓ Iron, % saturation, ferritin ↑ TIBC
Vitamin B_{12} deficiency (megaloblastic)	↑ MCV	↓ Vitamin B_{12}
Folate deficiency (megaloblastic)	↑ MCV	↓ Folate
Decreased erythropoietin production (e.g., from chronic kidney disease)	Normal MCV	↓ Erythropoietin level ↑ Creatinine ↑ Ferritin, % saturation
Cancer/inflammation	Normal MCV	↓ Iron, TIBC ↓ Erythropoietin level (usually)
Bleeding (Resulting in RBC Loss)		
Bleeding from gastrointestinal tract, epistaxis (nosebleed), trauma, bleeding from genitourinary tract (e.g., menorrhagia)	↓ Hgb and Hct (*Note:* Hgb and Hct may be normal if measured soon after bleeding starts) ↓ MCV (normal MCV initially) ↑ Reticulocytes	↓ Iron, % saturation, ferritin (later)
Hemolytic (Resulting from RBC Destruction)		
Altered erythropoiesis (sickle cell disease, thalassemia, other hemoglobinopathies)	↓ MCV ↑ Reticulocytes Fragmented RBCs (various shapes)	
Hypersplenism (hemolysis)	↑ MCV	
Drug-induced anemia	↑ Presence of spherocytes	
Autoimmune anemia	↑ Presence of spherocytes	
Mechanical heart valve–related anemia	Fragmented red cells	

↓, decreased; ↑, increased; %, percent; CBC, complete blood count; Hct, hematocrit; Hgb, hemoglobin; MCV, mean corpuscular volume; RBC, red blood cell; TIBC, total iron-binding capacity.

Adapted from Prchal, J. T. (2016a). Clinical manifestations and classification of erythrocyte disorders. In K. Kaushansky, M. A. Lichtman, J. T. Prchal, et al. (Eds.). *Williams hematology* (9th ed.). New York: McGraw-Hill Medical.

Chart 29-1

Causes of Hemolytic Anemias

Inherited Hemolytic Anemia

Sickle cell disease
Thalassemia

Red Blood Cell Membrane Abnormality

Acanthocytosis
Hereditary elliptocytosis
Hereditary spherocytosis
Stomatocytosis

Enzyme Deficiencies

Glucose-6-phosphate dehydrogenase deficiency

Acquired Hemolytic Anemia

Antibody Related

Autoimmune hemolytic anemia
Iso-antibody/transfusion reaction
Cold agglutinin disease

Not Antibody Related

Disseminated intravascular coagulation
Hypersplenism
Infection
  Bacterial
  Parasitic
Liver disease
Mechanical heart valve
Microangiopathic hemolytic anemia
Paroxysmal nocturnal hemoglobinuria
Toxins
Trauma
Uremia

- The presence or absence of end products of erythrocyte destruction in the circulation (e.g., increased bilirubin level, decreased haptoglobin level).

Clinical Manifestations

Several factors influence the development of symptoms associated with anemia. The severity of the anemia, the rapidity with which the anemia developed, the duration (chronicity) of the anemia, metabolic requirements of the patient, the presence of other conditions, such as cardiac or pulmonary disease, and complications or related features of the condition that produced the anemia are some of these factors.

In general, the more quickly the anemia develops, the more severe the symptoms (Bunn, 2017a). An otherwise healthy patient may be able to tolerate as much as a 50% reduction in hemoglobin over several months without pronounced symptoms or significant incapacity; however, a rapid loss of 30% of the hemoglobin over minutes may lead to profound vascular collapse in the same person. A patient who gradually becomes anemic, such as a woman experiencing heavy menses over several months with hemoglobin levels between 9 and 11 g/dL, may have few or no symptoms except for slight tachycardia on exertion or fatigue.

People who are more active or who have significant life demands are more likely to have symptoms than those who are more sedentary. Patients with hypothyroidism with decreased oxygen demands may be asymptomatic without tachycardia or dyspnea with a hemoglobin of 10 g/dL. Similarly, those with co-existing cardiac, vascular, or pulmonary disease may develop pronounced symptoms of anemia (e.g., dyspnea, chest pain, muscle pain, or cramping) with a higher hemoglobin level than those without concurrent health problems. Some anemias, such as SCD, or autoimmune diseases are often complicated by other abnormalities that do not result from the anemia but are inherent with the associated disease. Pain and other symptoms may overshadow those caused by the anemia.

Complications of severe anemia include heart failure, paresthesias, and delirium. Patients with underlying heart disease are more likely to have angina and symptoms associated with heart failure than those without heart disease. Complications of specific types of anemia are included in the description of each type.

Assessment and Diagnostic Findings

A number of studies are performed to determine the type and cause of the anemia. Initial evaluation includes hemoglobin, hematocrit, reticulocyte count, and RBC indices, including mean corpuscular volume (MCV), and red cell distribution width (RDW). Other studies may include iron studies (serum iron level, total iron-binding capacity [TIBC], percent saturation, and ferritin), serum vitamin B_{12}, folate levels, haptoglobin, and erythropoietin levels (Elder, Winland-Brown, & Porter, 2019; Nair, 2018). The remaining complete blood count (CBC) values are also useful in determining if the anemia is an isolated condition or associated with another hematologic condition such as **leukemia**

(i.e., malignancy of the WBCs) or myelodysplastic syndrome (MDS). Bone marrow aspiration may be performed to asses for cellular abnormalities. Additional studies such as colonoscopy or upper endoscopy may be performed to determine if underlying conditions causing the anemia are present. Lesions in the gastrointestinal (GI) tract including ulcers, polyps, or tumors may be sources of blood loss.

Medical Management

Management of anemia is directed toward correcting or controlling the cause of the anemia; if the anemia is severe, the erythrocytes that are lost or destroyed may be replaced with a transfusion of packed red blood cells (PRBCs). Management of the various types of anemia is covered in the discussions that follow.

Gerontologic Considerations

Anemia is the most common hematologic condition affecting older adults, particularly those admitted to hospitals and in long-term care facilities. The overall prevalence of anemia is 17% in older adults, including approximately 10% of community-dwelling older adults, 45% of nursing homes residents, and 40% of those who are hospitalized. Most have mild anemia with hemoglobin level of 11 g/dL or higher, but even mild anemia may be associated with decreased functional ability and increased morbidity and mortality. Mild anemia in older adults is associated with decreased physical performance, decreased mobility, increased frailty, increased depression, increased risk of falls, and delirium (Lanier, Park, & Callahan, 2018). Studies have identified an association between anemia and cognitive decline. Older adults with anemia are more likely to have fatigue, dyspnea, and confusion because of reduced cardiac reserve and inability to respond with an increase in heart rate and increased cardiac output. Those with preexisting renal and cardiac disease and those who have had recent surgery are at increased risk for morbidity and mortality when anemic (Stauder, Valent, & Theurl, 2018).

NURSING PROCESS

The Patient with Anemia

Assessment

The health history and physical examination provide important data about the type of anemia involved, the extent and type of symptoms it produces, and the impact of the symptoms on the patient's life. Weakness, fatigue, and general malaise are common symptoms, and pallor of the skin and mucous membranes (conjunctivae, oral mucosa) are common signs (Fig. 29-1).

Jaundice, angular cheilitis (inflammation and fissures in the corners of the mouth), and brittle, concave, ridged nails may be associated with **megaloblastic anemia** (characterized by abnormally large, nucleated RBCs) or hemolytic anemia. The tongue may be sore and beefy red in megaloblastic anemia, and smooth and red with iron deficiency anemia. Patients with iron deficiency anemia often experience pica, a craving for ice, starch, or dirt (Cadet, 2018). Restless leg syndrome is also common among those with iron deficiency anemia (Van Wyk, 2018). The health history should include a medication history because some medications may depress bone marrow activity, induce hemolysis, interfere with folate metabolism, or cause GI irritation that leads to bleeding. An accurate social history should include alcohol intake, noting the amount consumed and the duration of alcohol use. Family history is also important since some types of anemia are inherited. The nurse should also inquire about athletic endeavors since extreme forms of exercise such as marathon running may influence erythropoiesis and erythrocyte survival (Leung, 2019).

A nutritional assessment is needed because it may indicate deficiencies in essential nutrients such as iron, vitamin B_{12}, and folate. People who follow strict vegetarian diets and do not supplement with vitamin B_{12} are at risk for megaloblastic anemia. Older adults may also have decreased intake of foods rich in vitamin B_{12} or folate.

Cardiac status should be assessed carefully. When hemoglobin levels are low, the heart attempts to compensate by pumping faster and harder to deliver more oxygen to hypoxic tissue. This increased cardiac workload can result in symptoms including tachycardia, palpitations, dizziness, orthopnea, and exertional dyspnea. Heart failure may eventually develop, evidenced by cardiomegaly (an enlarged heart), hepatomegaly (an enlarged liver), and peripheral edema.

GI assessment may reveal complaints of nausea, vomiting (with specific questions regarding the appearance of any emesis [e.g., looks like "coffee grounds"]), melena (dark stools), diarrhea, anorexia, and glossitis (inflammation of the tongue). Stool should be tested for occult blood.

Women should be asked about their menstrual periods (e.g., excessive flow, other vaginal bleeding) and the use of iron and vitamin supplements during pregnancy. Neurologic examination is important because pernicious anemia with vitamin B_{12} deficiency affects the function of the central and peripheral nervous systems (see later discussion). Examination should include assessment for the presence and extent of peripheral numbness and paresthesia, ataxia, impaired coordination, and confusion. Delirium can sometimes result from other types of anemia, particularly in older adults. It is important to monitor relevant laboratory results over time and note any changes (see Chapter 28).

Figure 29-1 • Pallor seen in the patient with anemia. Reprinted with permission from Tkachuk, D. C., & Hirschman, J. V. (2007). *Wintrobe's atlas of clinical hematology* (Fig. 1.1, p. 9). Philadelphia, PA: Lippincott Williams & Wilkins.

Diagnosis

Nursing Diagnoses

Based on assessment data, major nursing diagnoses may include:

- Fatigue associated with decreased hemoglobin and diminished oxygen-carrying capacity of the blood
- Impaired nutritional status associated with inadequate intake of essential nutrients
- Activity intolerance associated with inadequate hemoglobin and hematocrit
- Impaired ability to manage regime associated with prescribed therapy

Collaborative Problems/Potential Complications

Potential complications may include the following:

- Heart failure
- Paresthesias
- Confusion
- Injury associated with falls

Planning and Goals

The major goals for the patient with anemia include decreased fatigue, attainment or maintenance of adequate nutrition, attainment or maintenance of adequate tissue perfusion, effective management of prescribed treatment plan, and absence of complications.

Nursing Interventions

Managing Fatigue

The most common symptom and complication of anemia is fatigue. Fatigue is often the symptom with the greatest negative impact on the patient's ability to function and subsequent quality of life. Fatigue is often described as overwhelming or oppressive. The sensation of fatigue may be severe even when the anemia is not severe enough to warrant transfusion. Fatigue may interfere with the patient's ability to engage in work as well as pleasurable activities with family and friends. Significant distress can stem from the inability to meet life's demands and responsibilities and the need to rely on others for assistance.

Nursing interventions can focus on assisting the patient to prioritize activities to establish a balance between activity and rest that is acceptable to the patient. Patients with chronic anemia will need assistance in establishing a program of activity and exercise to avoid deconditioning associated with inactivity. It is also important to assess for other conditions that may contribute to fatigue, such as pain, depression, and sleep disturbances.

Maintaining Adequate Nutrition

Inadequate intake of essential nutrients, including iron, vitamin B_{12}, folic acid and protein, can cause some forms of anemia. The symptoms associated with anemia (fatigue, anorexia) can interfere with maintaining adequate nutritional intake. A well-balanced diet should be encouraged. The nurse should advise the patient that alcohol can interfere with utilization of some essential nutrients and recommend limited alcohol intake (Stouten, Riedel, Droogendijk, et al., 2016). Dietary education involving family members when possible should be individualized to address specific needs and include cultural preferences for food preparation and selection (see Chapter 4). Dietary supplements (e.g., vitamins and iron) may be prescribed.

Equally important, the patient and family need to understand the role of nutritional supplements in the proper context. Some forms of anemia are not associated with nutritional deficiency. In some cases, excessive use of supplements will not improve the anemia and may be harmful. For example, patients with anemia who receive long-term transfusion therapy are at risk for iron overload from their transfusions. In this situation chelation therapy is implemented to reduce accumulation of excess iron (Murray, De Gelder, Pringle, et al., 2016; see Chapter 30 for discussion of chelation therapy). The use of oral iron supplements may exacerbate the situation.

Managing Activity Intolerance

Patients with severe anemia, with acute blood loss from hemorrhage or severe hemolysis, may not tolerate decreased blood volume or reduced circulating erythrocytes. Lost volume can be replaced with transfusions or intravenous fluids based on symptoms and laboratory test results. Supplemental oxygen may be needed, especially if there is underlying cardiac or pulmonary disease. Monitoring the patient's vital signs and pulse oximetry, especially with activity, is an important nursing action. Medications, including antihypertensive drugs, may need to be adjusted or withheld based on the patient's vital signs.

Promoting Effective Management of Prescribed Therapy

Medications, including nutritional supplements, are frequently prescribed for patients with anemia. It is important that patients understand the purpose of these therapies, how to take them, and how to manage side effects of treatment. Nurses play an important role in promoting adherence to the prescribed plan by educating patients and family caregivers about ways to incorporate the therapeutic plan in daily activities. For example, side effects of oral iron supplements including GI distress may make adherence to treatment difficult for some patients and may contribute to some patients stopping treatment. Nurses can provide important education

and support to assist patients to cope with side effects. Abrupt cessation of some medications, including high-dose steroids for treatment of hemolytic anemia, can have serious consequences for patients. The cost of some medications, such as hematologic growth factors, can be quite high. Patients requiring these medications may need assistance to find alternative ways to obtain the necessary medication. Nurses may need to collaborate with social workers or other health care team members to assist patients in meeting these needs.

Monitoring and Managing Potential Complications

A significant complication of anemia is heart failure associated with chronic diminished blood volume and the heart's compensatory effort to increase cardiac output. Patients with anemia should be assessed for signs and symptoms of heart failure (see Chapter 25).

In megaloblastic anemias associated with folate or vitamin B_{12} deficiency, there is potential for neurologic complications. Neurologic assessment of patients with megaloblastic anemia should be performed. Patients may complain of paresthesias, often manifested by numbness and, as the anemia progresses, symptoms worsen and other signs become apparent. Position and vibration sense may be diminished. Difficulty maintaining balance and gait disturbances may occur. Mental status changes, beginning with confusion and progressing to more severe memory changes and delirium can occur with severe folate or vitamin B_{12} deficiency (Elder et al., 2019).

Evaluation

Expected patient outcomes may include:

1. Reports less fatigue
    a. Follows a graduated plan of rest, activity, and exercise
    b. Prioritizes activities
    c. Paces activities according to energy level
2. Attains and maintains adequate nutrition
    a. Eats a healthy diet
    b. Develops a meal plan that promotes optimal nutrition
    c. Maintains appropriate amounts of iron, vitamins, and protein from diet and supplements
    d. Adheres to nutritional supplements when prescribed
    e. Verbalizes understanding of rationale for using recommended nutritional supplements when prescribed
    f. Verbalizes understanding of rationale for avoiding nonrecommended nutritional supplements
3. Maintains appropriate activity level

a. Vital signs will be within baseline for patient
b. Pulse oximetry value within normal limits

4. Absence of complications
   a. Avoids or limits activities that trigger dyspnea, palpitations, dizziness, or tachycardia
   b. Uses rest and comfort measures to relieve dyspnea
   c. Has vital signs within baseline for patient
   d. Has no signs of increased fluid retention (e.g., peripheral edema, decreased urine output, neck vein distention)
   e. Remains oriented to time, place, and situation
   f. Verbalizes understanding of importance of serial CBC and other laboratory test measurements
   g. Maintains safe home environment; obtains and uses assistance as necessary

Hypoproliferative Anemias

The hypoproliferative anemias include iron deficiency anemia, anemias in renal disease, anemia of inflammation, aplastic anemia, and megaloblastic anemias.

Iron Deficiency Anemia

Iron deficiency anemia results when the intake of dietary iron is inadequate for synthesis of hemoglobin. The body is able to store about one fourth to one third of its iron requirements, and it is not until those stores are depleted that iron deficiency anemia develops. Iron deficiency anemia may occur when total body iron stores are adequate, but the amount of iron delivered to the erythroid precursors is inadequate. This is referred to as functional iron deficiency (Hashemi, Mashhadi, Mohammadi, et al., 2017). Iron deficiency anemia is the most common type of anemia in all age groups, and it is the most common form of anemia worldwide, affecting as many as one in eight people (Bunn & Heeney, 2017). It is especially prevalent in developing countries where iron stores may be chronically depleted because of lack of sources for iron-rich foods and from blood loss associated with intestinal parasites (Harper, Besa, & Conrad, 2019).

Iron deficiency anemia is also common among adults in the United States, with the most common cause being blood loss. Blood loss should always be considered as the cause of iron deficiency anemia until proven otherwise. The most common cause of this anemia in men and postmenopausal women is GI bleeding from ulcers, gastritis, tumors, or inflammatory bowel disease. The

most common causes of iron deficiency anemia in premenopausal women are menorrhagia (i.e., excessive menstrual bleeding) and pregnancy with inadequate iron intake. Patients with chronic alcohol abuse and patients who take aspirin, steroids, or nonsteroidal anti-inflammatory drugs (NSAIDs) may have chronic blood loss from the GI tract, leading to iron loss and subsequent anemia. Other causes include iron malabsorption, as seen after gastrectomy or bariatric surgery, or from celiac disease and inflammatory bowel diseases (Harper et al., 2019).

Clinical Manifestations

Patients with iron deficiency primarily have symptoms of anemia. If the deficiency is severe or prolonged, they may also have a smooth, red tongue; brittle and ridged nails; and angular cheilosis. These signs subside after iron replacement therapy. The health history may be significant for multiple pregnancies, GI bleeding, and pica (Camaschella, 2019).

Assessment and Diagnostic Findings

The definitive method of establishing the diagnosis of iron deficiency anemia is bone marrow aspiration (see Chapter 28 for further discussion of bone marrow aspiration). The aspirate is stained to detect iron, which is at a low level or even absent. However, few patients with suspected iron deficiency anemia undergo bone marrow aspiration. In many patients, the diagnosis can be established with other tests, particularly in patients with a history of conditions that predispose them to this type of anemia.

A strong correlation exists between laboratory values that measure iron stores and hemoglobin levels. After iron stores are depleted (as reflected by low serum ferritin levels), the hemoglobin level falls. The diminished iron stores cause small erythrocytes to be produced by the marrow. Therefore, as the anemia progresses, the MCV, which measures the size of the erythrocytes, also decreases. Hematocrit and RBC levels are also low in relation to the hemoglobin level. Other laboratory tests that measure iron stores are useful but not as precise as ferritin levels. Typically, patients with iron deficiency anemia have a low serum iron level and an elevated TIBC, which measures the transport protein supplying the marrow with iron as needed (also referred to as transferrin) (Camaschella, 2019). However, other disease states, such as infection and inflammatory conditions, can also cause a low serum iron level and TIBC, as well as an elevated ferritin level. If these are suspected, measuring the soluble transferring receptor can aid in differentiating the cause of anemia. This test result will be increased in the setting of iron deficiency, but not in chronic inflammation (Camaschella, 2019).

Medical Management

Oral iron supplementation is often the primary mode of treatment for iron deficiency anemia. Several oral iron preparations, including ferrous sulfate, ferrous gluconate, and ferrous fumarate, are available. Ferric maltol, another oral preparation, was approved by the U.S. Food and Drug Administration (FDA) in 2019 for use in iron deficiency anemia in those with inflammatory bowel disease. After taking oral iron preparations, hemoglobin typically begins to increase within a few weeks and the anemia may be corrected within a few months. Replenishing iron stores takes several months so it is important that patients continue taking oral iron supplements for 6 to 12 months. If oral iron is poorly absorbed or poorly tolerated, or large amounts of supplemental iron are needed, intravenous (IV) iron may be given in repeated doses (see Chart 29-2). Initial evidence has shown that ferric maltol is not inferior to parenteral iron and may be an alternative for patients who cannot tolerate other oral preparations or do not wish to have parenteral iron; however, it is unknown whether use of ferric maltol will decrease demands for parenteral iron preparations (Harper et al., 2019).

Chart 29-2

Parenteral Iron Formulations

- Older formulations of parenteral iron had a high molecular weight and carried a significant risk for hypersensitivity reactions, including anaphylaxis. Newer formulations have a low molecular weight and a markedly lower risk for anaphylaxis.
- Ferric gluconate: Each 5 mL contains 62.5 mg of elemental iron; 125 mg is diluted in 100-mL normal saline and infused over 1 hour, or 5 mL undiluted is given as a slow IV push injection over 5 minutes. Although the likelihood of an allergic reaction is very low, a test dose is often given prior to the first infusion.
- Iron sucrose: Each 5 mL contains 100 mg of elemental iron; 100 to 200 g can be given, undiluted, as a slow IV push over 2 to 5 minutes. This procedure can be repeated as often as every 3 days for a cumulative dose of 1000 mg within a 2-week period.
- Ferumoxytol injection: The 17 mL vial is diluted in 50 to 200 mL of normal saline or 5% dextrose and water and infused over 15 minutes. Close observation for signs and symptoms of hypersensitivity reaction, including monitoring blood pressure and pulse, is recommended.

Adapted from Comerford, K. C., & Durkin, M. T. (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer.

Nursing Management

Preventive education is important for women who are menstruating and for those who are pregnant. Food sources rich in iron include organ meats (e.g., beef or calf's liver, chicken liver), other meats, beans (e.g., pinto, black, and garbanzo beans), leafy green vegetables, raisins, and molasses. Eating iron-rich foods with a source of vitamin C (e.g., orange juice) improves iron absorption.

The nurse assists the patient in selecting healthy diet options. Nutritional counseling can be provided for those who have an inadequate diet. Patients with history of strict vegetarian or other diets lacking in essential nutrients should be counseled about how to meet their dietary needs. The nurse also encourages the patient to continue the prescribed therapy for as long as needed to replenish iron stores even when fatigue and other symptoms have resolved.

Oral iron is best absorbed on an empty stomach, making it important for patients to be instructed to take the supplement approximately 1 hour before or 2 hours after meals. The least expensive, standard form of oral iron, ferrous sulfate, is tolerated by most patients. GI side effects, including constipation, cramping, nausea, and vomiting may result in difficulty adhering to the prescribed regimen. Decreasing the frequency of administration or taking iron supplements with food may reduce symptoms but will diminish iron absorption, thus, it may take longer to replete iron stores. Taking iron with vitamin C can enhance absorption, but it may also increase the frequency of side effects (Heffernan, Evans, Holmes, et al., 2017). Some iron formulations have been designed to limit GI side effects by adding stool softeners to reduce constipation or sustained release formulations to reduce gastritis and nausea. However, enteric-coated tablets may be poorly absorbed. Slow release formulations are absorbed beyond the duodenum; however, the duodenum is the site where maximum iron absorption takes place (Auerbach & Adamson, 2016). Educational materials to assist patients with use of iron supplements are available (see Chart 29-3).

Chart 29-3 **PATIENT EDUCATION**

Taking Oral Iron Supplements

The nurse instructs the patient to:

- Take iron on an empty stomach (1 hour before or 2 hours after a meal), preferably with orange juice or other source of vitamin C. Iron absorption is reduced by food, especially dairy products.
- Reduce gastrointestinal distress by using the following schedule when more than one tablet per day is prescribed: Take one tablet per day for the first few days, then increase to two tablets per day, then three tablets per day in divided doses. This allows gradual adjustment to the iron. If unable to tolerate oral supplements due to gastrointestinal distress despite using this intervention, a reduced amount of iron may be used rather than stopping it completely. Reduced doses will require that the treatment duration is extended to adequately replenish iron stores.
- Increase intake of foods rich in vitamin C to enhance iron absorption (citrus fruits and juices, strawberries, tomatoes, broccoli).
- Note that stool will be dark in color and often appear black.
- Eat foods high in fiber to reduce problems with constipation. A stool softener may be needed.
- Be aware that liquid iron preparations may stain the teeth. They may be taken through a straw or by placing the spoon at the back of the mouth. Rinse the mouth thoroughly after each dose.

If taking iron on an empty stomach causes GI distress, the patient may need to take it with meals. However, this may reduce absorption by as much as 40%, therefore increasing the time needed to replenish iron stores. Antacids and dairy products should be avoided with iron as they can greatly diminish its absorption. Polysaccharide iron complex preparations are available. These reduce GI toxicity but are more expensive. Liquid forms of iron that cause less GI distress are also available. Oral iron replacement therapy may change the color of the stool but should not cause a false-positive result for occult blood on stool analysis.

IV supplementation may be used when the patient's iron stores are very low, if the patient cannot tolerate oral forms of iron, or both. The nurse must be aware of the type of parenteral formulation of iron ordered so that risk for anaphylaxis can be determined. High-molecular formulations are associated with a much higher risk for anaphylaxis and are seldom used. Administering a test dose of low-molecular formulations of iron dextran is recommended by many manufacturers. The nurse must assist the patient in understanding the need for repeated doses to replenish iron stores or to maintain iron stores in the setting of chronic blood loss, such as hemodialysis or chronic GI bleeding.

Anemias in Renal Disease

The degree of anemia in patients with chronic kidney disease (CKD) can vary greatly; however, in general, patients do not become severely anemic until the glomerular filtration rate (GFR) is less than 30 mL/min/1.73 m^2 (Fishbane & Spinowitz, 2018). The symptoms of anemia may be the most troubling of the patient's symptoms. In patients with CKD, anemia contributes to increased cardiac output, reduced oxygen utilization, decreased cognition and ability to concentrate, reduced immune responsiveness, and reduced libido. Anemia may be more severe in patients with both CKD and diabetes (Fishbane & Spinowitz, 2018). Anemia in patients with CKD is discussed in Chapter 48.

Anemia of Inflammation

Anemia of inflammation describes anemia associated with chronic diseases including inflammation, infection, and malignancy. This classification was previously known as anemia of chronic disease (Weiss, Ganz, & Goodnough, 2019). This classification also includes anemia of critical illness that can develop within days after the onset of serious illness, and the anemia associated with aging. Many chronic inflammatory diseases are associated with **normochromic**, **normocytic** anemia (i.e., RBCs are of normal color and size). These disorders include rheumatoid arthritis, chronic infections, and many cancers. It is important that the underlying condition be identified so that it can be treated appropriately.

The anemia of inflammation is usually mild to moderate and not progressive. The hemoglobin level does not usually fall below 9 g/dL and bone marrow samples have normal cellularity and normal stores of iron. Erythropoietin levels are low and iron use is blocked by **erythroid cells** (cells that are or will become mature RBCs). Erythrocyte survival may also be shortened.

Many patients with anemia of inflammation have few symptoms related to their anemia and do not require treatment. Treatment of the underlying disorder allows iron stored in the bone marrow to be utilized, promoting increased RBC production and facilitating the rise of hemoglobin levels. Iron supplementation is not beneficial for these patients.

Gerontologic Considerations

Evidence suggests that inflammation may have a significant role in the development of anemia in older adults (Price, 2019). Higher-than-normal levels of inflammatory **cytokines** are found in older adults, and this pro-inflammatory state may predispose older adults to frailty. Frailty is manifested by weight loss, impaired mobility, generalized weakness, and loss of balance

and is strongly associated with anemia of inflammation. Erythropoietin levels may not rise as expected in response to decreased hemoglobin (Price, 2019).

Aplastic Anemia

Aplastic anemia is a rare disease caused by a decrease in or damage to bone marrow stem cells, damage to the microenvironment within the bone marrow, and replacement of marrow with fat. Stem cell damage is caused by the body's T cells, which mediate an attack on the bone marrow resulting in **aplasia** (i.e., markedly reduced hematopoiesis). Therefore, in addition to severe anemia, significant **neutropenia** (i.e., lower-than-normal neutrophil count) and **thrombocytopenia** (i.e., lower-than-normal platelet count) also occur.

Pathophysiology

Aplastic anemia is a life-threatening condition associated with bone marrow failure evidenced by **pancytopenia** (i.e., anemia, neutropenia, and thrombocytopenia; lower-than-normal counts of erythrocytes, neutrophils, and platelets) (Peslak, Olson, & Babushok, 2017). It can be acquired, or in rare cases, congenital, but most cases are idiopathic (i.e., without apparent cause) (Young, 2018). It may also be associated with certain medications, chemicals, or radiation damage. Agents that have been associated with bone marrow aplasia include benzene and benzene derivatives (i.e., airplane glues, paint remover, dry cleaning solutions). Certain toxic materials, including inorganic arsenic, glycol ethers, plutonium, and radon, have also been suggested as possible causes (Young, 2018). Nonviral hepatitis may be a precipitating factor in about 10% of cases (Peslak et al., 2017).

Clinical Manifestations

The onset of symptoms of aplastic anemia is often insidious. Complications stemming from bone marrow failure may occur before the diagnosis is made. Typical complications include infection and symptoms of anemia, including fatigue, pallor, and dyspnea. Purpura (bruising) associated with thrombocytopenia may develop. Any combination of these signs and symptoms should prompt a CBC and hematologic evaluation. Lymphadenopathy and splenomegaly may also occur. Retinal hemorrhages are common.

Assessment and Diagnostic Findings

Aplastic anemia occurs in some situations when a medication or chemical is ingested in toxic amounts; however, it may occur even when medications are

taken at the recommended dosage. This is known as an idiosyncratic reaction in those who are highly susceptible, possibly due to a genetic defect in the biotransformation of the medication or elimination process. The CBC reveals pancytopenia. Patients may have neutrophil counts less than 1,500/mm^3, hemoglobins less than 10 g/dL, and platelet counts less than 50,000/mm^3 (Segel & Lichtman, 2016). A bone marrow biopsy typically reveals an extremely hypoplastic or aplastic bone marrow (i.e., with few or no cells), often replaced with fat.

Medical Management

It is believed that aplastic anemia is an immune-mediated condition in which T lymphocytes attack hematopoietic stem cells with subsequent reduction in production of erythrocytes, leukocytes, and platelets. Aplastic anemia can be successfully treated in many cases. Patients under 60 years of age who are otherwise healthy can often be cured with a hematopoietic stem cell transplant (HSCT) from a compatible donor (see Chapter 12) (Young, 2018). In other situations, treatment with immunosuppressive therapy using antithymocyte globulin (ATG) and androgens or cyclosporine is useful in managing the disease (Young, 2018). ATG is a purified gamma-globulin solution that is obtained from rabbits or horses immunized with human T lymphocytes. Side effects of such therapy include fever and chills. There is risk for anaphylaxis with associated bronchospasm and hypotension requiring emergency treatment. Serum sickness, associated with rash, fever, arthralgias, and pruritus may occur in some patients but can be prevented or reduced in some cases with premedication with corticosteroids (Segel & Lichtman, 2016). Serum sickness resolves slowly, often over a few weeks when it occurs.

Immunosuppressive therapies prevent T cells from destroying stem cells. If relapse does occur, resuming the same immunosuppressive therapy may induce another remission but the response rate is usually reduced (Segel & Lichtman, 2016). Corticosteroids may be beneficial in the short-term; however, in aplastic anemia, long-term use is associated with bony abnormalities including aseptic necrosis and osteopenia.

Supportive therapies play a critical role in the management of aplastic anemia. All potentially offending medications should be discontinued. Transfusions with PRBCs and platelets are frequently required (see Chapter 28 for discussion of transfusions); however, judicious use of blood products is necessary, especially for patients who are candidates for bone marrow transplant because of the risk for alloimmunization (Peslak et al., 2017). Aggressive treatment of infections is necessary. Deaths associated with aplastic anemia are most often caused by bacterial or fungal infection and bleeding.

Prophylaxis against invasive fungal infection is needed for patients who are severely neutropenic. Patients who become lymphopenic after ATG require prophylaxis for pneumocystis pneumonia.

Nursing Management

Patients with aplastic anemia are at high risk for problems associated with deficiencies of erythrocytes, leukocytes, and platelets. Thorough assessment for signs of infection and bleeding are critical (see later sections on Neutropenia and Thrombocytopenia for specific interventions). Nursing care includes monitoring for side effects of therapy, including hypersensitivity reactions while administering ATG. Patients who require long-term cyclosporine therapy should be monitored for long-term effects, including renal and liver dysfunction, hypertension, pruritus, visual changes, tremor, and skin cancer. Education regarding drug–drug interactions between ATG and many other drugs is necessary. Patients should be informed that stopping immunosuppressive therapy abruptly is not recommended.

Megaloblastic Anemias

Anemias associated with vitamin B_{12} or folic acid deficiency cause the same bone marrow and peripheral blood changes because both are needed for normal DNA synthesis. The erythrocytes produced with these nutritional deficiencies are abnormally large, thus they are termed megaloblastic red blood cells. Other cells from the myeloid stem cell lines (nonlymphoid leukocytes and platelets) are also abnormal. Bone marrow analysis shows hyperplasia (an abnormal increase in the number of cells) and the precursor erythroid and myeloid cells are abnormally large and irregular in appearance. Many of these abnormal cells are destroyed within the bone marrow leading to an insufficient number of mature cells entering the peripheral blood. Over time, pancytopenia may develop. Cells that enter the circulation are often irregularly shaped; neutrophils are hypersegmented, and platelets may be abnormally large. Erythrocytes are abnormally shaped and shapes can vary greatly; this is known as **poikilocytosis**. Because erythrocytes are very large, the MCV is very high, often exceeding 110 fL. Megaloblastic anemias usually develop over months, allowing the body to compensate; thus, symptoms do not often occur until the anemia is severe (Green, 2016). In patients with light skin, the skin may develop a pale-yellow color resulting from simultaneous pallor and mild jaundice from red blood cell hemolysis.

Pathophysiology

The pathophysiologic mechanisms that undergird megaloblastic anemias are most commonly because of either a folic acid or vitamin B_{12} deficiency, as noted previously.

Folic Acid Deficiency

Folic acid is stored in the body as compounds known as folates. Folate stores are smaller than those of vitamin B_{12} and can be depleted within months if dietary intake of folate is deficient (Green, 2016). Folate is found in green vegetables and liver. Folate deficiency is rarely seen in patients who consume uncooked vegetables. Alcohol ingestion increases folic acid requirements and it is not uncommon for those with alcohol abuse disorder to have a diet deficient in folate and other nutrients. Folic acid requirements are also higher in those with liver disease, chronic hemolytic anemias, and in women who are pregnant because erythrocyte production is increased with these conditions. Small bowel diseases such as celiac disease may interfere with normal absorption of folic acid (Green, 2016).

Vitamin B_{12} Deficiency

Deficiency of vitamin B_{12} can occur in several ways. Inadequate dietary intake is unusual but sometimes can occur in people who follow a vegan diet and do not consume any meat or dairy products. Impaired absorption from the GI tract is more common, especially in older adults. Nearly 20% of older adults have low vitamin B_{12} levels; 5% to 10% have symptoms related to vitamin B_{12} deficiency (Langan & Goodbred, 2017). Vitamin B_{12} deficiency can occur in patients with disorders such as inflammatory bowel disease, or in patients who have had GI surgery such as ileal resection, bariatric surgery, or gastrectomy. Use of metformin for treatment of type 2 diabetes as well as chronic use of histamine blockers, antacids, and proton pump inhibitors to reduce gastric acid can also inhibit vitamin B_{12} absorption (Lanier et al., 2018).

Absence of intrinsic factor also impairs vitamin B_{12} absorption. When associated with lack of intrinsic factor, the anemia is referred to as pernicious anemia. Intrinsic factor is normally secreted by cells in the gastric mucosa; it binds to vitamin B_{12} and transports it to the ileum where it is absorbed. Without intrinsic factor, vitamin B_{12} taken orally cannot be absorbed and deficiency with associated anemia eventually results. Diseases of the pancreas and ileum may impair absorption even when adequate intrinsic factor and vitamin B_{12} are present. Pernicious anemia tends to run in families. It is typically a disease of adults, especially older adults. The body typically has large stores of vitamin B_{12} so years may pass before deficiency results in anemia. The body is able to compensate over time and the anemia is often severe before the patient becomes symptomatic. Because patients with

pernicious anemia and low vitamin B_{12} levels have an increased incidence of gastric cancer they may benefit from screening for gastric cancer with endoscopy at regular intervals (Miranti, Stolzenberg-Solomon, Weinstein, et al., 2017).

Clinical Manifestations

Symptoms of folic acid and vitamin B_{12} deficiencies are similar, and the two anemias may coexist. However, the neurologic manifestations of vitamin B_{12} deficiency do not occur with folic acid deficiency, and they persist if vitamin B_{12} is not replaced. Therefore, careful distinction between the two anemias must be made.

After the body's stores of vitamin B_{12} are depleted, the patient may begin to show signs and symptoms of the anemia. However, because the onset and progression of the anemia are so gradual, the body can compensate well until the anemia is severe, so the typical manifestations of anemia (weakness, listlessness, fatigue) may not be apparent initially. The hematologic effects of vitamin B_{12} deficiency are accompanied by effects on other organ systems, particularly the GI tract and nervous system. Patients with pernicious anemia develop a smooth, sore, red tongue and mild diarrhea. They are extremely pale, particularly in the mucous membranes. They may become confused; more often, they have paresthesias in the extremities (particularly numbness and tingling in the feet and lower legs). They may have difficulty maintaining their balance because of damage to the spinal cord, and they also lose position sense (proprioception). These symptoms are progressive, although the course of illness may be marked by spontaneous partial remissions and exacerbations. Without treatment, heart failure associated with severe anemia may result, often leading to death several years after onset of symptoms (Leung, 2019).

Assessment and Diagnostic Findings

Serum levels of both folic acid and vitamin B_{12} are analyzed. Small amounts of folate can increase the serum folate level; therefore, measurement of the amount of folate within the red blood cells is a more sensitive test to determine true folate deficiency although it is not commonly performed.

The traditional method of determining the cause of vitamin B_{12} deficiency was the Schilling test, but in recent years this has been replaced by other testing methods. A vitamin B_{12} assay is usually the initial test performed but the reliability of the results is sometimes questionable, when vitamin B_{12} levels are not unequivocally low. Elevated methylmalonic acid and homocysteine levels are more sensitive for the diagnosis of vitamin B_{12} deficiency (Lanier et al., 2018). An intrinsic factor antibody test is often more useful in

determining the presence of pernicious anemia. A positive test indicates that antibodies are present that interfere with the binding of the intrinsic factor–vitamin B_{12} complex to receptors in the ileum, preventing absorption. While not specific for only pernicious anemia, it is useful in helping arrive at the diagnosis.

Medical Management

Folate deficiency is easily treated in most cases by increasing the amount of folic acid in the diet and taking 1 mg of folic acid daily as a supplement. Folic acid can be given intramuscularly to those people with conditions associated with malabsorption. While many multivitamin supplements contain folic acid, the amount may not be enough to replace body stores completely. When folate deficiency is associated with alcohol abuse, supplementation should continue as long as the patient is consuming alcohol.

Vitamin B_{12} deficiency is treated with vitamin B_{12} replacement. People who follow a vegan diet can prevent or treat deficiency with oral supplements with vitamins or fortified soy milk. When deficiency is caused by impaired absorption or absence of intrinsic factor (i.e., pernicious anemia), replacement is typically given by monthly intramuscular injections. It is possible to treat patients with oral preparations in the absence of intrinsic factor but much larger doses are required. Intranasal sprays and gels are also available options to avoid the need for intramuscular injections.

As vitamin B_{12} is replaced, the reticulocyte count rises, often within 1 week, and within 4 to 8 weeks blood counts return to normal (Green, 2016). The tongue begins to feel better and appears less red after several days. Recovery from neurologic symptoms takes more time, and, if the neuropathy is severe, the patient may not fully recover. To prevent a recurrence of pernicious anemia, vitamin B_{12} supplementation must continue for life.

Nursing Management

Assessment of patients who have or are at risk for megaloblastic anemia includes inspection of the skin, tongue, and mucous membranes. Mild jaundice may be evident and is best seen in the sclera with natural lighting. Vitiligo and premature graying of the hair are frequently present in those with pernicious anemia. Careful neurologic assessment is important to identify neurologic complications. Assessment should include tests of position, vibration sense, and cognitive function. The nurse should pay close attention to the patient's gait and stability with ambulation. Safety is a concern when gait, coordination and position sense are affected. Physical and occupational therapy referrals may be needed to assist in obtaining assistive devices and making sure patients

are instructed in their use. When sensation is impaired, patients should be instructed to avoid excessive heat and cold.

Mouth and tongue soreness may impair nutritional intake. The nurse may instruct the patient to choose soft bland foods that are less likely to cause further discomfort.

Promoting Home, Community-Based and Transitional Care

Education for patients with pernicious anemia must include the chronic nature of this condition and the necessity of monthly vitamin B_{12} injections or daily oral vitamin B_{12} supplements even when symptoms have resolved. Patients or a family caregiver can be taught to administer injections. The risk for gastric cancer is increased in patients with gastric atrophy associated with pernicious anemia making it important that patients understand the need for ongoing follow-up care and screening (see Chapter 40 for further discussion on gastric cancer).

Hemolytic Anemias

In hemolytic anemias, the erythrocytes have a shortened lifespan; thus, their number in the circulation is reduced. Fewer erythrocytes result in decreased available oxygen, causing hypoxia, which in turn stimulates an increase in erythropoietin release from the kidney. Erythropoietin then stimulates the bone marrow to compensate by producing new erythrocytes and releasing some of them into the circulation somewhat prematurely as reticulocytes. If the red cell destruction persists, the hemoglobin is broken down excessively; the majority of the heme is converted to bilirubin, conjugated in the liver, and excreted in the bile (Packman, 2016). Hemolytic anemias are far less common than other forms of anemia with approximately 5% of all anemias caused by hemolysis (Schick, 2019).

The mechanisms of erythrocyte breakdown vary, but common laboratory features are characteristic of hemolytic anemia. These include elevated reticulocyte count, increased fraction of indirect (unconjugated) bilirubin, and decreased **haptoglobin** (a binding protein for free hemoglobin) as additional hemoglobin is released from the cells. Anemia worsens if hemolysis persists and the bone marrow is unable to replace the destroyed cells.

Hemolytic anemia is associated with a variety of conditions. Inherited forms include SCD, thalassemias, G-6-PD deficiency, and hereditary spherocytosis. Acquired forms include immune hemolytic anemia, non–immune-mediated paroxysmal nocturnal hemoglobinuria, microangiopathic hemolytic anemia, heart valve–related hemolysis and anemias associated with hypersplenism.

Sickle Cell Disease

SCD is an autosomal recessive disorder caused by inheritance of the sickle hemoglobin (HbS) gene. It is associated with severe hemolytic anemia. The HbS gene results in production of a defective hemoglobin molecule that causes the erythrocyte to change shape when exposed to low oxygen tension. In some circumstances, even the oxygen level in venous blood can cause this change. The erythrocyte usually has a round, biconcave, pliable shape which in SCD can easily become rigid and sickle shaped (see Fig. 29-2). The long, rigid cells can subsequently adhere to the walls of small blood vessels where they accumulate, causing decreased blood flow to the tissues and organs in that region. When blood flow is severely reduced, ischemia or infarction of the tissue can cause severe pain, swelling, and fever referred to as a sickle cell crisis. Because the sickling process takes time, if the patient is exposed to adequate amounts of oxygen, the process can be reversed before the cell membranes become too rigid, allowing the erythrocytes to return to their normal shape. Sickle cell crises are intermittent and can be triggered by cold because of vasoconstriction that slows blood flow.

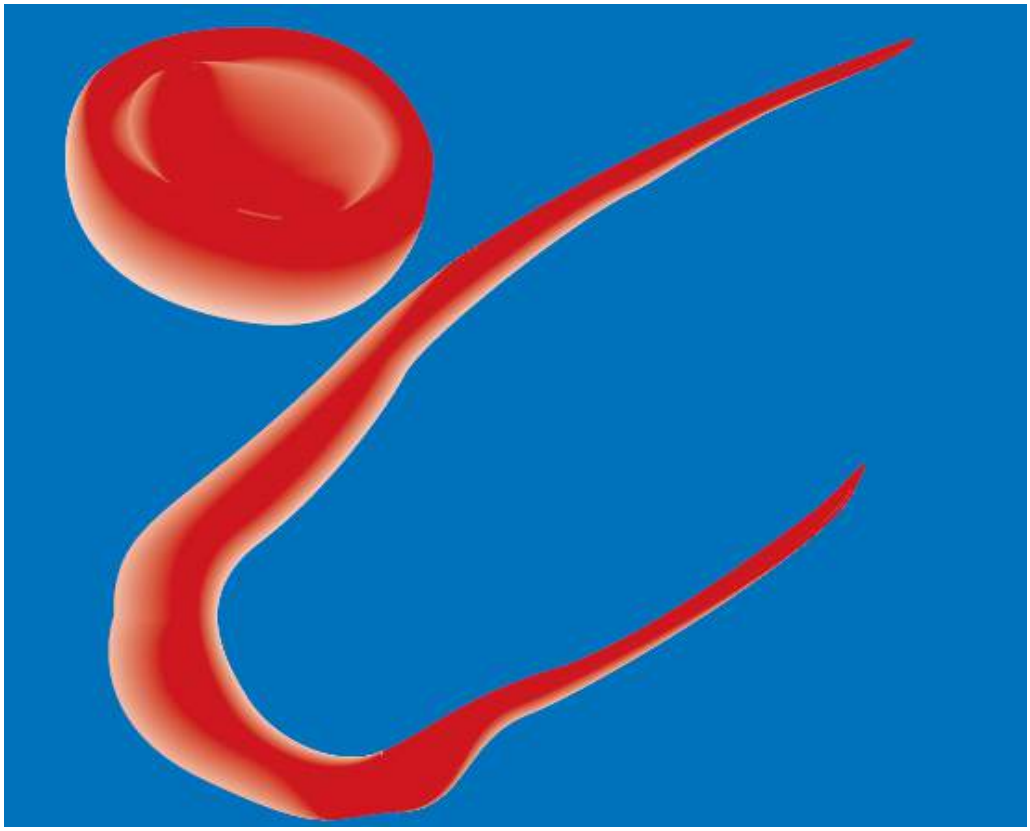

Figure 29-2 • A normal red blood cell (**upper left**) and a sickled red blood cell.

The HbS gene is inherited primarily in people of African descent. It may also be seen to a lesser degree in people of Middle Eastern and Mediterranean descent, and some tribal populations in India (Bunn, 2017b). Sickle cell anemia is the most severe form of SCD and is found in approximately 1 in 365 African Americans (National Heart Lung and Blood Institute, 2014). Other less severe forms of SCD include sickle cell hemoglobin C (SC) disease, sickle cell hemoglobin D (SD) disease, and sickle cell beta-thalassemia. Clinical presentation and treatment for these forms of the disease are the same as for sickle cell anemia.

The term sickle cell trait refers to the carrier state for SCD in which the patient has inherited a sickle gene from one parent and a normal gene from the other parent. Less than 50% of the hemoglobin within the erythrocytes is HbS. Those with sickle cell trait may be unaware that it is present unless severe hypoxia is experienced. Approximately 10% of African Americans have sickle cell trait (Bunn, 2017b). It is important that patients with sickle cell trait understand that if two people with sickle cell trait have children, the children have approximately one in four odds of inheriting two abnormal genes and will manifest SCD (see Chapter 6 for additional discussion of genetic diseases).

Clinical Manifestations

Symptoms of SCD vary and are not solely based on the amount of HbS present. Symptoms and complications are the result of chronic hemolysis and thrombosis. Sickled cells hemolyze rapidly and have a shortened lifespan. Anemia is typically present with hemoglobin values between 5 and 11 g/dL (Natrajan & Kutlar, 2016). Jaundice is often present. The bone marrow expands early in life to compensate for the resulting anemia, sometimes causing enlargement of the bones in the face and skull. Chronic anemia is often associated with tachycardia, cardiac murmurs, and cardiomegaly. Arrhythmias and heart failure may also occur, especially in adults.

Any organ can be affected by thrombosis, but those areas with slower circulation are frequently involved, including the lungs, spleen, and central nervous system (CNS). All tissues and organs can be affected by thrombosis in the microcirculation caused by the sickling process leading to hypoxia and tissue damage and necrosis. Patients with SCD are particularly susceptible to infections, especially pneumonia and osteomyelitis. Additional complications of SCD include stroke, kidney injury, impotence, and pulmonary hypertension (see Table 29-2).

TABLE 29-2 Complications in Sickle Cell Disease[a]

Organ Involved	Mechanisms[a]	Diagnostic Findings	Signs and Symptoms
Spleen	Primary site of sickling → infarctions → ↓ phagocytic function of macrophages	Autosplenectomy; ↑ infection (especially pneumonia, osteomyelitis)	Abdominal pain; fever, other signs of infection
Lungs	Infection	Pulmonary infiltrate	Chest pain; dyspnea
	Infarction → ↑ pulmonary pressure → pulmonary hypertension	↑ $sPLA_2$[b]	Chest pain; dyspnea
Central nervous system	Infarction	Stroke	Weakness; cognitive dysfunction, speech and swallowing dysfunction
Kidney	Sickling → damage to renal medulla	Hematuria; inability to concentrate urine; kidney injury	Dehydration
Heart	Anemia	Tachycardia; cardiomegaly → heart failure	Weakness, fatigue, dyspnea
Bone	↑ Erythroid production	Widening of medullary spaces and cortical thinning	Ache, arthralgias
	Infarction of bone	Osteosclerosis → avascular necrosis	Bone pain, especially hips
Liver	Hemolysis	Jaundice and gallstone formation; hepatomegaly	Abdominal pain
Skin and peripheral vasculature	↑ Viscosity/stasis → infarction → skin ulcers	Skin ulcers; ↓ wound healing	Pain
Eye	Infarction	Scarring, hemorrhage, retinal detachment	↓ Vision; blindness
Penis	Sickling → vascular thrombosis	Priapism → impotence	Pain, impotence

→, leading to; ↓, decreased; ↑, increased; $sPLA_2$, secretory phospholipase A_2.

[a]Problems encountered in sickle cell disease vary and are the result of a variety of mechanisms, as depicted in this table. Common physical findings and symptoms are also variable.

[b]Elevated $sPLA_2$ levels can predict impending acute chest syndrome (see text).

Adapted from Natrajan K., & Kutlar, A. (2016). Disorders of hemoglobin structure: Sickle cell anemia and related abnormalities. In K. Kaushansky, M. A. Lichtman, J. T. Prchal,

et al. (Eds.). *Williams hematology* (9th ed.). New York: McGraw-Hill Medical.

Sickle Cell Crisis

Three types of sickle cell crises affect adults. The most common is *acute vaso-occlusive crisis* (Kim, Brathwaite, & Kim, 2017). This very painful condition is the result of accumulation of erythrocytes and leukocytes in the microcirculation restricting blood flow to the tissue and causing hypoxia, inflammation, and necrosis. Substances released after tissue perfusion is restored include free radicals and free plasma hemoglobin, which cause oxidative damage to the blood vessel. As a result, the endothelial tissues in the vessel become dysfunctional (Bunn, 2017b). *Aplastic crisis* results from infection with the human parvovirus. The hemoglobin level falls rapidly and the marrow cannot compensate, as evidenced by an absence of reticulocytes (Natrajan & Kutlar, 2016). *Sequestration crisis* results when sickled cells are pooled in organs. In young children, the most common site of sequestration is the spleen; however, in many children with SCD over 10 years of age, the spleen has been infarcted and is no longer functional (Natrajan & Kutlar, 2016). In adults, the most common organs involved are the liver and the lungs.

Acute Chest Syndrome

Acute chest syndrome is a frequent complication in those hospitalized with SCD and is associated with significant morbidity and mortality. Acute chest syndrome is most frequently manifested by fever; respiratory distress that is manifested with tachypnea, cough and wheezing; and new infiltrates on the chest x-ray (Jain, Bakshi, & Krishnamurti, 2017). It is a common cause of death in young adults with SCD (Field, 2019). Infection with atypical bacteria including *Chlamydia pneumoniae* and *Mycoplasma pneumoniae* and viruses, including influenza, are often the cause. Other causes of acute chest syndrome include pulmonary thromboembolism, pulmonary fat embolism, bone marrow embolism, and pulmonary infarction. The patient's clinical condition can deteriorate very quickly leading to respiratory failure. Medical management includes blood transfusion, antibiotics, bronchodilators, inhaled nitric oxide, and when respiratory failure occurs, mechanical ventilation. Risk for acute chest syndrome can be reduced through immunization against influenza and pneumococcal pneumonia, and with use of incentive spirometry during vaso-occlusive crises, and with blood transfusion perioperatively (Jain et al., 2017). Prompt recognition and aggressive treatment can result in good outcomes for this potentially life-threatening condition.

Pulmonary Hypertension

Pulmonary hypertension is a common sequela of SCD and is a common cause of death (Natrajan & Kutlar, 2016). The onset of symptoms of pulmonary

hypertension is insidious; diagnosis is difficult in the early stages and is usually delayed until irreversible damage occurs. Symptoms include fatigue, dyspnea on exertion, dizziness, chest pain, or syncope. Pulse oximetry is usually normal and breath sounds are often clear to auscultation until the condition is quite advanced. Pulmonary artery pressures are elevated above baseline but are generally lower than seen with idiopathic or hereditary pulmonary hypertension. Screening of patients with SCD with Doppler echocardiography may be helpful in identifying increased pulmonary artery pressure (Kling & Farber, 2019). High levels of the amino-terminal form of brain natriuretic peptide can be a biomarker for pulmonary hypertension in people with SCD and serve as a predictor of mortality (Kling & Farber, 2019). Computed tomography (CT) scan of the chest frequently reveals microvascular pulmonary occlusion and decreased lung perfusion while chest x-ray may appear normal.

Stroke

Stroke is a catastrophic consequence of SCD that affects approximately 10% of patients under 20 years of age (Natrajan & Kutlar, 2016). Ischemic stroke is most common, especially in young children and older adults, while hemorrhagic stroke is more common in young adults. The mechanisms vary but often result from decreased blood flow due to anemia, hemolysis, and increased hypoxic stress. Silent cerebral infarction occurs in about 40% of patients with SCD who have strokes, resulting in neurocognitive decline (Vichinsky, 2017). Medical management of stroke includes red blood cell transfusion to reduce the amount of hemoglobin S to less than 30% to reduce the risk of cerebral edema (George, 2019).

Reproductive Disorders

The adverse effects of SCD on sexual function have become more evident as patients with the disease are living longer. Hypogonadism with associated low testosterone levels, delayed puberty, low libido, erectile dysfunction, and infertility occur frequently in men with SCD (Huang & Muneyyirci-Delale, 2017). Episodes of priapism (prolonged penile erection, without sexual stimulation) also contribute to significant pain and decreased libido. Over time, repeated episodes lead to permanent damage and erectile dysfunction, thereby making priapism a medical emergency that needs early recognition and treatment to preserve normal sexual function (Field, Vemulakonda, DeBaun, et al., 2019). In addition to physical signs and symptoms, these problems can also lead to embarrassment and depression.

In young women, menarche may be delayed, but menstrual patterns are generally normal. Fertility problems in women are not well described. Contraception is important when hydroxyurea is used in SCD treatment

because of its teratogenic effects. Concerns about infertility may be associated with poor adherence to hydroxyurea therapy. Although most pregnancies complicated by maternal SCD are likely to result in live births, these pregnancies are at increased risk of obstetrical and fetal complications, as well as medical complications of SCD (Vichinsky, 2018).

Assessment and Diagnostic Findings

The patient with sickle cell trait usually has a normal hemoglobin level, normal hematocrit, and normal blood smear. Conversely, the patient with SCD has a low hematocrit and sickled cells on the blood smear. The white blood cell count and platelet count are often elevated as a result of a chronic inflammatory state (Natrajan & Kutlar, 2016). Abnormal hemoglobin is identified by hemoglobin electrophoresis.

Medical Management

Patients with SCD are typically diagnosed in childhood, with anemia often occurring in infancy and crises beginning as early as 1 or 2 years of age. Some children die in the first few years of life as a result of infection; however, outcomes have improved considerably in recent years. Average life expectancy is lower than the general population, rarely exceeding the sixth decade (Field, 2019). Young adults often experience multiple, severe complications from their disease. A subgroup of patients experiences a decrease in symptoms and complications after age 30; however, at present there is no means to predict who will fall into this group. Death is most often caused by cardiac, lung, kidney, or neurologic complications, or from infection (Field, 2019).

Treatment of SCD is the focus of continued research. In addition to aggressive management of symptoms, including pain, and complications, there are a few primary treatment modalities.

Hematopoietic Stem Cell Transplant

HSCT may cure SCD. However, this treatment modality is available to only a small subset of affected patients, either due to a lack of compatible donors or due to severe organ damage (e.g., renal, liver, lung) that may be already present in the patient (see Chapter 12 for further discussion of HSCT).

Pharmacologic Therapy

For patients with SCD, hydroxyurea is a chemotherapeutic agent that is effective in increasing levels of fetal hemoglobin (i.e., hemoglobin F), which in turn decreases the formation of sickled cells. It is the only drug currently approved by the FDA for treatment of SCD. Studies have demonstrated that

patients with SCD who received hydroxyurea experienced fewer episodes of painful crisis, had a lower incidence of acute chest syndrome, and needed fewer transfusions (Matte, Zorzi, & De Franceschi, 2019). Additional studies have shown a 40% decrease in mortality in patients receiving hydroxyurea (Natrajan & Kutlar, 2016). It is unknown whether hydroxyurea can prevent or reverse organ damage. Side effects of the drug include chronic lowering of the leukocyte count, teratogenesis, and potential for later development of a malignancy. Patients' response to the drug can vary widely. The incidence and severity of side effects are variable. Adherence to the prescribed treatment regimen may be difficult for some patients.

Patients with SCD often require daily folic acid supplements to maintain the amount needed for increased erythropoiesis to counteract the effects of hemolysis. Infections are common and should be treated promptly with the appropriate antibiotics. Pneumococcal pneumonia is common in children with SCD while in adults, *Staphylococcus aureus* infection is more common, involving bones and joints (Natrajan & Kutlar, 2016). Patients should be immunized against pneumococcal infection and receive annual influenza vaccines.

Acute chest syndrome is managed by prompt treatment with antibiotics. Incentive spirometry has been shown to significantly reduce the incidence of pulmonary complications. In severe cases, bronchoscopy may be needed to identify the source of acute chest syndrome symptoms. Hydration is important but must be monitored carefully to avoid fluid overload. Corticosteroids may also be helpful. Transfusion can reduce hypoxia. Pulmonary function should be monitored carefully to detect symptoms of pulmonary hypertension as soon as possible so that therapies, including hydroxyurea and HSCT, can be of the greatest benefit.

Transfusion Therapy

RBC transfusions have been shown to be highly effective in several situations: in an acute exacerbation of anemia (e.g., aplastic crisis, severe vaso-occlusive crisis), in the prevention of severe complications from anesthesia and surgery, in improving the response to infection (when it results in exacerbated anemia), in the case of acute chest syndrome and multiple organ dysfunction syndrome (MODS), and in thwarting the cerebral edema from a stroke. Transfusions are also effective in diminishing episodes of sickle cell crisis in pregnant women, although such transfusions do not improve fetal survival. Ongoing transfusion therapy may be effective in preventing or managing complications from SCD by keeping the HbS level to less than 30% (DeBaun, 2018).

Transfusions are not without risks, so it is important to consider the risks of complications versus benefits. Complications include difficulty with venous access, which necessitates placement of a vascular access device, and the concomitant risk for access site infection and thrombosis. Additional risks

include other infections, particularly hepatitis; delayed hemolytic transfusion reactions; and iron overload that requires treatment with chelating agents.

Iron overload is very likely with long-term/ongoing transfusion therapy, causing deposition of iron in vital organs, including the liver, heart, pancreas, kidneys, and pituitary gland. It is sometimes difficult to distinguish organ damage associated with the disease process from damage associated with iron overload. Iron chelation therapy, aimed at keeping iron levels at near normal, reduces complications (see Chapter 30 for further discussion of chelation therapy) (Coates & Wood, 2017). An additional complication of transfusion therapy is increased blood viscosity without reduction in the concentration of hemoglobin S. Exchange transfusion, where some of the patient's blood is removed and replaced by RBC transfusion, may reduce the risk of increasing blood viscosity (Davis, Allard, Qureshi, et al., 2017). Additionally, repeated transfusions may result in development of multiple antibodies to other blood antigens, making cross matching increasingly difficult, and lead to increased risk for hemolytic transfusion reaction. This phenomenon is referred to as alloimmunization (Davis et al., 2017). Some patients who are alloimmunized have an increased risk of avascular necrosis, end-organ damage, and death (Holmes-Maybank, Martin, & Duckett, 2017). Hemolytic transfusion reaction may mimic the signs and symptoms of sickle cell crisis. A distinguishing feature of a hemolytic reaction versus sickle cell crisis is that the patient becomes more anemic after the transfusion than before. Close observation after hemolytic transfusion reaction is needed and further transfusion should be avoided until after the hemolytic process subsides. Patients are supported with corticosteroids, such as prednisone, intravenous immunoglobulins (IVIG) and erythropoietin alfa.

For the procedural guidelines for managing immunoglobulin therapy, go to thepoint.lww.com/Brunner15e.

Supportive Therapy

Supportive care is essential for patients with SCD. Pain management is a significant problem. Acute pain is most often associated with vaso-occlusive crisis and is the frequent reason for hospitalization and emergency department visits in people with SCD. Pain may also be neuropathic in nature stemming from damage or inflammation of nerves as seen with avascular necrosis and leg ulcers (see Fig. 29-3). Chronic non-neuropathic pain may result from CNS dysfunction, including CNS sensitivity to peripheral afferent pain signals, or differences in psychosocial aspects of pain perception (Darbari & Brandow,

2017). Pain severity may interfere with ability to work, even when patients do seek assistance with pain management from health care providers.

The use of medications for acute pain relief is critical and should be appropriate for the etiology of the pain. Aspirin may be useful in patients with mild pain; it decreases inflammation and risk for potential thrombosis (because it inhibits platelet adhesion). NSAIDs are useful for moderate pain or in combination with opioid analgesics. While there is no risk of developing tolerance to NSAIDs there is a "ceiling effect" by which increased doses do not improve analgesia but increase the risk for adverse effects. NSAID use must be monitored carefully because of the risk for renal dysfunction and GI bleeding. Severe acute pain is most often treated with parenteral opioids (Okwerekwu & Skirvin, 2018). Patient-controlled analgesia is frequently used for this purpose in the acute care setting (see Chapter 9 for additional information on pain management). Neuropathic pain can be effectively managed with gabapentinoids, tricyclic antidepressants, and serotonin and norepinephrine reuptake inhibitors (Sharma & Brandow, 2019). With chronic pain management, the principal goal is to maximize functioning; pain may not be completely eliminated without sacrificing function. This concept may be difficult for patients to understand and ongoing education and support is often needed. Nonpharmacologic pain management strategies are important in this setting. Such strategies include physical therapy including heat, massage and exercise; occupational therapy; cognitive and behavioral therapies, including distraction and relaxation techniques; and support groups (Okwerekwu & Skirvin, 2018).

Figure 29-3 • Chronic skin ulcers seen in a patient with sickle cell anemia. Reprinted with permission from Tkachuk, D. C., & Hirschman, J. V. (2007). *Wintrobe's atlas of clinical hematology* (Fig. 1.71, p. 36). Philadelphia, PA: Lippincott Williams & Wilkins.

Hydration is critical during a painful crisis. Oral hydration may be sufficient if the patient is able to maintain adequate intake. IV hydration may be needed if the patient is unable to consume 2 to 3 L of fluid during a crisis episode. Supplemental oxygen may also be needed.

Another significant problem for people with SCD is fatigue. Fatigue can interfere with ability to perform effectively at work and school and reduce quality of life. Its causes, as with pain, may be multifactorial. Fatigue may occur in response to hypoxia associated with low levels of normal hemoglobin and decreased capacity to carry oxygen with sickled cells. Endothelial cells in the blood vessels become inflamed as a result of hypoxia. Inflammatory cytokines are increased in patients with SCD resulting in reduced muscle strength and decreased exercise capacity, increased resting energy expenditure, and sleep disturbances, all exacerbating fatigue. Sleep disturbances and depression are common and contribute to fatigue (Ahmadi, Poormansouri, Beiranvand, et al., 2018).

Working with patients who have multiple episodes of severe pain and fatigue can be challenging. Health care providers must recognize that patients with SCD are confronted with lifelong experiences with severe pain and fatigue that impair physical and social functioning that may be associated with depression and helplessness. Patients without adequate sources of support may have more issues with coping.

NURSING PROCESS

The Patient with Sickle Cell Crisis

Assessment

The patient is asked to identify factors that precipitated previous crises and measures taken to prevent and manage crises. If a sickle cell crisis is suspected, the nurse needs to determine whether the pain currently experienced is the same as or different from the pain typically encountered in crisis. Pain levels should always be assessed (see Chapter 9). A similar assessment should be made of the patient's fatigue, including the impact of fatigue on the current lifestyle, quality of life, and the extent that the fatigue influences pain and interferes with sleep.

Because the sickling process can interrupt circulation in any organ or tissues, a thorough assessment of all body systems is needed. Particular attention should be placed on assessing pain, swelling, and fever. Careful examination of all joints for pain and swelling is necessary. The abdomen is assessed for pain and tenderness because of the possibility of splenic infarction.

The cardiovascular and respiratory systems must also be assessed carefully. These assessments include measurement of oxygen saturation, auscultation of breath sounds, and recognition of signs of cardiac failure, including the presence of dependent edema, increased size of the point of maximum impulse, and cardiomegaly (as seen on a chest x-ray). The patient is assessed for signs and symptoms of dehydration by a history of reduced fluid intake, and careful examination of mucous membranes, skin turgor, urine output, and serum creatinine and blood urea nitrogen levels.

A meticulous neurologic examination is essential to identify symptoms of cerebral hypoxia, but it is also important to recognize that evidence of ischemia may be present on magnetic resonance imaging (MRI) or Doppler studies before becoming evident on the physical examination. MRI or Doppler may be used for early diagnosis resulting in improved patient outcomes because therapy can be initiated promptly. Cognitive dysfunction is often present and may reflect reduced blood flow and oxygenation to the brain. Assessment for neurologic abnormalities is important in identifying silent cerebral ischemia or infarction.

Assessment for the presence of infectious processes is crucial as many patients with SCD are susceptible to infection. Special attention should be paid to examination of the chest, long bones, and femoral head because pneumonia and osteomyelitis are particularly common. Leg ulcers are common, frequently recurrent, occur in as many as 75% of adults with SCD, and may become infected and slow to heal (El Khatib & Hayek, 2016) (see Fig. 29-3).

The degree of anemia and ability of the bone marrow to replenish erythrocytes are assessed with hemoglobin level, hematocrit, and reticulocyte counts, and comparing these to baseline values. The patient's current and past history of medical care must also be obtained, particularly long-term transfusion therapy, hydroxyurea treatment, and prior treatment of infections.

Diagnosis

Nursing Diagnoses

Based on the assessment data, major nursing diagnoses may include:

- Acute pain, chronic pain, and fatigue associated with tissue hypoxia due to agglutination of sickled cells within blood vessels
- Risk for infection
- Risk for powerlessness associated with illness-induced helplessness
- Lack of knowledge regarding sickle cell crisis prevention

Collaborative Problems/Potential Complications

Potential complications may include the following:

- Hypoxia, ischemia, and poor wound healing leading to skin breakdown and ulcers
- Dehydration
- Cerebrovascular disease (stroke)
- Anemia
- Acute kidney injury and chronic kidney failure
- Heart failure, pulmonary hypertension, and acute chest syndrome
- Impotence and impaired fertility
- Cognitive dysfunction
- Poor adherence to therapy
- Mutual conflict and distrust between patient and health care providers due to poorly managed acute and chronic pain

Planning and Goals

The major goals for the patient are relief of pain, decreased incidence of crisis, enhanced sense of self-esteem and power, and absence of complications.

Nursing Interventions

Managing Pain

Acute pain during a sickle cell crisis can be unpredictable and severe. The patient's subjective description of pain rating on a pain scale is useful in directing its treatment (see Chapter 9). Swollen joints should be supported and elevated until swelling subsides. Relaxation techniques, breathing exercises, yoga, and self-hypnosis may be helpful to some patients in

coping with pain (DeBaun & Vichinsky, 2019). Following acute pain episodes, aggressive measures should be taken to preserve joint function. Physical therapy, whirlpool baths, and transcutaneous electrical nerve stimulation (TENS) are among modalities that may be used. While heat packs may be helpful, cold packs and ice should be avoided as cold may precipitate sickling (DeBaun & Vichinsky, 2019).

It is not unusual for patients to have difficulty coping with repeated episodes of acute pain and with chronic pain, making adherence to the prescribed treatment regimen difficult. Some patients with SCD develop substance use disorder although the incidence of substance abuse among people with SCD is not unlike that of patients with other chronic conditions (Natrajan & Kutlar, 2016). This can be a result of inadequate treatment of acute pain during episodes of crisis, which then leads to a lack of trust of the health care system and of health care providers. Research findings suggest that prompt treatment of pain during vaso-occlusive crises can improve patient satisfaction with care and also decrease patient length of stay or treatment times (Kim et al., 2017) (see Chart 29-4 Nursing Research Profile: Acute Pain Management for Patients with Sickle Cell Disease).

Managing Fatigue

Fatigue experienced with SCD may be acute or chronic. Assisting the patient to find a balance between activity and rest is important. Patients need to develop strategies to help cope with the demands on their lives while dealing with their fatigue. Maximizing nutrition, hydration, adequate sleep, and tissue perfusion can all help to minimize fatigue. Research is needed to better understand fatigue in this patient population and identify the most effective ways to relieve it. Although there are validated scales that have been used to quantify the extent of fatigue in patients with SCD, such as the PROMIS Fatigue short form®, standards for when to assess fatigue are currently lacking (Aslani, Georgios, & Maria, 2018; Hildenbrand, Quinn, Mara, et al., 2019).

Preventing and Managing Infection

Nursing care focuses on monitoring patients for signs and symptoms of infection. Prescribed antibiotics should be administered as soon as possible. If oral antibiotics are prescribed at home, patients and caregivers must understand the importance of completing the entire course of antibiotics. Patients should be encouraged to seek immunizations per the latest guidelines (see Chapter 3, Table 3-3), particularly the pneumonia and influenza vaccines.

Promoting Coping Skills

SCD may cause patients to feel powerless and lacking in self-worth because of the health problems associated with repeated crises and chronic health conditions. These feelings can be exacerbated when pain and fatigue

are not well controlled. Optimizing management of pain and fatigue are critical in helping patients to cope with their illness. Listening to and advocating for the needs of patients is important for building a therapeutic relationship based on mutual respect and trust. Nursing care that focuses on patients' strengths and not their deficits aids in promoting effective coping. Providing patients with opportunities to make decisions about their care can help foster autonomy and a sense of control. Supportive guidance can help patients understand the importance of adhering to their therapeutic regimen.

Chart 29-4 NURSING RESEARCH PROFILE

Acute Pain Management for Patients with Sickle Cell Disease

Kim, S., Brathwaite, R., & Kim, O. (2017). Evidence-based practice standard care for acute pain management in adults with sickle cell disease in an urgent care center. *Quality Management in Healthcare, 26*(2), 108–115.

Purpose

Vaso-occlusive episodes (VOEs) are the most common reason patients with sickle cell disease (SCD) seek emergency or urgent care services. Evidence-based guidelines specify that patients with SCD who seek urgent care for treatment of VOE should receive analgesics quickly. However, these guidelines are not followed by many clinicians, resulting in poorly managed pain in this patient population. The purpose of this study was to find whether implementing a VOE analgesic care algorithm in an urgent care (UC) center would decrease patient time to receipt of analgesics, improve patient satisfaction with care, and decrease length of treatment time.

Design

The setting for this study was an urban tertiary care UC center. Eligible participants were adults at least 18 years of age who sought care at the UC center for VOE from SCD. A Quality Improvement (QI) best practice VOE analgesic intervention was conducted with UC center staff so that all were educated to follow the algorithm. Data were collected over 6 months. Time to administration of first analgesic medication for participants postintervention (n = 63) was compared with historical controls preintervention (n = 61), as were participant reports of satisfaction with care and their length of stay in the UC center.

Findings

The mean time to administration of analgesics decreased significantly from pre- to postintervention, from 92 minutes to 62 minutes (p = 0.001). Likewise, participant satisfaction with care improved from pre- to postintervention (p = 0.002) and mean time in the UC center decreased significantly from pre- to postintervention, from 283 minutes to 256 minutes (p = 0.01).

Nursing Implications

Findings from this study suggest that administering analgesics quicker to patients with SCD complicated with VOE not only mitigates their pain, but may also improve their satisfaction with care, and decrease their time in treatment. This may indirectly help to foster patient trust of the health care system and of providers. Nurses can leverage findings from this study to replicate this best practice algorithm and improve the care of patients with SCD complicated with VOE.

Minimizing Knowledge Deficits

Patients with SCD benefit greatly from understanding the circumstances that may precipitate a sickle cell crisis and the steps they can take to prevent or diminish the symptoms they may experience during a crisis. Keeping warm, reducing risks for infection, and maintaining adequate hydration can be effective in reducing the occurrence and severity of crises.

When hydroxyurea is prescribed for women of childbearing age, they should be informed that the drug can cause harm to an unborn fetus and advised that pregnancy should be avoided.

Monitoring and Managing Potential Complications

Many of the measures for managing potential complications have already been described. Other measures follow.

Leg Ulcers. Leg ulcers require careful management and protection from trauma and contamination. Referral to a wound-ostomy-continence nurse or other wound care specialist may facilitate healing and promote prevention. If leg ulcers fail to heal, skin grafting may be needed (El Khatib & Hayek, 2016). Meticulous aseptic technique during wound care is needed to reduce risk for hospital-acquired wound infections.

Priapism and Impotence. Male patients may experience sudden, painful erection known as priapism. Initial management can include warm compresses or warm bath, and mild to moderate exercise, oral hydration, and masturbation with ejaculation (Field et al., 2019). If the priapism persists longer than 3 hours the patient should seek medical attention; treatment may consist of IV hydration, administration of analgesics, and possible aspiration of blood from the corpus carvernosa with or without injection of a sympathomimetic drug (Al-Qudah, 2016; Field et al., 2019). Repeated episodes of priapism may lead to extensive vascular damage resulting in impotence.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care. Because patients with SCD are typically diagnosed during childhood, their parents typically participate in the initial education. As the child ages, educational interventions prepare the child to assume more responsibility for self-care. Most families can learn about vascular access device management and chelation therapy. Nurses in outpatient facilities or home health nurses may need to provide follow-up care for patients with vascular access devices.

Continuing and Transitional Care. The illness trajectory of SCD is highly variable, often with unpredictable episodes of complications or crises. Care is frequently on an emergency basis, especially for some patients with pain management problems. All health care providers who offer services to patients with SCD and their families must communicate regularly with each

other. Alternative methods of care delivery including day hospitals for acute symptom management and patient-centered medical homes, where multidisciplinary care is emphasized, are available in some regions. Nurses play an important role in serving as coordinators and facilitators of care by communicating with health care providers in a variety of settings to optimize the care of patients. Patient education about which parameters are important to monitor and how to monitor them is also a critical role for nurses. Making certain that patients understand when to seek urgent care for acute problems is essential.

Evaluation

Expected patient outcomes may include the following:

1. Control of pain and fatigue
   a. Uses analgesic agents appropriately to relieve pain
   b. Uses nonpharmacologic strategies to help relieve pain and fatigue, such as relaxation techniques, breathing exercises, and guided imagery
2. Absence of infection
   a. Is afebrile
   b. Maintains leukocyte count within normal baseline (4500/mm^3 to 11,000/mm^3)
   c. Identifies importance of completing antibiotics as prescribed
   d. Demonstrates measures to prevent infection (i.e., obtains recommended immunizations)
3. Expresses improved sense of control
   a. Participates in goal setting, planning, and implementing daily activities
   b. Participates in making decisions about care
   c. Adheres to prescribed medical therapy
4. Increases knowledge about disease process
   a. Identifies situations and factors that can precipitate sickle cell crisis
   b. Describes lifestyle changes needed to prevent crisis
   c. Describes the importance of warmth, adequate hydration, and prevention of infection in preventing crisis
5. Absence of complications

Thalassemias

The thalassemias are a group of hereditary anemias characterized by **hypochromia** (an abnormal decrease in the hemoglobin content of erythrocytes), extreme **microcytosis** (smaller than normal size erythrocytes),

hemolysis, and variable degrees of anemia. The thalassemias occur worldwide, but the highest prevalence is found in people of Mediterranean, African, and Southeast Asian ancestry (Weatherall, 2016).

Thalassemias are associated with impaired hemoglobin synthesis so that one or more globulin chains in the hemoglobin molecule are reduced. When this occurs, the imbalance in the configuration of the hemoglobin molecule causes it to precipitate in premature or mature erythrocytes. This increases the rigidity of erythrocytes, leading to premature cell destruction.

Thalassemias are classified into two major groups according to which hemoglobin chain is affected, alpha or beta. The alpha-thalassemias occur mainly in people of Southeast Asian and eastern Mediterranean descent (i.e., Middle Eastern), and the beta-thalassemias are most prevalent in those of African descent. Thalassemias are not limited to any geographic region because of extensive immigration (Weatherall, 2016). Symptoms of the alpha-thalassemias are typically less severe than those of beta-thalassemias. In alpha-thalassemias, erythrocytes are often quite microcytic but anemia, when present, is usually mild.

The severity of beta-thalassemia varies depending on the extent to which the hemoglobin chains are affected. Patients with mild forms have microcytosis and mild anemia. When untreated, severe beta-thalassemia (i.e., thalassemia major or Cooley's anemia) can be fatal within the first few years of life. HSCT offers a chance of cure. When this is not possible, treatment consists of PRBC transfusion and iron chelation therapy, as needed (Fibach & Rachmilewitz, 2017). Patient education for adolescents and young adults should include preconception counseling about the risk of thalassemia major in offspring (see Chapter 6 for discussion about genetic counseling and evaluation services).

Thalassemia major is characterized by severe anemia, profound hemolysis, and ineffective erythropoiesis. With early initiation of regular transfusions with PRBCs, growth and development through childhood is supported. Iron overload that can result from multiple transfusions can lead to organ dysfunction. Regular chelation therapy can reduce complications associated with iron overload and prolong life in those with thalassemia major. Long-term survivors of beta thalassemia may experience neurologic complications including cognitive dysfunction, peripheral neuropathy, and cerebrovascular disease (Fibach & Rachmilewitz, 2017).

Glucose-6-Phosphate Dehydrogenase Deficiency

The Glucose-6-Phosphate Dehydrogenase (G-6-PD) gene is responsible for the abnormality seen in this disorder. The gene produces an enzyme within the erythrocyte that is necessary to stabilize the cell membrane. Some patients produce an enzyme so defective that they have chronic hemolytic anemia;

however, the most common type of defect only results in hemolysis when cells are under certain types of stress, associated with fever and certain types of medications. G-6-PD deficiency is one of the most common X-linked genetic blood disorders in the world, affecting more than 400 million people (see Chapter 6 for discussion of X-linked disorders). However, women may also develop the disease because one of the X chromosomes is inactivated in each cell of the female embryo; thus, a female who is heterozygous for the deficiency would have one half normal red blood cells and one half with the deficiency. While the deficient cells are at risk for hemolysis, symptoms are generally milder in affected women because normal cells are not subject to hemolysis. In the United States, African Americans and people of Mediterranean descent are most likely to be affected with G-6-PD (Anderle, Bancone, Domingo, et al., 2018). The type of deficiency found in person with Mediterranean ancestry is typically more severe than that in African Americans; it results in more hemolysis and sometimes life-threatening hemolytic anemia.

Oxidant drugs have hemolytic effects for people with G-6-PD deficiency, particularly some antibiotics including sulfadiazine, nitrofurantoin, trimethoprim-sulfamethoxazole, moxifloxacin, and chloramphenicol, as well as antimalarial agents including chloroquine, primaquine, and dapsone. Other medications associated with hemolysis include phenazopyridine, rasburicase, methylthioninium, tolonium chloride, tamsulosin, glyburide, nonsteroidal anti-inflammatory drugs, and the street drug amyl nitrate (van Solinge & van Wijk, 2016). A severe hemolytic episode can also occur in affected people after ingesting fava beans, menthol, tonic water, and some Chinese herbs.

Clinical Manifestations

Patients are typically asymptomatic and have normal hemoglobin levels and reticulocyte counts. However, within several days after exposure to an offending agent, pallor, jaundice, and hemoglobinuria develop. The reticulocyte count increases, and symptoms of hemolysis develop. Special stains of peripheral blood often show Heinz bodies (degraded hemoglobin) within the erythrocytes. Hemolysis may be mild and self-limited; however, in more severe cases, usually in the Mediterranean type of the disease, spontaneous recovery does not occur.

Assessment and Diagnostic Findings

The diagnosis is made by a screening test for the deficiency or by quantitative assay of G-6-PD.

Medical Management

Treatment requires discontinuation of the offending agent. Transfusion is not usually necessary unless severe hemolysis is present, as may be seen in the Mediterranean variety of G-6-PD deficiency.

Nursing Management

Patients should be educated about the disease and provided with a list of medications and other substances to be avoided. Patients with G-6-PD deficiency should always seek medical advice before taking any new medication or supplement. The G-6-PD Deficiency organization Web site (see Resources) is an excellent source of information. If hemolysis occurs, nursing interventions are the same as for hemolysis with other conditions. Patients should be advised to wear Medic-Alert bracelets that identify that they have G-6-PD deficiency. Genetic counseling may also be indicated (see Chapter 6).

Immune Hemolytic Anemias

Immune hemolytic anemias can result from exposure of erythrocytes to antibodies. Alloantibodies (antibodies against the host or "self") occur as a result of immunization of a person to foreign antigens (e.g., the immunization of an Rh-negative person with Rh-positive blood). Alloantibodies tend to be of the immunoglobulin G (IgG) type and cause immediate destruction of sensitized erythrocytes either within the blood vessels (intravascular) or the liver. Hemolysis and anemia associated with hemolytic transfusion reaction is an example of alloimmune hemolytic anemia.

Autoantibodies may develop for a number of reasons. In some circumstances, the person's immune system is dysfunctional and falsely identifies its own erythrocytes as foreign and produces antibodies against them. This may be seen in people with chronic lymphocytic leukemia (CLL) (see Chapter 30). Another cause of autoimmune hemolytic anemia is a deficiency of suppressor lymphocytes, which normally prevents antibody production against the patient's own antigens. Erythrocytes are then sequestered in the spleen and destroyed by macrophages outside of blood vessels (extravascular hemolysis) (Phillips & Henderson, 2018).

Autoimmune hemolytic anemias may be classified based on the body temperature involved when the antibodies react with the RBC antigen. Warm-body antibodies are the most common (80%) and bind to erythrocytes most actively in warm-body conditions (37°C [98.6°F]); cold-body antibodies react in cold conditions (0°C [32°F]) (Packman, 2016). Autoimmune hemolytic anemia is associated with other disorders in most cases (e.g., medication exposure, lymphoma, CLL, other malignancies, collagen vascular diseases, autoimmune diseases, infection). In idiopathic autoimmune hemolytic states, the cause for antibody production is unknown. This primary form affects

people of all ages and genders equally, while secondary forms occur more frequently in females and in people over the age of 45 years (Packman, 2016).

Clinical Manifestations

Clinical signs and symptoms vary and often reflect the severity of anemia. The hemolysis may range from very mild, with the patient's bone marrow able to compensate adequately with few or no symptoms, to severe, with life-threatening anemia. Most patients complain of fatigue and dizziness. Splenomegaly, with associated abdominal discomfort, is a common finding; hepatomegaly, lymphadenopathy, and jaundice are also frequently seen.

Assessment and Diagnostic Findings

Laboratory tests show a low hemoglobin level and hematocrit, usually associated with an elevated reticulocyte count. Erythrocytes appear abnormal; **spherocytes** (small, spherically shaped erythrocytes) are often seen on the peripheral blood smear. The serum bilirubin level is elevated, and if the hemolysis is severe, the haptoglobin level is low or absent. The Coombs test (also known as the direct antiglobulin test), which detects antibodies on the surface of the erythrocytes, is typically positive.

Medical Management

Any possible contributing medication should be immediately discontinued. Treatment most often consists of high doses of corticosteroids until hemolysis decreases; this is especially beneficial when treating warm-antibody–induced hemolysis (Packman, 2016). Corticosteroids have several actions including suppressing antibody production, reducing the affinity of antibodies for the erythrocytes, and reducing destruction of erythrocytes by macrophages in the spleen (Go, Winters, & Kay, 2017). If the hemoglobin levels return to normal, often within a few weeks, the corticosteroid dose can be gradually reduced, and in some cases be tapered and eventually discontinued. However, treatment with corticosteroids does not produce lasting effects. In severe cases, transfusions with PRBCs are needed to maintain adequate levels of hemoglobin until the hemolytic process can be reduced. The antibodies may react to donor cells, making careful typing and cross matching essential. Transfusions are given slowly and cautiously with careful monitoring for transfusion reaction. Folic acid supplementation should be given when hemolysis is severe, because the bone marrow will attempt to compensate by increasing hematopoietic activity (Hill, Stamps, Massey, et al., 2017).

If corticosteroids do not result in remission, splenectomy (removal of the spleen) may be necessary to remove a major site of erythrocyte destruction. If

neither corticosteroids nor splenectomy are successful, immunosuppressive medications may be given (Hill et al., 2017). Immunosuppressive drugs used include cyclophosphamide and azathioprine. Cyclophosphamide has a rapid onset of action but is associated with significant toxicity. Azathioprine has a slower onset of action but less toxicity. Danazol, a synthetic androgen, may be beneficial for some patients, especially when used in combination with corticosteroids. Immunosuppressive drugs and corticosteroids must be tapered slowly over several months to avoid a flare of the immune system leading to an exacerbation of hemolysis. Monoclonal antibodies, including rituximab, can be effective in some patients and may offer long-term control of symptoms (Hill et al., 2017).

Quality and Safety Nursing Alert

Cross-matching blood when antibodies are present can be difficult. If imperfectly cross-matched PRBCs must be transfused, the nurse should begin the infusion very slowly (10 to 15 mL over 20 to 30 minutes) and monitor the patient very carefully for signs and symptoms of a hemolytic transfusion reaction.

For patients with cold-antibody hemolytic anemia, no treatment may be needed, other than to advise the patient to keep warm. Relocation to a warmer climate may be advisable in some cases. In other situations, where hemolysis is more severe, more aggressive interventions as previously described may be needed.

Nursing Management

Patients may have difficulty understanding the complex nature of their illness and may need repeated explanations in terms they can understand. Patients who have had splenectomy should receive the pneumococcal pneumonia vaccine and annual influenza vaccine and be informed that they are permanently at increased risk for infection. Patients receiving long-term corticosteroid therapy, particularly those with diabetes or hypertension, need careful monitoring. They must understand the need for their medications and avoid abruptly discontinuing them. A written explanation and a tapering schedule should be provided, emphasizing adjustments based on hemoglobin levels. Similar information should be provided when immunosuppressive agents are used. Corticosteroid therapy is associated with risks and patients should be monitored frequently for complications (see Chapter 45, Table 45-3, Corticosteroid therapy and implications for nursing practice).

Hereditary Hemochromatosis

Hereditary hemochromatosis is a genetic condition characterized by excess iron absorption from the GI tract. Normally, the GI tract absorbs 1 to 2 mg of iron daily, but in those with hereditary hemochromatosis, this rate is significantly increased. The excess iron is deposited in various organs, especially the liver, skin, and pancreas; and less frequently, the heart, testes, and thyroid gland. Eventually, affected organs become dysfunctional. Although hereditary hemochromatosis is diagnosed in 1% to 6% of the U.S. population, the actual prevalence is unknown because it is not always recognized. The genetic defect associated with hemochromatosis is most commonly seen as a specific mutation (C282Y homozygosity) of the *HFE* gene. Despite the high prevalence of the genetic mutation, the actual expression of the disease is much lower; the reason for this discrepancy is not clear. The prevalence of hemochromatosis is lower in Asian Americans, African Americans, Latinos, and Pacific Islanders and higher in people of European descent (Kowdley, Brown, Ahn, et al., 2019). Women are less often affected than men because women lose iron through menses.

Clinical Manifestations

Tissue damage is seldom evident until middle age because the accumulation of iron in body organs occurs gradually. Symptoms of weakness, lethargy, arthralgia, and weight loss are common and occur earlier in the course of the disease. The skin may appear hyperpigmented or bronze in color from melanin deposits and **hemosiderin**, an iron-containing pigment. Cardiac arrhythmias and cardiomyopathy can occur, with resulting dyspnea and edema. Endocrine dysfunction can be manifested as hypothyroidism, diabetes, and hypogonadism with testicular atrophy, diminished libido, and impotence. Cirrhosis is common in later stages of the disease, shortens life expectancy, and is a risk factor for hepatocellular carcinoma (Kowdley et al., 2019).

Assessment and Diagnostic Findings

Diagnostic laboratory findings include an elevated serum ferritin and high serum transferrin saturation. CBC values are often normal. The definitive diagnostic test for hemochromatosis was formerly a liver biopsy but that test has been replaced by testing for the associated genetic mutation. While the prevalence of the genetic mutation is high (1 in 200 to 300 in persons of Northern European descent) few people with the gene will actually develop sufficient iron overload to cause symptoms and organ dysfunction (Bacon, 2019).

Medical Management

Therapy often involves the removal of excess iron with therapeutic phlebotomy (removal of whole blood via venipuncture). Each unit of blood removed results in a decrease of 200 to 250 mg of iron. Initial treatment typically involves weekly removal of one unit of whole blood. As the ferritin level decreases, the frequency of phlebotomy can be decreased. The goal is to maintain an iron saturation between 10% and 50% and a serum ferritin level of less than 100 mcg/L (Ganz, 2016). Evaluation of iron studies should be repeated regularly and phlebotomy resumed when the ferritin level rises. CBCs and iron panel tests should be performed at regular intervals during treatment to ensure that the patient is not becoming anemic. If moderate anemia occurs, a delay in phlebotomy is often adequate to correct the problem. Aggressive removal of excess iron can prevent organ dysfunction and the complications associated with organ damage. Fatigue, skin pigmentation changes, and fibrosis are partially reversed by achieving and maintaining normal ferritin levels. Screening for hepatocellular carcinoma includes monitoring alpha-fetoprotein levels and serial abdominal ultrasounds (Kowdley et al., 2019).

Nursing Management

Patients with hemochromatosis frequently limit their iron intake; however, this is not typically effective as lone therapy. They should be advised to avoid taking additional iron supplements. Vitamin C supplementation should also be limited because it enhances iron absorption. Patients with hemochromatosis must be careful to avoid substances that might impair liver function including excessive alcohol ingestion. Other body systems should be monitored for evidence of organ dysfunction, particularly the endocrine and cardiac systems, so that appropriate interventions can be initiated without delay. Children of patients who are homozygous for the *HFE* gene mutation should be screened for the mutation. Patients who are heterozygous for the gene do not develop the disease but should be advised that they may transmit the gene to their children.

POLYCYTHEMIA

Polycythemia refers to an increased volume of RBCs. The term is used when the hematocrit is elevated (more than 55% in males and 50% in females). Dehydration can cause elevated hematocrit but not usually to the level seen with polycythemia. Polycythemia is classified as either primary or secondary. Primary polycythemia, also known as polycythemia vera, is a myeloproliferative neoplasm that is discussed in Chapter 30.

Secondary Polycythemia

Secondary polycythemia is caused by excessive production of erythropoietin. This may occur in response to a reduced amount of oxygen, which acts as a stimulus for production. Heavy smoking, obstructive sleep apnea (OSA), chronic obstructive pulmonary disease (COPD), severe heart disease, or conditions such as living at high altitudes or exposure to low levels of carbon monoxide may be responsible for increased erythropoietin production. Certain hemoglobinopathies (e.g., hemoglobin Chesapeake), in which the hemoglobin has a high affinity for oxygen, or genetic mutations that cause abnormally high erythropoietin levels may also increase erythropoiesis (Prchal, 2016b). Secondary polycythemia can also occur from certain neoplasms that stimulate erythropoietin production (e.g., renal cell carcinoma), excessive use of exogenous erythropoietin, and androgen use.

Management

When secondary polycythemia is mild, treatment may not be necessary. When treatment is necessary, however, it involves treating the primary condition. If the cause cannot be corrected (e.g., treatment of OSA or improving function with smoking cessation), therapeutic phlebotomy may be needed for symptom management and to reduce blood viscosity and volume. Therapeutic phlebotomy is not indicated when the cause for the elevated RBC count is an appropriate response to tissue hypoxia (Prchal, 2016b).

Neutropenia

Neutropenia is defined as a neutrophil count less than 2,000/mm^3. It is the result of decreased production of neutrophils or increased destruction of cells (see Chart 29-5). Neutrophils are essential in preventing and limiting bacterial infection. A patient with neutropenia is at increased risk for infection from both exogenous and endogenous sources (the GI tract and skin are common endogenous sources). The risk for infection is based not only on the severity of the neutropenia but also on its duration. The actual number of neutrophils, known as the **absolute neutrophil count (ANC)**, is determined by a simple mathematical calculation using information from the CBC and differential (see Chapter 12 for further discussion of the ANC). The risk for infection increases proportionately with a decrease in the neutrophil count. The risk is low when the ANC is greater than 1000/mm^3, and high when less than 500/mm^3 and greatest when less than 100/mm^3 (Dale & Welte, 2016). The duration of neutropenia is another risk factor for developing infection as is the underlying etiology (see Chart 29-6).

Chart 29-5

Causes of Neutropenia

Decreased Production of Neutrophils

- Aplastic anemia, due to medications or toxins
- Chemotherapy
- Metastatic cancer, lymphoma, leukemia
- Myelodysplastic syndromes
- Radiation therapy

Ineffective Granulocytopoiesis

- Megaloblastic anemia

Increased Destruction of Neutrophils

- Bacterial infections
- Hypersplenism
- Immunologic disorders (e.g., systemic lupus erythematosus)
- Medication induced[a]
- Viral disease (e.g., infectious hepatitis, mononucleosis)

[a]Formation of antibody to medication, leading to a rapid decrease in neutrophils.

Adapted from Dale, D. C., & Welte, K. (2016). Neutropenia and neutrophilia. In K. Kaushansky, M. A. Lichtman, J. T. Prchal, et al. (Eds.). *Williams hematology* (9th ed.). New York: McGraw-Hill Medical.

Clinical Manifestations

There are no definite symptoms of neutropenia until the patient develops an infection. A routine CBC with differential can reveal neutropenia before the onset of infection.

Chart 29-6 RISK FACTORS

Development of Infection and Bleeding in Patients with Hematologic Disorders

Risk for Infection	Risk for Bleeding
• *Severity of neutropenia*: Risk for infection is proportional to severity of neutropenia. • *Duration of neutropenia:* Increased duration of neutropenia leads to increased risk for infection. • *Nutritional status:* Decreased protein stores lead to decreased immune response and anergy. • *Deconditioning:* Decreased mobility leads to decreased respiratory effort, leading to increased pooling of secretions. • *Lymphocytopenia; disorders of lymphoid system (chronic lymphocytic leukemia, lymphoma, and myeloma)*: Decreased cell-mediated and humoral immunity. • *Invasive procedures:* Breaks in skin integrity create increased opportunities for organisms to enter blood system. • *Hypogammaglobinemia:* Decreased antibody formation.	• *Severity of thrombocytopenia:* Risk increases when platelet count decreases; usually not a significant risk until platelet count drops below 10,000/mm^3, or less than 50,000/mm^3 with trauma or when an invasion procedure is performed. • *Duration of thrombocytopenia:* Risk increases when duration increases (e.g., risk is less when duration is transient as after chemotherapy than when duration is prolonged as with decreased cell production by bone marrow). • *Sepsis:* Mechanism unclear; appears to cause increased platelet consumption. • *Increased intracranial pressure:* Increased blood pressure leads to rupture of blood vessels. • *Liver dysfunction:* Decreased synthesis of multiple clotting factors. • *Renal dysfunction:* Decreased platelet function. • *Dysproteinemia:* Protein coats surface of platelet, leading to decreased platelet function; protein causes increased blood viscosity, which leads to stretching of capillaries an increased risk for rupture and bleeding. • *Alcohol abuse:* Suppressive effect on bone marrow results in deceased platelet production and impaired platelet function; impaired liver function results in decreased production of clotting factors.

- *Poor hygiene:* Increased organisms on skin and mucous membranes, including perineum.
- *Poor dentition; mucositis*: Decreased endothelial integrity leads to increased opportunity for organisms to enter blood system.
- *Antibiotic therapy*: Increased risk for superinfection, often fungal.
- *Certain medications*: See text.

Adapted from Dale, D. C., & Welte, K. (2016). Neutropenia and neutrophilia. In K. Kaushansky, M. A. Lichtman, J. T. Prchal, et al. (Eds.). *Williams hematology* (9th ed.). New York: McGraw-Hill Medical; Diz-Kucukkaya, R., & Lopez, J. (2016). Thrombocytopenia. In K. Kaushansky, M. A. Lichtman, J. T. Prchal, et al. (Eds.). *Williams hematology* (9th ed.). New York: McGraw-Hill Medical; Vasu, S., & Caligiuri, M. A. (2016). Lymphocytosis and lymphopenia. In K. Kaushansky, M. A. Lichtman, J. T. Prchal, et al. (Eds.). *Williams hematology* (9th ed.). New York: McGraw-Hill Medical.

Quality and Safety Nursing Alert

Patients with neutropenia do not always exhibit classic signs of infection. Fever is the most common indicator of infection, but is not always present, particularly if the patient is taking corticosteroids or is an older adult.

Medical Management

Treatment of neutropenia varies depending on its etiology. If the neutropenia is medication induced, the offending agent should be discontinued immediately whenever possible. Treatment of an underlying neoplasm can temporarily

make the neutropenia worse, but after bone marrow recovery, treatment may improve it. Corticosteroids may be used if the neutropenia is caused by an immunologic disorder. The use of growth factors such as granulocyte colony-stimulating factor or granulocyte-macrophage colony-stimulating factor can be effective in increasing neutrophil production when the cause is reduced cell production. Withholding or reducing the dose of chemotherapy or radiation therapy may be necessary when the neutropenia is caused by these cancer treatments; however, when treatment is potentially curative, administration of growth factors is preferable so that the maximum antitumor effect of the cancer treatment can be achieved (Lyman, 2019).

If the neutropenia is associated with fever, it is assumed that the patient has an infection. Cultures of blood, urine, and sputum, as well as a chest x-ray are obtained. Broad-spectrum antibiotics are initiated immediately after cultures are obtained to ensure adequate treatment of infectious organisms. After culture and sensitivity results are obtained, the antibiotic regimen may be changed.

Nursing Management

Nurses in all settings can play a crucial role in assessing the severity of neutropenia and in preventing and managing complications, which most often include infections. Knowledge of risk factors for developing infection is an integral part of nursing care, particularly for those who work with patients who have cancer. Patient education is equally important, particularly at the time of discharge from the hospital or in the outpatient setting so that the patient can put an appropriate self-care plan into effect, including knowing when to seek medical attention (see Chart 29-7). Patients at risk for neutropenia should have blood drawn for a CBC with differential; the frequency is based on the suspected duration and severity of the neutropenia. To assess the severity of neutropenia and risk for infection, nurses must assess the ANC (see Chapter 12 for formula). Nursing interventions related to neutropenia are delineated in Chapters 12 and 30.

Lymphopenia

Lymphopenia is defined as a lymphocyte count less than 1500/mm^3. It may occur as a result of exposure to ionizing radiation, long-term use of corticosteroids, uremia, infections (particularly viral infections), neoplasms (breast and lung cancer and advanced Hodgkin disease), and some protein-losing enteropathies which may cause lymphocytes from the GI tract to be lost (Vasu & Caligiuri, 2016). When lymphopenia is mild, there are no serious sequelae, but when it is severe, it can result in bacterial infections (due to

reduced B lymphocytes) or in opportunistic infections (due to reduced T lymphocytes). T-lymphocyte depletion is frequently associated with viral infections, including human immune deficiency virus (HIV). Excessive or prolonged use of alcohol can also impair lymphocyte production; lymphocyte counts can improve when alcohol intake is discontinued (Vasu & Caligiuri, 2016).

Bleeding Disorders

The failure of normal hemostatic mechanisms can result in bleeding which may be severe. Bleeding is commonly provoked by trauma; however, in certain circumstances, it can occur spontaneously. The causes of bleeding disorders can be categorized based upon whether there is a deficiency of platelets or a defect in the platelets, or based upon whether there is an inherited or acquired coagulation factor abnormality, or based upon a defect in the vasculature. When the cause is platelet or coagulation factor abnormalities, bleeding can occur anywhere in the body. When the source is a vascular abnormality the site of bleeding is more localized. Some patients may have simultaneous defects in more than one hemostatic mechanism.

Chart 29-7 **HOME CARE CHECKLIST**

The Patient at Risk for Infection

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of alterations in neutrophils, lymphocytes, immunoglobulins on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- State changes in lifestyle (e.g., diet, activity) or home environment necessary to decrease risk for infection.
  - Maintain good hand hygiene technique, oral hygiene, total body hygiene, and skin integrity.
  - Avoid cleaning birdcages and litter boxes; consider avoiding garden work (soil) and fresh flowers in stagnant water.
  - Maintain a high-calorie, high-protein diet, with fluid intake of 3000 mL daily (unless fluids are restricted).
  - Avoid people with infections and crowds.
  - Perform deep breathing; use incentive spirometer every 4 hours while awake if mobility is restricted.
  - Provide adequate lubrication with gentle vaginal manipulation during penile-vaginal intercourse; avoid anal intercourse.
- Identify signs and symptoms of infection to report to the primary provider, such as fever; chills; wet or dry cough; breathing problems; white patches in the mouth; swollen glands; nausea; vomiting; persistent abdominal pain; persistent diarrhea; problems with urination or changes in the character of the urine; red, swollen, or draining wounds; sores or lesions on the body; persistent vaginal discharge with or without itching; and severe fatigue.
- Demonstrate how to monitor for signs of infection.
- Describe to whom, how, and when to report signs of infection.
- Describe appropriate actions to take should infection occur.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

The bone marrow may be stimulated to increase platelet production. This can be a reactive response to significant bleeding, or a more general response to increased hematopoiesis, as in iron deficiency anemia. Sometimes an increase in platelets does not result from increased platelet production, but from a loss of platelet pooling in the spleen. The spleen typically holds about one third of circulating platelets at any time. If the spleen is absent (e.g., after splenectomy) the platelet reservoir is lost, and an abnormally high number of platelets enter the circulation. Eventually the rate of platelet production slows to reestablish a more normal platelet level.

Clinical Manifestations

Signs and symptoms of bleeding disorders vary according to the type of defect. A careful history and physical examination can be useful in determining the source of the hemostatic defect. Abnormalities of the vascular system are sources of localized bleeding, usually into the skin. Because platelets are primarily responsible for stopping bleeding from small vessels, patients with decreased platelets develop **petechiae,** often in clusters. These lesions can be seen on the skin and mucous membranes and occur throughout the body (see Fig. 29-4). Bleeding from platelet disorders can be severe, but most often, bleeding from platelet disorders can be controlled when pressure is applied.

In contrast, coagulation factor defects do not tend to cause superficial bleeding because the primary hemostatic mechanisms are still intact. Instead, bleeding occurs deeper within the body (e.g., subcutaneous or intramuscular hematomas, hemorrhage into joint spaces). External bleeding diminishes very slowly when local pressure is applied; it frequently recurs several hours after pressure is removed. An example of this would be severe bleeding that occurs several hours after tooth extraction. Risk factors for bleeding are listed in Chart 29-6.

Figure 29-4 • Petechiae. Reprinted with permission from *Wintrobe's clinical hematology* (10th ed). (1999). Color plate 62.4. Philadelphia, PA: Lippincott Williams & Wilkins.

Medical Management

Management varies based on the underlying bleeding disorder. If bleeding is significant, transfusion of blood products may be indicated. The specific blood product used is determined by the underlying defect and the extent of blood loss. If fibrinolysis is excessive, hemostatic agents such as aminocaproic acid can be useful to inhibit the process, but this agent must be used cautiously because excessive inhibition of fibrinolysis can lead to thrombosis. A patient scheduled for an invasive procedure may need to have transfusions of select blood products to reduce risk for excessive bleeding.

Nursing Management

Patients who have bleeding disorders or who have the potential for development of such disorders as a result of disease or therapeutic agents must be educated to monitor themselves frequently and carefully for signs of bleeding (see Chart 29-8). They should understand the importance of avoiding activities that increase the risk for bleeding, such as contact sports. The skin should be examined for evidence of bleeding, including petechiae and ecchymoses (bruises) and the nose and gums should also be examined for bleeding. When bleeding disorders are severe, patients who are hospitalized are monitored for bleeding by testing all drainage and excreta (feces, urine, emesis, and, gastric drainage) for obvious and occult blood.

Chart 29-8 **HOME CARE CHECKLIST**

The Patient at Risk for Bleeding

At the completion of education, the patient and/or caregiver will be able to:

- Describe the source and function of platelets and clotting factors.
- State the impact of an alteration in platelets on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- State changes in lifestyle (e.g., diet, activity) or home environment necessary to decrease risk of bleeding.
  - Avoid the use of suppositories, enemas, and tampons
  - Avoid constipation
  - Avoid vigorous sexual intercourse and anal sex
  - Avoid contact sports
  - Avoid or limit aggressive manual labor
  - Use an electric razor for shaving and a soft-bristled toothbrush for teeth brushing
  - Notify health care professional before having dental work or other invasive procedures
- Identify medications and other substances to avoid (e.g., aspirin-containing medications, alcohol).
- Identify signs and symptoms of bleeding.
- Demonstrate how to monitor for signs of bleeding.
- Describe to whom, how, and when to report signs of bleeding.
- Demonstrate appropriate actions to take should bleeding occur.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

TABLE 29-3 Causes and Management of Thrombocytopenia

Cause	Management
Decreased Platelet Production	
Hematologic malignancy; especially acute leukemia	Treat leukemia, platelet transfusion
MDS	Treat MDS, platelet transfusion
Bone marrow metastases from solid tumors	Treat solid tumor
Aplastic anemia	Treat underlying condition
Megaloblastic anemia	Treat underlying anemia
Toxins	Remove toxin
Medications (e.g., sulfa drugs, methotrexate)	Discontinue medication
Infection (especially sepsis, viral infections, tuberculosis, chronic hepatitis C)	Treat underlying infection
Chronic alcohol abuse	Refrain from alcohol, refer for substance use disorder
Chemotherapy	Delay or decrease dose, platelet transfusion
Chronic liver disease	Treat underlying disorder
Radiation (e.g., pelvic irradiation)	Platelet transfusion
Delayed engraftment after stem cell transplantation	Platelet transfusion
Increased Platelet Destruction	
Due to antibodies:	Treat underlying condition
ITP	
SLE	
Malignant lymphoma	
CLL	Treat CLL and/or treat as ITP
Medications	Discontinue medication
Due to infection: Bacteremia/sepsis; post-viral infection	Treat infection
Sequestration of platelets in spleen	If severe, splenectomy may be needed
Increased Platelet Consumption	
DIC	Treat underlying condition triggering DIC; refer to text for indicated treatments
Major bleeding	Transfusion support, surgery if appropriate
Severe pulmonary embolism/severe thrombosis	Treat clot
Intravascular devices (intra-aortic balloon pump, cardiac assist devices)	Transfusion support as needed
Extracorporeal circulation (hemofiltration, extracorporeal lung assist)	Transfusion support as needed

CLL, chronic lymphocytic leukemia; DIC, disseminated intravascular coagulation; ITP, idiopathic thrombocytic purpura; MDS, myelodysplastic syndrome; SLE, systemic lupus erythromatosus.

Thrombocytopenia

Thrombocytopenia (low platelet level) can result from a variety of factors, including reduced production of platelets in the bone marrow, increased destruction of platelets, or increased consumption of platelets (e.g., the use of platelets for clot formation). Causes and treatments are summarized in Table 29-3.

Clinical Manifestations

Bleeding and petechiae rarely occur with platelet counts greater than 50,000/mm^3, but excessive bleeding can occur after surgery or other trauma. When platelet counts fall to 20,000/mm^3 or less, petechiae may occur. Additionally, nasal and gingival bleeding, excessive menstrual bleeding, and excessive bleeding from surgery or dental extractions can occur. Spontaneous and potentially fatal bleeding in the CNS or GI tract can occur when platelet counts fall to less than 5000/mm^3. If platelet function is abnormal as a result of disease (e.g., MDS) or medications (e.g., aspirin) the risk of bleeding may be much greater even when the platelet count is mildly reduced.

Assessment and Diagnostic Findings

Bone marrow aspiration and biopsy are used to identify platelet deficiency associated with decreased production. A number of genetic causes of thrombocytopenia have been identified. Autosomal dominant, autosomal recessive, and X-linked mutations are among such disorders. When platelet destruction is the cause of thrombocytopenia, the bone marrow shows increased megakaryocytes and normal or increased platelet production as the body attempts to compensate for the decreased platelets in the circulation. Screening for hepatitis B or C, which can cause thrombocytopenia, should be done.

An important cause to exclude is pseudothrombocytopenia. Platelets aggregate and clump in the presence of ethylenediaminetetraacetic acid (EDTA), the anticoagulant present in the tube used for CBC collection. This clumping can be seen 0.8% to 1.25% of the population. Manual examination of the peripheral smear can easily detect platelet clumping as the cause of thrombocytopenia. Redrawing the blood in a tube anticoagulated with citrate rather than EDTA, followed by rapid analysis of the platelet count can provide a more accurate count.

Medical Management

Secondary thrombocytopenia is usually managed with treatment of the underlying disease. If platelet production is impaired, platelet transfusion may be needed to increase the platelet count and stop bleeding or prevent spontaneous hemorrhage. If excessive platelet destruction occurs, transfused platelets may also be destroyed. The most common cause of increased platelet destruction is immune thrombocytopenic purpura (ITP) (see the following discussion). In some circumstances, splenectomy may be a therapeutic intervention, but it is not always feasible. For example, when an enlarged spleen is associated with portal hypertension related to cirrhosis, splenectomy may cause further issues with bleeding.

Nursing Management

When determining nursing interventions, the nurse considers the cause of the thrombocytopenia, the likely duration, and overall condition of the patient. Education is an important intervention to promote safety and should include fall prevention, particularly for older adults and those who are frail. Interventions for patients with secondary thrombocytopenia are the same as those for a patient with cancer who is at risk for bleeding (see Chapter 12).

Immune Thrombocytopenic Purpura

ITP is a condition that affects people of all ages but is most common in children and young women. This disorder is also referred to as idiopathic thrombocytopenic purpura, and immune thrombocytopenia. Primary ITP occurs as an isolated disorder while secondary ITP is associated with other disorders including autoimmune disorders (e.g., antiphospholipid antibody syndrome), viral infections (e.g., hepatitis C, HIV), and some drugs (e.g., cephalosporins, sulfonamides, furosemide). A platelet count less than 100,000/mm^3 with no explicable cause is the primary criterion for the diagnosis (Nomura, 2016).

Pathophysiology

Primary ITP is an acquired immune disorder characterized by thrombocytopenia that results from pathologic antiplatelet antibodies, impaired production of megakaryocytes, and T-cell–mediated destruction of platelets. Secondary ITP is associated with other underlying disorders, including autoimmune disease (systemic lupus erythematosus or rheumatoid arthritis), HIV infection, *Helicobacter pylori* infection, or underlying immune dysregulation syndromes, such as common variable immunodeficiency. The

majority of adults with ITP (approximately 80%) have primary ITP. With both types of ITP, antiplatelet antibodies develop and bind to the patient's platelets. The antibody-bound platelets are then destroyed by the reticuloendothelial system (RES) and tissue macrophages. The body attempts to compensate for the platelet destruction by increasing platelet production within the bone marrow (Lambert & Gernsheimer, 2017).

Clinical Manifestations

ITP is often asymptomatic; the low platelet count frequently is an incidental finding. Platelet counts of less than 30,000/mm^3 are not uncommon. Common signs of thrombocytopenia include easy bruising, heavy menses, and petechiae on the extremities or trunk (see Fig. 29-4). Patients who experience only bruising and petechiae tend to have fewer complications from bleeding than those with bleeding from mucosal surfaces, such as the GI tract and respiratory system (sometimes described as "wet purpura"). Patients with wet purpura have a greater risk of life-threatening bleeding which requires immediate aggressive treatment to reduce complications (Diz-Kucukkaya & Lopez, 2016). Severe thrombocytopenia, characterized by platelet count less than 20,000/mm^3, a prior history of minor bleeding episodes, and advanced age, is a risk factor for severe bleeding. Despite low platelet counts, platelets are typically immature yet very functional, with the ability to adhere to endothelial surfaces and each other. This may explain why spontaneous bleeding does not always occur. Treatment is not necessary unless bleeding becomes severe or if surgery or another invasive procedure is required (Diz-Kucukkaya & Lopez, 2016).

Assessment and Diagnostic Findings

A careful history and physical examination are essential to aid in excluding other causes of thrombocytopenia and identify sites of bleeding. Patients should be tested for hepatitis C and HIV, if not previously done to rule them out as potential causes. Bone marrow aspirate may reveal an increased number of megakaryocytes. The severity of the thrombocytopenia is highly variable.

H. pylori infection is associated with ITP, and treatment to eradicate the infection may improve the platelet count. The correlation between *H. pylori* infection and ITP is not clear; it is postulated that the presence of the *H. pylori* organism may stimulate an autoimmune reaction (Aljarad, Alhamid, Tarabishi, et al., 2018).

Medical Management

The primary goal of treatment is to achieve a platelet count high enough to maintain hemostasis. Because the risk for bleeding does not typically increase until the platelet count is less than 30,000/mm^3, a patient whose platelet count exceeds 30,000/mm^3 to 50,000/mm^3 may be carefully monitored without immediate intervention. However, if the platelet count is less than 30,000/mm^3 or if bleeding occurs, the goal is to improve the patient's platelet count and not to cure the disease. The decision to treat is made based upon the severity of bleeding (if any) and not solely on the platelet count. Potential treatment side effects, the patient's lifestyle, activity level, concurrent use of medications, and treatment preferences are also considered. A person with a sedentary lifestyle can tolerate a low platelet count more safely than a more active person; however, increasing age is also associated with increased risk for bleeding and mortality (Diz-Kucukkaya & Lopez, 2016).

Treatment for ITP usually involves several approaches. If the patient is taking a medication known to be associated with ITP (e.g., quinine, sulfa-containing drugs), then that medication should be discontinued. Transfusions are often ineffective because antiplatelet antibodies bind with transfused platelets, causing them to be destroyed. Platelet counts may drop even further after platelet transfusion. Thus, despite extremely low platelet counts, platelet transfusions may result in catastrophic bleeding in patients with wet purpura. Aminocaproic acid, a fibrinolytic enzyme inhibitor that slows the dissolution of blood clots, may be useful for patients with significant mucosal bleeding that is resistant to other treatments.

The mainstay of short-term therapy is the use of immunosuppressive agents. These agents block the binding receptors on macrophages to reduce platelet destruction. The American Society of Hematology recommends dexamethasone or prednisone in adults with newly diagnosed ITP as the types of corticosteroids that might be selected for initial therapy. Continuous long-term use of corticosteroids is not recommended because of the risk for side effects (Neunert, Terrell, Arnold, et al., 2019). Platelet counts typically begin to rise within a few days after initiating treatment with corticosteroids. The platelet count tends to decrease once the corticosteroid dose is tapered but may remain sufficiently adequate to prevent bleeding.

IVIG is commonly used to treat ITP. It renders its effect by binding to the receptors on macrophages. However, the need for high doses of IVIG and its high cost are disadvantages.

For the procedural guidelines for managing immunoglobulin therapy, go to thepoint.lww.com/Brunner15e.

The effects of treatment are transient in most cases. Another approach to treatment of chronic ITP is the use of anti-D immunoglobulin in patients who are Rh (D) positive. The exact mechanism of action is unknown, but it is theorized that the anti-D binds to the patient's erythrocytes, which are in turn destroyed by the body's macrophages. The receptors in the RES may become flooded with sensitized erythrocytes, which then reduce the number of antibody-coated platelets. This then results in a transient reduction of hematocrit and an increased number of platelets in some patients with ITP (Neunert et al., 2019).

Eventually, the platelet count again declines and additional therapy is needed. Second-line treatment options should take the patient's individual needs and the potential treatment-related side effects into account.

Splenectomy is an alternative treatment and typically results in a sustained increase in platelets. Many patients can maintain a "safe" platelet count of more than 30,000/mm^3 after splenectomy; however, many patients may have a recurrence of thrombocytopenia months or years later (Neunert et al., 2019). Patients who undergo splenectomy are permanently at risk for serious infection and should receive pneumococcal, influenzae, and meningococcal vaccines approximately 2 weeks prior to splenectomy, or 2 to 3 weeks postoperatively if splenectomy is performed emergently (Bonanni, Grazzini, Niccolai, et al., 2017) (see Chapter 19 for information on pneumonia vaccine).

Other management strategies include use of monoclonal antibodies, such as rituximab. Patients may have long lasting effects with increased platelet counts for up to 1 year after treatment. Unfortunately, when the response dwindles, platelets may fall to unsafe levels, making additional treatment necessary (Neunert et al., 2019).

Two thrombopoietin receptor agonists are available for treatment of refractory ITP. These include romiplostim and eltromopag. Romiplostim is given as a weekly subcutaneous injection and eltromopag is given orally. The response varies widely, and treatment must be continued indefinitely (Depré, Aboud, Ringel, et al., 2016).

Nursing Management

Nursing care includes a thorough assessment of the patient's lifestyle to determine risks for bleeding associated with activities. A careful medication history should also be obtained, including use of over-the-counter (OTC) medications, herbs, and nutritional supplements. The nurse must be alert to sulfa-containing medications and others that may interfere with platelet function (e.g., aspirin, NSAIDs). The nurse must assess for a history of recent viral illness and reports of headache, visual disturbances, and other symptoms that may indicate intracranial bleeding. Patients admitted to the hospital with wet purpura and low platelet counts should have neurologic assessment

included with their vital sign measurements. Injections and rectal medications should be avoided. Rectal temperature measurements should also be avoided because they may cause trauma to the rectal mucosa and stimulate bleeding.

There is evidence that patients with ITP experience an increase in fatigue when compared to those without the disease that is not associated with the duration of the disease, corticosteroid use, bleeding, or low platelet counts (Diz-Kucukkaya & Lopez, 2016). Assessment of the extent of the patient's fatigue can be beneficial in helping the patient to identify coping strategies.

Patient and family education should address signs of exacerbation (e.g., petechiae and ecchymoses), how to contact appropriate health care personnel, the name and type of medications inducing ITP (if appropriate) current medical treatment (name of medications, side effects, tapering schedule, if indicated), frequency of monitoring for the platelet count, and follow-up appointments.

The patient should be instructed to avoid all agents that interfere with platelet function, including herbal therapies and OTC medications. The patient should avoid constipation, straining, and vigorous flossing of the teeth. Electric razors should be used for shaving and soft-bristled toothbrushes should be used for dental hygiene. Patients and their partners should be counseled to avoid vigorous sexual intercourse when platelet counts are low. Patients who are receiving long-term corticosteroids should understand that they are at increased risk for complications including osteoporosis, proximal muscle wasting, cataract formation, and dental caries (see Chapter 45, Table 45-3). Bone mineral density should be monitored, and patients may benefit from supplemental calcium, vitamin D, and bisphosphonate to reduce risk for significant bone disease.

Platelet Defects

Quantitative platelet defects (i.e., thrombocytopenia, thrombocytosis) are not uncommon, however qualitative defects may also occur. Despite normal platelet counts, when qualitative defects are present, platelets do not function normally. A platelet function analyzer is used to evaluate platelet function. This technique is valuable for rapid screening. Examination of platelet morphology with the peripheral blood smear in the laboratory can also identify possible qualitative defects. Platelet morphology is frequently hypogranular and pale and may also be larger than normal (Coutre, 2018).

Aspirin may induce a platelet disorder. Even small amounts of aspirin can reduce normal platelet aggregation and increase bleeding time for several days after ingestion. Although this typically does not cause bleeding in most people, patients with thrombocytopenia and coagulation disorders such as hemophilia

can experience significant bleeding after ingestion of aspirin, especially in conjunction with trauma and invasive procedures.

Chart 29-9 PHARMACOLOGY

Medications and Substances That Impair Platelet Function

Medications

- Angiotensin-converting enzyme inhibitors
- Angiotensin receptor blockers
- Antibiotics
- Beta-lactams
- Cephalosporins
- Penicillins
- Beta-blockers
- Calcium channel blockers
- Chemotherapeutic agents
- Mithramycin
- Vincristine
- Diuretics
- Ethacrynic acid
- Furosemide
- HMG-CoA reductase inhibitors (i.e., “statins”)
  - Atorvastatin
  - Simvastatin
- Methylxanthines
  - Aminophylline
  - Theophylline
- Milrinone
- Misoprostol
- Nitrates
  - Isosorbide
  - Nitroglycerin
- Phosphodiesterase inhibitors
- Pentoxyfilline
- Sildanafil
- Tadalafil
- Protease inhibitors
- Ritonavir
- Tipranavir
- Phenytoin
- Selective serotonin reuptake inhibitors
  - Fluoxetine
  - Fluvoxamine
  - Paroxetine
  - Sertraline
- Tricyclic antidepressants
  - Doxepin
  - Imipramine

Tyrosine kinase inhibitors
Dasatinib
Imatanib
Valproic acid

Food and Food Additives

Caffeine
Ethanol (Alcohol)
Fish oils
Garlic
Ginger
Grape juice

Over-the-Counter and Herbal Supplements

Ginkgo biloba
Ginseng
Saw palmetto
Vitamin C
Vitamin E

Adapted from Comerford, K. C., & Durkin, M. T. (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer; Coutre, S. (2019). Congenital and acquired disorders of platelet function. *UpToDate*. Retrieved on 1/1/2020 at: www.uptodate.com/contents/congenital-and-acquired-disorders-of-platelet-function; Nagalla, S., & Bray, P. F. (2017). Hematology: Drug-induced platelet dysfunction. Cancer Therapy Advisor. Retrieved on 1/1/2020 at: www.cancertherapyadvisor.com/home/decision-support-in-medicine/hematology/drug-induced-platelet-dysfunction/

NSAIDs can also impair platelet function, but the effects are not as prolonged as with aspirin (4 days vs. 7 to 10 days). Other causes of platelet dysfunction include end-stage renal disease, MDS, multiple myeloma, cardiopulmonary bypass, herbal remedies, and other medications (see Chart 29-9).

Clinical Manifestations

Bleeding can range from mild to severe. The severity does not necessarily correlate with the platelet count or with tests that measure coagulation (prothrombin time [PT], activated partial thromboplastin time [aPTT]). However, results from these tests may be useful in determining the etiology of the bleeding disorder when abnormalities are present (Levi, Seligsohn, & Kaushansky, 2016). For example, an elevated PT in the setting of a normal aPTT and platelet count may suggest factor VII deficiency, whereas an elevated aPTT in the setting of a normal PT and platelet count is suggestive of

von Willebrand disease (vWD) or hemophilia. Ecchymoses, particularly on the extremities, are frequently evident. Patients with platelet dysfunction are at increased risk for bleeding after trauma or invasive procedures (e.g., dental extraction, biopsy).

Medical Management

Platelet dysfunction that is associated with a medication requires stopping the medication when possible, especially when bleeding occurs. If platelet dysfunction is present, bleeding may be prevented by transfusion of platelets prior to an invasive procedure. Antifibrinolytic agents (e.g., aminocaproic acid) may be needed to prevent significant bleeding after procedures; desmopressin, a synthetic vasopressin analogue, can reduce the duration of bleeding and improve hemostasis for some patients (Levi et al., 2016).

Nursing Management

Patients with platelet dysfunction should be instructed to avoid substances that can interfere with platelet function. These include OTC medications such as aspirin and NSAIDs, as well as some herbal preparations, nutritional supplements, and alcohol. Patients should notify all health care providers, including dentists, of their underlying condition before undergoing any invasive procedure so that measures to reduce risk for bleeding can be implemented. Maintaining good oral hygiene is important to promote good dental health and reduce risk for gingival bleeding.

Inherited Bleeding Disorders

Two of the more commonplace inherited bleeding disorders include hemophilia and vWD. Each of these is discussed in the sections that follow.

Hemophilia

There are two forms of hemophilia: hemophilia A and hemophilia B. Both are clinically similar but are distinguishable by laboratory tests. Hemophilia A is caused by a genetic defect that results in deficient or defective factor VIII. Hemophilia B, also known as Christmas disease, is due to a genetic defect that causes a deficiency or defect in factor IX. Hemophilia is a relatively common disease, with hemophilia A occurring in 1 of every 5000 to 7000 births. Hemophilia A is five times more common than hemophilia B (Escobar & Key, 2016). Both hemophilia A and hemophilia B are inherited as X-linked traits, making both conditions much more common in males than in females.

Females can be carriers of the gene but are typically asymptomatic. It is estimated that one third of cases result from spontaneous mutations rather than familial transmission (National Hemophilia Foundation, 2019).

The tendency for developing bleeding is the basis for the classification of hemophilia (Escobar & Key, 2016):

- Severe disease is defined by a plasma factor activity level of less than 1 IU/dL, or less than 1% normal factor VIII levels.
- Moderate disease reflects a level of 1 to 5 IU/dL or factor VIII level between 1% and 5% of normal.
- Mild disease reflects a level above 5 IU/dL or factor VIII level above 5%.

Hemophilia is often recognized in early childhood, usually in the toddler period. However, patients with mild hemophilia may not be diagnosed until they experience severe trauma or surgery.

Clinical Manifestations

Hemophilia is manifested by hemorrhages into various parts of the body; hemorrhages can be severe and can occur even with minimal trauma. The frequency and severity of bleeding depend on the degree of factor deficiency and the severity of the precipitating trauma. Those with mild factor deficiency rarely develop spontaneous bleeding; hemorrhage is usually associated with trauma. In contrast, spontaneous bleeding, including hemarthroses and hematomas, occur frequently in patients with severe factor deficiency (Escobar & Key, 2016).

About 75% of bleeding in patients with hemophilia occurs in the joints. Joints most frequently affected include the knees, elbows, ankles, shoulders, wrists, and hips. Pain is often noticed prior to the presence of swelling and limitations in movement. Recurrent joint hemorrhages can lead to joint arthropathy that causes ankylosis and chronic pain (see Fig. 29-5). Patients with severe factor deficiency may become disabled due to joint damage early in life. Bleeding may be superficial as hematomas or as deep hemorrhages into muscle and subcutaneous tissue. With severe factor VIII deficiency, hematomas can occur without trauma and extend into the surrounding tissue. Hematomas in the muscles, particularly in the extremities, may cause peripheral nerve compression with impaired sensation. Over time, nerve compression may lead to weakness and atrophy of the affected area.

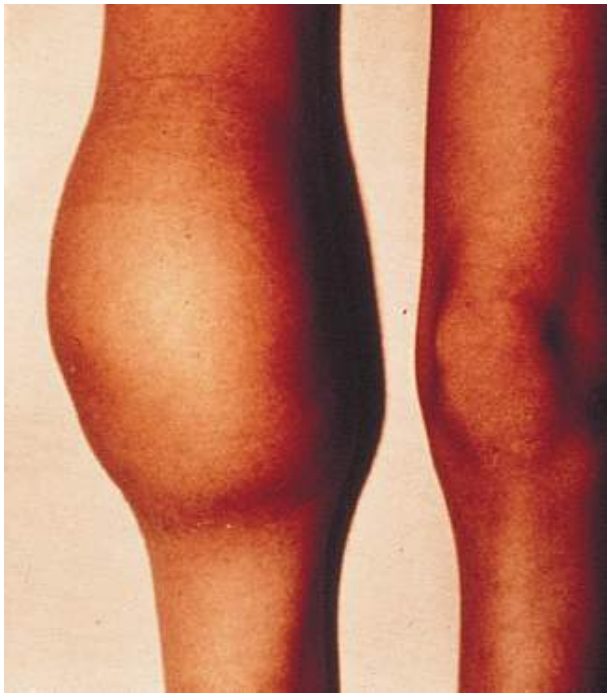

Figure 29-5 • Hemophilic arthropathy: Sequelae of recurrent joint bleeding. Reprinted with permission from *Wintrobe's clinical hematology* (10th ed). (1999). Color plate 68. Philadelphia, PA: Lippincott Williams & Wilkins.

Bleeding is not limited to joints and muscles. Dental procedures, including extractions, are associated with bleeding. Spontaneous hematuria and GI bleeding may also occur. Bleeding is also common in other mucous membranes, including the nasal passages and conjunctivae as well as soft tissue. Falls in adults are particularly dangerous. Intracranial and extracranial hemorrhages are the most serious sites of bleeding. Any head trauma requires immediate evaluation and treatment. Surgical procedures often result in excessive bleeding at the surgical site. Clot formation and wound healing are often poor.

Medical Management

Recombinant forms of factor VIII and IX concentrates are available and decrease the need for using plasma-derived factor concentrates and fresh-frozen plasma. Concentrates are used when patients are actively bleeding; it is important that treatment is initiated as soon as possible to reduce risk for bleeding complications. Factors should be administered prophylactically prior to traumatic procedures to prevent excessive bleeding (Escobar & Key, 2016). Children frequently receive prophylactic treatment three to four times per week to reduce risk for joint complications. The cost and challenges with adhering to the prescribed regimen may limit the effectiveness of this approach

(Thornburg & Duncan, 2017). Initiating prophylactic treatment in adolescents and young adults can also lead to positive outcomes by reducing joint complications, pain, and disability and improving quality of life (Reding, 2018).

Development of neutralizing antibodies (inhibitors) to factor concentrates is a significant complication of factor replacement therapy. Up to 33% of patients with hemophilia A and 3% of patients with hemophilia B develop antibodies to factor concentrates (Reding, 2018). The presence of these inhibitors may be transient; however, the effects may be significant and lead to partial or complete refractoriness to factor replacement, leading to increased risk for bleeding. Ideally, antibody titers should remain low. It is important to identify rising antibody titers as soon as possible. To reduce the impact of inhibitors, inducing immune tolerance is critical. Immunosuppressive therapy in the form of corticosteroids, IVIG or cyclophosphamide may be used to remove inhibitors. Emicizumab is a new bispecific humanized monoclonal antibody that is effective in preventing bleeding in patients with hemophilia A. Initially indicated as effective therapy for patients with inhibitors, it is now also indicated for patients without inhibitors (Franchini, Marano, Pati, et al., 2019; Young, Liesner, Chang, et al., 2019). Patients with severe factor deficiency should be screened for antibodies, particularly prior to invasive procedures, so that appropriate therapy aimed at reducing risk for bleeding complications can be started. Other therapeutic options include administration of recombinant factor VIIa or activated prothrombin complex concentrates (Reding, 2018).

Aminocaproic acid inhibits fibrinolysis and subsequently stabilizes blood clots. It can be very effective as an adjunctive measure to treat mucosal bleeding after oral surgery. Desmopressin induces a significant but short-lived increase in factor VIII levels; the mechanism of this response is unclear. In patients with mild forms of hemophilia A, desmopressin is very useful and can significantly reduce the requirement for blood products (Mannucci, 2018).

Nursing Management

Most adult patients with hemophilia are diagnosed during childhood. They frequently need assistance in coping with the disease because it is chronic and imposes restrictions on their lifestyle. Additionally, the disease is inherited and can be passed to future generations. Helping patients cope with their condition, assisting them to identify positive aspects of their lives, and encouraging independence and self-sufficiency are important nursing activities. This must be balanced with promoting safety and preventing trauma that can result in acute bleeding. As patients mature, they can be encouraged to work through their feelings, progressing toward acceptance, and assuming greater responsibility for maintaining an optimal state of health.

Patients with mild factor deficiency may not be diagnosed until they reach adulthood if they do not have surgery or significant trauma during childhood. The nurse must provide these patients with extensive education to understand activity restrictions and self-care strategies to reduce risk for hemorrhage and complications associated with bleeding. Safety at home and at work should be emphasized.

Patients and family caregivers need to learn how to administer factor concentrate at home at the earliest signs of bleeding to minimize bleeding and reduce complications. Prophylactic factor replacement can be beneficial in reducing morbidity associated with repeated episodes of bleeding. This method requires factor administration several times a week, making adherence to the regimen difficult. Nurses can help patients and families understand the potential benefits of prophylactic therapy while helping them to minimize the disadvantages. Patients with hemophilia are also instructed to avoid agents that can interfere with platelet aggregation that can add additional risk for bleeding. Aspirin, NSAIDs, some herbal and nutritional supplements (e.g., nettle, chamomile, alfalfa), and alcohol should be avoided. Oral hygiene is an important measure to reduce gingival bleeding, and good dental health should be promoted to reduce the need for extractions over the long term. While application of pressure may be helpful in controlling bleeding from minor injuries in patients with factor deficiency, it is inadequate in the presence of severe factor deficiency. Nasal packing for epistaxis should be avoided because bleeding often resumes when packing is removed. Splints and other orthopedic devices may be beneficial in supporting and immobilizing joints and muscles affected by hemorrhage. All injections should be avoided; invasive procedures (e.g., endoscopy, lumbar puncture) should be avoided or performed after administration of appropriate factor replacement. Patients with hemophilia should carry or wear medical identification (e.g., Medic-Alert bracelets). Additionally, patients and families should have a written emergency plan that includes measures to be taken in specific situations along with names and telephone numbers for emergency contacts.

During bleeding episodes, the extent of bleeding must be carefully assessed. Patients at risk for significant complications (e.g., bleeding into the respiratory tract or CNS) require close observation, specifically assessing for respiratory distress and altered levels of consciousness. Patients who have had recent surgery need careful monitoring to assess for bleeding from surgical sites. Frequent monitoring of vital signs, drains, and dressings is necessary to identify postoperative bleeding.

Significant pain requiring analgesics is often associated with hematomas and joint hemorrhage. Warm baths can be helpful in relieving pain, promoting relaxation, and improving mobility. During bleeding episodes, heat should be avoided because it may exacerbate bleeding; applications of cold are more efficacious.

Factor concentrates used since 1985 are free of viruses, including hepatitis C and HIV; however, patients treated prior to that time were exposed to these viruses (Escobar & Key, 2016). Patients who have acquired HIV and other viral infections may need assistance in coping with these additional diagnoses and the consequences of infection.

Genetic testing and counseling should be offered to female carriers so they can make informed decisions regarding childbearing and managing pregnancy (see Chapter 6).

Gerontologic Considerations

Advances in treatment have led to extended lifespans for patients with hemophilia, causing unique challenges for older patients with this disorder. Older adult patients with hemophilia are likely to have been managed with blood component transfusion and plasma-derived clotting factors prior to the advent of universal screening, at least early in life. For this reason, HIV and hepatitis B and C infections are not uncommon in this population; these infections carry significant risk for liver cancer and other liver diseases (Mannucci, 2019). Intracranial hemorrhage is the third most common cause of death after HIV and hepatitis and result from trauma. The likelihood of acquiring inhibitors increases with age.

Cardiovascular disease among adults with hemophilia can be difficult to manage. Antiplatelet therapy (including aspirin) can be challenging for patients with severe hemophilia. Stent placement and coronary artery bypass graft surgery are accompanied by significant risk but aggressive factor replacement therapy can make these therapeutic treatments possible (Kanellopoulou & Nomikou, 2018). Close collaboration and coordination of care with the patient's hematologist are required to improve outcomes.

Arthropathy is a major cause of morbidity in older patients with hemophilia and can result in reduced range of motion, impaired functioning, and chronic pain. However, quality of life can improve with arthroplasty and multidisciplinary rehabilitation tailored to address the special needs of older adults with hemophilia (Mannucci, 2019).

von Willebrand Disease

vWD is an inherited bleeding disorder characterized by a deficiency in von Willebrand factor (vWF), which is necessary for factor VIII activation. The disease is characterized primarily by mucosa-associated bleeding and bleeding following surgery and trauma. vWD is the most common inherited bleeding disorder, affecting up to 1% of the general population. It typically has an autosomal dominant inheritance pattern, affecting both genders equally (Rick, 2019). vWD is divided into types 1, 2, and 3. Type 1 accounts for 70% to 80%

of cases, and is characterized by a quantitative deficiency of vWF. Type 2, accounting for approximately 20% of cases, is caused by dysfunctional vWF. Type 2 is further subdivided on the basis of certain phenotypic characteristics. Type 3 vWD is rare and accounts for fewer than 5% of cases. It is the most severe form, and is caused by the absence of circulating vWF (Leebeek, & Eikenboom, 2016). Figure 29-6 illustrates the differences in clotting found with hemophilia and vWD.

Clinical Manifestations

Bleeding most often involves the mucous membranes. Nosebleeds, heavy menses, easy bruising, and prolonged bleeding from cuts and surgical sites are common. Soft tissue and joint hemorrhages are not seen often, unless the patient has type 3 vWD. As laboratory values fluctuate, so does bleeding. For example, postoperative bleeding may be minor with one procedure but significant with another (Rick, 2019).

Assessment and Diagnostic Findings

vWD may be suspected based upon a personal or family history of bleeding that may then be confirmed by laboratory evidence of abnormalities in vWF, factor VIII, or both. The diagnosis of vWD is based on measurements of vWF antigen; the level of vWF–dependent platelet adhesion, measured with the use of the vWF–ristocetin cofactor activity assay; and the coagulant activity of factor VIII. Type 3 vWD is diagnosed when vWF antigen is undetectable (or the level is less than 5 IU/dL). These results are variable with individual patients over time, making it important to review laboratory values over time and not rely on single measurements (Rick, 2019).

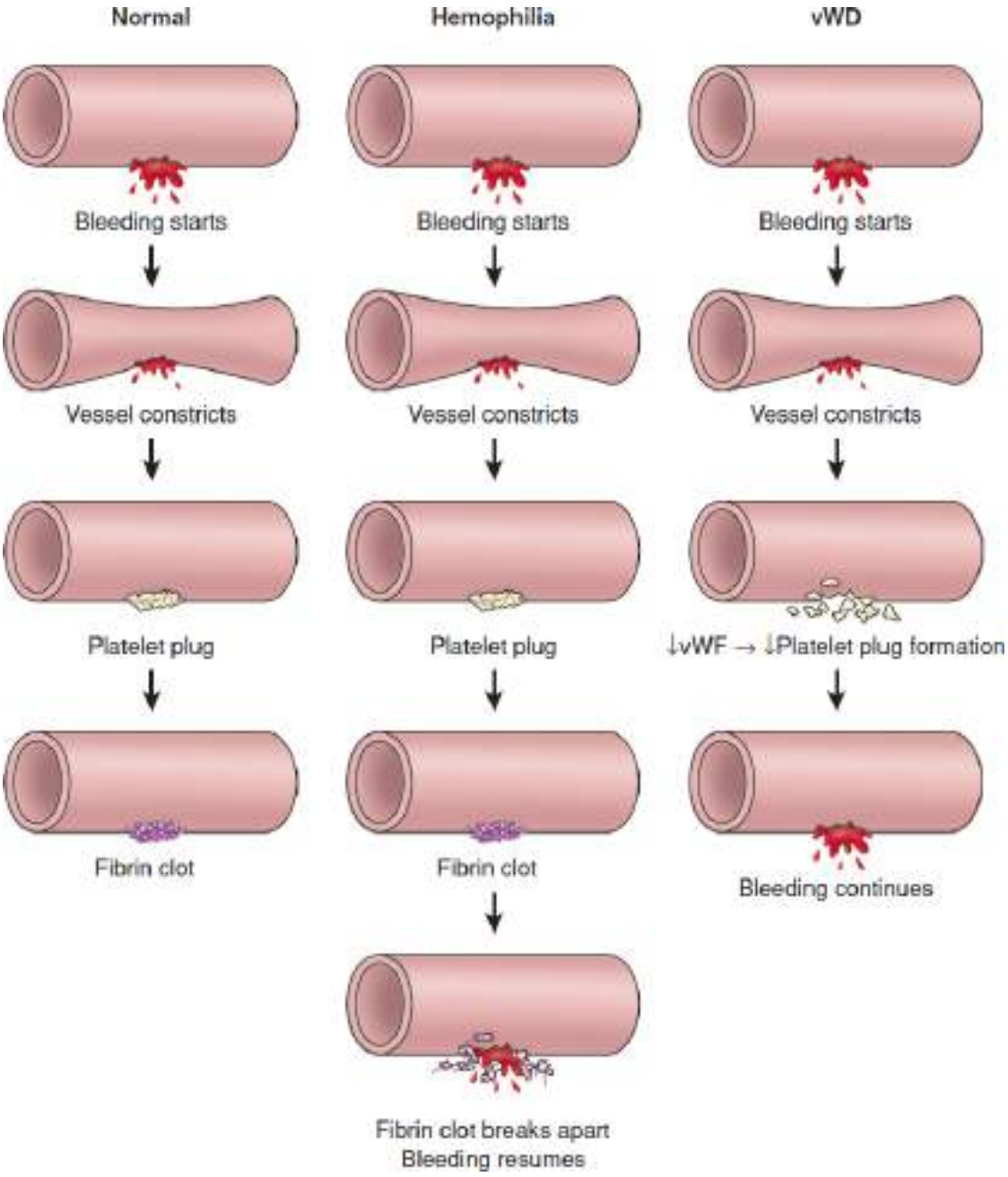

Figure 29-6 • Differences in bleeding. Normal, hemophilia, and von Willebrand disease (vWD). Reprinted with permission from Thomas, M., & Morrow, K. *Veterans Administration Palo Alto Health Care System*. Palo Alto: CA.

Management

The goal of treatment is to replace the deficient protein (e.g., vWF or factor VIII) at the time of spontaneous bleeding or prior to an invasive procedure to prevent subsequent bleeding. Desmopressin is often used to prevent bleeding associated with dental and surgical procedures or to manage mild bleeding after surgery in patients with mild vWD; it is often not effective in treating

those with type 3 vWD (Leebeek, & Eikenboom, 2016). Desmopressin provides a transient increase in factor VIII coagulant activity and may also correct bleeding time. Desmopressin can be given as an IV infusion or intranasally. IV administration is preferred for invasive procedures, including surgery. Hyponatremia and seizures may occur after repeated doses; therefore, treatment longer than 3 consecutive days is not typically indicated.

Factor replacement concentrates of vWF and factor VIII are the treatments of choice for patients with type 3 vWD and most patients with type 2. The dosage and frequency of administration of these agents depend on the patient's factor VIII level and extent of bleeding. Treatment may be needed for up to 7 to 10 days after a surgical procedure and 3 to 4 days postpartum. In patients with type 3 vWD, prophylactic use of replacement agents is often successful in preventing or limiting spontaneous bleeding. Formation of antibodies to these agents is most likely to occur in patients with type 3 vWD receiving high doses.

Other agents are also effective in controlling bleeding. Aminocaproic acid is useful in managing mild mucosal bleeding because it inhibits dissolution of the thrombus at the site of bleeding. Topical agents that augment thrombin formation at the site of application help to achieve hemostasis in dental procedures. Estrogen-progesterone compounds may reduce bleeding associated with menses. Platelet transfusions are useful when there is significant bleeding. Cryoprecipitate, which is rich in vWF and factor VIII, typically is used only in emergencies due to risk for iatrogenic transmission of viruses. Herbs and medications that interfere with platelet function should be avoided (Leebeek & Eikenboom, 2016).

Acquired Bleeding Disorders

There are a plethora of acquired bleeding disorders. Common causes include liver disease, vitamin K deficiency, and heparin-induced thrombocytopenia (HIT).

Liver Disease

Excluding factor VIII, most blood coagulation factors are synthesized in the liver. Therefore, liver dysfunction (due to cirrhosis, hepatitis, and tumor) can lead to reduced amounts of the factors needed for coagulation and hemostasis (see Chapter 43). Prolongation of the PT may indicate severe hepatic dysfunction, unless associated with vitamin K deficiency. Patients may experience minor bleeding (e.g., ecchymoses) but are also at risk for significant bleeding, especially after surgery or trauma. Transfusion of fresh-frozen plasma may be needed to replace clotting factors and prevent or stop

bleeding. Life-threatening hemorrhage associated with peptic ulcer or esophageal varices may occur. In the event of significant hemorrhage, transfusion of fresh-frozen plasma, PRBCs, and platelets is often necessary.

Vitamin K Deficiency

Vitamin K is an essential element for synthesis of many coagulation factors. Vitamin K deficiency is often seen in patients who are malnourished. Prolonged use of some antibiotics can reduce the intestinal flora that produce vitamin K, causing depletion of vitamin K stores. Correction of the deficiency can be achieved with oral or subcutaneous administration of vitamin K (phytonadione). Adequate synthesis of coagulation factors is reflected in normalization of the PT.

Heparin-Induced Thrombocytopenia

HIT is a serious complication of heparin-based therapy, a medication commonly prescribed for its anticoagulant effects (see Chapter 26 for description of indications for heparin). HIT involves the formation of antibodies against the heparin–platelet complex. HIT may occur in as many as 5% of patients receiving heparin (Brien, 2019). The type of heparin used, the duration of therapy (4 to 14 days), and surgery (especially if cardiopulmonary bypass is used) appear to be risk factors for developing HIT. Bovine heparin preparations are more likely to lead to HIT than porcine preparations; even low–molecular-weight heparins (LMWHs) carry risk for HIT. Neither the dose nor the route of administration of heparin is a risk factor. Women appear to be at higher risk and young adults are at low risk for developing this condition. A decline in the platelet count is the hallmark sign that most often develops 5 to 10 days after heparin therapy is initiated; therefore, monitoring the platelet count in patients receiving heparin therapy is essential. The platelet count can drop significantly, typically by 50% of the baseline over a period of 1 to 3 days. Autoantibodies develop that may activate platelets, causing thromboses. After patients with HIT are successfully managed, these autoantibodies typically disappear in 2 to 3 months.

Affected patients are at increased risk for thrombosis, either venous, arterial, or both, with thromboses that may manifest as deep vein thrombosis (DVT), acute coronary syndrome (ACS), stroke, or thrombosis to major vessels in an extremity, leading to amputation. Venous thromboembolism (VTE) is the most common manifestation of thrombosis secondary to HIT (i.e., DVT or pulmonary embolism [PE]) (Brien, 2019).

Treatment for HIT includes immediate cessation of heparin (including heparin-coated catheters) and initiation of another form of anticoagulation. If the heparin is discontinued without providing an alternative form of

anticoagulation, the patient is at increased risk of developing new thrombi. Argatroban, a thrombin inhibitor, is an FDA-approved anticoagulant for the treatment of HIT. Oral anticoagulation with warfarin is contraindicated because it initially promotes thrombosis in the microvasculature by depletion of protein C. This can lead to tissue ischemia and gangrenous limbs, ultimately resulting in amputation if untreated (Arepally, 2017). Patients who develop thrombosis in the presence of HIT should receive anticoagulation for 3 to 6 months; in the absence of thrombosis, treatment may be shorter. Patients must be aware that the condition may be reactivated with re-exposure to heparin, even in small amounts, within 3 to 4 months of the diagnosis (Arepally, 2017).

Disseminated Intravascular Coagulation

Disseminated intravascular coagulation (DIC) is a systemic syndrome that is characterized by microthromboses and bleeding. DIC may be precipitated by sepsis, trauma, cancer, shock, abruptio placentae, allergic reactions, and other conditions. Most cases are associated with infection or malignancy (Levi & Seligsohn, 2016). The severity of DIC varies but it is potentially life-threatening.

Pathophysiology

Normal hemostatic mechanisms are altered in DIC. The inflammatory response generated by the underlying disease initiates the process of inflammation and coagulation within the vasculature. The normal anticoagulation pathways in the body are impaired, and fibrinolysis is suppressed allowing numerous small clots to form in the microcirculation. Coagulation time is initially normal; however, when platelets and clotting factors form microthrombi, coagulation fails. The result of these processes leads to both excessive clotting and bleeding (see Fig. 29-7).

The clinical manifestations of DIC are primarily reflected in compromised organ function or failure. Decline in organ function is usually a result of excessive clot formation (with resultant ischemia to all or part of the organ) or, less often, of bleeding. The excessive clotting triggers the fibrinolytic system to release fibrin degradation products, which are potent anticoagulants, furthering the bleeding. The bleeding is characterized by low platelet and fibrinogen levels; prolonged PT, aPTT, and thrombin time; and elevated fibrin degradation products and D-dimers.

The mortality rate can exceed 80% in patients who develop severe DIC with ischemic thrombosis, frank hemorrhage, and MODS. Identification of patients who are at risk for DIC and recognition of the early clinical

manifestations of this syndrome can result in prompt medical intervention, which may improve the prognosis. However, the primary prognostic factor is the ability to treat the underlying condition that precipitated DIC (Levi & Seligsohn, 2016).

Clinical Manifestations

During the initial process of DIC, the patient may have no new symptoms—the only manifestation being a progressive decrease in the platelet count. As the thrombosis becomes more extensive, the patient exhibits signs and symptoms of thrombosis in the organs involved. Then, as the clotting factors and platelets are consumed to form these thrombi, bleeding occurs. Initially, the bleeding is subtle, but it can develop into frank hemorrhage. Signs and symptoms depend on the organs involved and are listed in Chart 29-10. Patients with frank DIC may exhibit bleeding from mucous membranes and venipuncture sites as well as the GI and urinary tracts. Bleeding may range from minimal, occult internal bleeding to copious bleeding from multiple orifices.

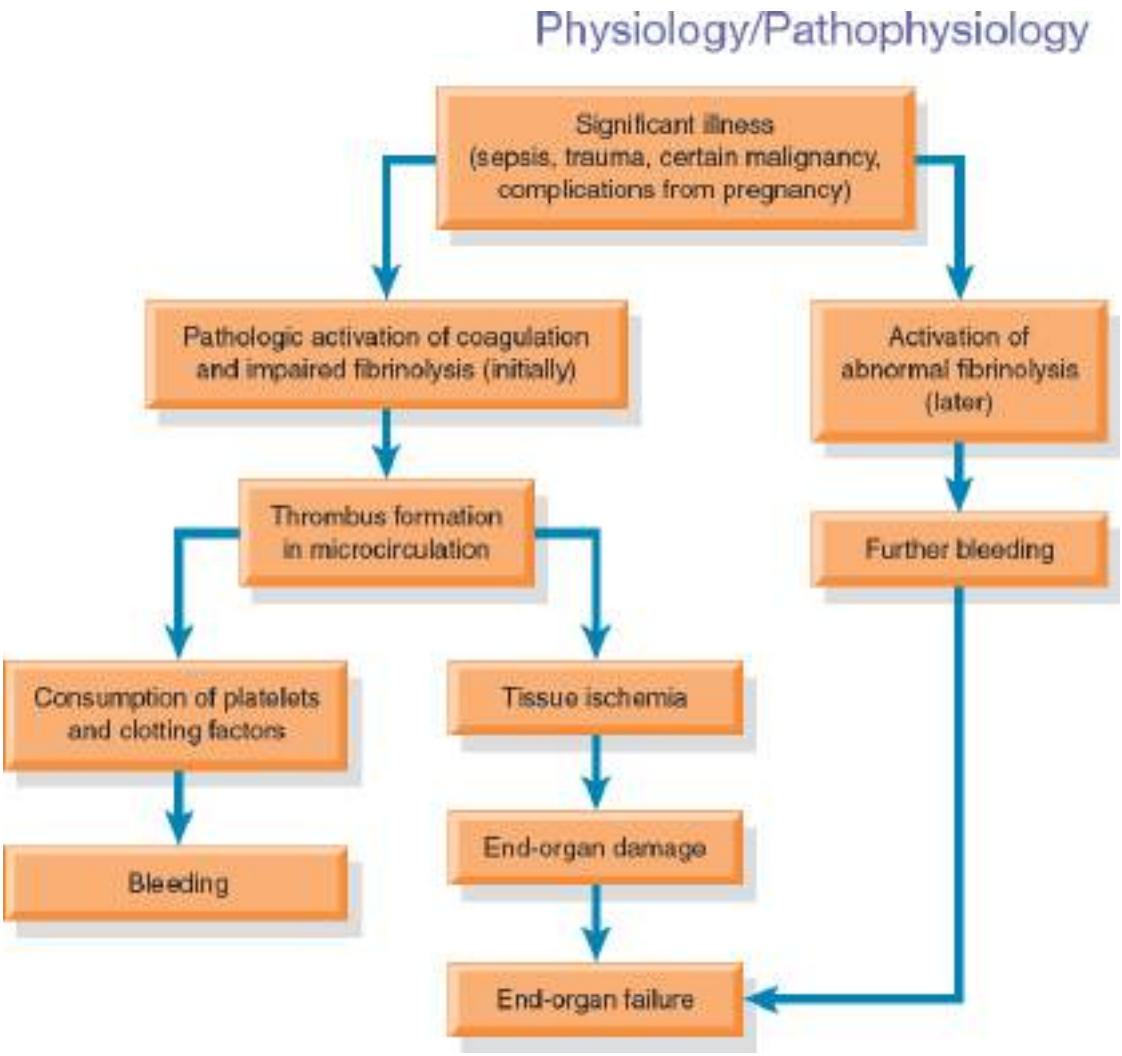

Figure 29-7 • Pathophysiology of disseminated intravascular coagulation.

Chart 29-10 ASSESSMENT

Assessing for Thrombosis and Bleeding in Disseminated Intravascular Coagulation

System	Signs and Symptoms of Microvascular Thrombosis	Signs and Symptoms of Microvascular and Frank Bleeding
Integumentary	↓ Temperature, sensation; ↑ pain; cyanosis in extremities, nose, earlobes; focal ischemia, superficial gangrene	Petechiae, including periorbital and oral mucosa; bleeding: gums, oozing from wounds, previous injection sites, around catheters (IVs, tracheostomies); epistaxis; diffuse ecchymoses; subcutaneous hemorrhage; joint pain
Circulatory	↓ Pulses; capillary filling time >3 seconds	Tachycardia
Respiratory	Hypoxia (secondary to clot in lung); dyspnea; chest pain with deep inspiration; ↓ breath sounds over areas of large embolism	High-pitched bronchial breath sounds; tachypnea; ↑ consolidation; signs and symptoms of acute respiratory distress syndrome
Gastrointestinal	Gastric pain; "heartburn"	Hematemesis (heme⊕ nasogastric output); melena (heme⊕ stools → tarry stools → bright-red blood from rectum); retroperitoneal bleeding (abdomen firm, distended, and tender to palpation; ↑ abdominal girth)
Renal	↓ Urine output; ↑ creatinine, ↑ blood urea nitrogen	Hematuria
Neurologic	↓ Alertness and orientation; ↓ pupillary reaction; ↓ response to commands; ↓ strength and mobility	Anxiety; restlessness; ↓ mentation, altered level of consciousness; headache; visual disturbances; conjunctival hemorrhage

↓, decreased; ↑, increased; heme⊕, positive for hemoglobin; IV, intravenous.

Note: Signs of microvascular thrombosis are the result of an inappropriate activation of the coagulation system, causing thrombotic occlusion of small vessels within all body organs. As the clotting factors and platelets are consumed, signs of microvascular bleeding appear. This bleeding can quickly worsen, becoming frank hemorrhage. Treatment must be aimed at the underlying disorder so that the stimulus for the syndrome is diminished or arrested.

Adapted from Levi, M., & Seligsohn, U. (2016). Disseminated intravascular coagulation. In K. Kaushansky, M. A. Lichtman, J. T. Prchal, et al. (Eds.). *Williams hematology* (9th ed.). New York: McGraw-Hill Medical.

Assessment and Diagnostic Findings

The diagnosis of DIC is frequently made based on laboratory tests that demonstrate the consumption of platelets and clotting factors (see Table 29-4). Although each test is useful in establishing the diagnosis of DIC, the specificity of each individual test is lacking. The International Society of Thrombosis and Haemostasis developed a highly sensitive and specific scoring system using platelet count, fibrin degradation products, PT, and fibrinogen level to diagnose DIC (Levi & Seligsohn, 2016) (see Table 29-5). Additionally, this system is useful in predicting the severity of the disease and subsequent mortality. Additional tests, such as thromboelastography, can be performed at the bedside and can effectively assess platelet function and fibrinolytic activity. Studies suggest that assessment of the status of the coagulation system at the bedside of critically ill patients is more useful than using conventional laboratory tests (Afzal & Syed, 2017).

TABLE 29-4 Laboratory Values Commonly Found in Disseminated Intravascular Coagulation[a]

Test	Function Evaluated	Normal Range	Changes in DIC
Platelet count	Platelet number	150,000–450,000/mm^3	↓
Prothrombin time (PT)	Extrinsic pathway	11–12.5 s	↑
Partial thromboplastin time (activated)(aPTT)	Intrinsic pathway	23–35 s	↑
Thrombin time (TT)	Clot formation	8–11 s	↑
Fibrinogen	Amount available for coagulation	170–340 mg/dL	↓
D-dimer	Local fibrinolysis	0–250 ng/mL	↑
Fibrin degradation products (FDPs)	Fibrinolysis	0–5 mcg/mL	↑
Euglobulin clot lysis	Fibrinolytic activity	≥2 h	≤1 h

[a]Because DIC is a dynamic condition, the laboratory values measured will change over time. Therefore, a progressive increase or decrease in a given laboratory value is likely to be more important than the actual value of a test at a single point in time.

↓, decreased; ↑, increased; DIC, disseminated intravascular coagulation.

Adapted from Fischbach, F. T., & Fischbach, M. A. (2018). *A manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Wolters Kluwer.

TABLE 29-5 Scoring System for Disseminated Intravascular Coagulation

Laboratory Test	0	1	2	3
Platelet count	>100,000/mm³	>50,000/mm³, <100,000/mm³	<50,000/mm³	
Fibrin degradation products	No increase		Moderate increase	Strong increase
Prothrombin time (upper limit of normal)	<3 s	>3 s, <6 s	>6 s	
Fibrinogen	>100 mg/dL	<100 mg/dL		

Note: 5 or more is compatible with overt disseminated intravascular coagulation.
Adapted from Taylor, F. B., Toh, C. H., Hoots, W. K., et al. (2001). Towards a definition, clinical and laboratory criteria, and a scoring system for DIC. *Journal of Thrombosis and Haemostasis, 5*(3), 445–650.

Medical Management

The most critical factor in managing DIC is treatment of the underlying cause; until the cause is controlled, DIC will continue. Correcting the secondary effects of tissue ischemia by increasing tissue oxygenation, replacing fluids, correcting electrolyte abnormalities, and administering vasopressor medications is also important. When serious hemorrhage is present, depleted coagulation factors and platelets are replaced to promote normal hemostasis and reduce bleeding. The extent of hemorrhage and need for any invasive procedure are important considerations in determining the decision to provide transfusion support. Cryoprecipitate is given to replace fibrinogen and factors V and VII (Levi & Seligsohn, 2016).

The use of a heparin infusion to interrupt the thrombosis process is a controversial treatment strategy. Heparin may inhibit the formation of microthrombi and allow improved tissue perfusion to vital organs. Traditionally, heparin has been used in patients with predominantly thrombotic manifestations or in those in whom blood component replacement failed to reduce hemorrhage or increased fibrinogen and other clotting levels. When bleeding is absent, LMWH can be used to prevent VTE, while therapeutic doses may be used when severe thrombosis is predominant. Normalization of plasma fibrinogen and diminished signs of bleeding serve as evidence of heparin's effectiveness. Fibrinolytic inhibitors, such as aminocaproic acid, are not routinely used as they block the lysis of fibrin that is necessary to preserve tissue perfusion. If bleeding is profuse and there is evidence of extensive fibrinolysis, fibrinolytic inhibitors are used along with continuous infusion of IV heparin (Levi & Seligsohn, 2016).

Recombinant forms of thrombomodulin were believed to inactivate thrombin, the main culprit in inciting the coagulopathy that undergirds DIC. However, a systematic review of clinical trials found no improvement in mortality rates with patients with DIC who were prescribed recombinant thrombomodulin (Murao & Yamakawa, 2019). All management strategies must be individualized to the specific patient, underlying cause of DIC, and response to interventions.

Nursing Management

Nurses need to identify patients at risk for DIC (see previous discussion on precipitating factors). It is important to assess patients frequently and thoroughly for signs and symptoms of thrombi and bleeding and monitor for progression of these signs (see Chart 29-10). Laboratory values must be monitored frequently to assess for trends over time as well as for changes in values.

Chart 29-11 describes care of the patient with DIC. Assessment and interventions should target potential sites of end-organ damage. As organs become ischemic from microthrombi, organ function diminishes; the kidneys, lungs, brain, and skin are particularly vulnerable. Lack of renal perfusion may result in acute tubular necrosis and kidney injury, sometimes requiring dialysis. Placement of a large-bore dialysis catheter is extremely hazardous for this patient population and should be accompanied by adequate platelet and plasma transfusions. Hepatic dysfunction is also relatively common, reflected in altered liver function tests, depleted albumin stores, and diminished synthesis of clotting factors. Respiratory function warrants careful monitoring and aggressive measures to diminish alveolar compromise. Suctioning should be performed as gently as possible to diminish the risk of additional bleeding. CNS involvement can be manifested as headache, visual changes, and alteration in level of consciousness.

Secondary Thrombocytosis

Increased platelet production is the primary mechanism of secondary or reactive **thrombocytosis**, characterized by an elevation in the platelet count. However, these elevations are rarely above 1 million/mm^3. This is in contrast to essential thrombocytosis which is a chronic myeloproliferative disease (see Chapter 30). In secondary thrombocytosis, platelet function and survival are typically normal; therefore, hemorrhage and thrombosis are rare (Kaushansky, 2016). A number of disorders are associated with a reactive increase in platelets, including infection, iron deficiency anemia, chronic inflammatory disorders, malignancy, acute hemorrhage, and splenectomy. Treatment is directed at the underlying disorder. When managed successfully, the platelet count often returns to normal.

THROMBOTIC DISORDERS

Several conditions can affect the balance of normal hemostasis, causing excessive thrombosis that can alter arterial or venous circulation. Arterial thrombosis is caused by platelet aggregation, while venous thrombosis is a result of accumulation of platelets, red blood cells, and thrombin. Abnormalities that predispose a person to thrombotic events include decreased clotting inhibitors in the circulation, impaired liver function, lack of fibrinolytic enzymes, and vascular abnormalities that promote platelet aggregation. Thrombosis may also occur as the initial manifestation of an occult malignancy or as a complication of a previously diagnosed cancer. In some cases, more than one precipitating factor exists. There are several inherited or acquired disorders, including hyperhomocysteinemia, antithrombin (AT) deficiency, protein C deficiency, protein S deficiency, activated protein C (APC) resistance, and factor V Leiden deficiency that can predispose patients to repeated episodes of thrombosis. These are also referred to as hypercoagulable states or thrombophilia. Inherited disorders should prompt a referral for familial genetic testing. Genetic testing is not indicated with acquired disorders.

Chart 29-11 PLAN OF NURSING CARE

The Patient with Disseminated Intravascular Coagulation

NURSING DIAGNOSIS: Risk for hypovolaemia associated with bleeding
GOAL: Hemodynamic status maintained; urine output ≥0.5 mL/kg/h over 6 hours or <400 mL in 24 hours

Nursing Interventions	Rationale	Expected Outcomes
1. Avoid procedures/activities that can increase intracranial pressure (e.g., coughing, straining to have a bowel movement).	1. Prevents intracranial bleeding	• Level of consciousness (LOC) stable • Central venous pressure 5–12 cm H_2O, systolic blood pressure ≥70 mm Hg • Urine output ≥0.5 mL/kg/h • Decreased bleeding • Decreased oozing • Decreased ecchymoses • Amenorrhea • Absence of oral and bronchial bleeding • Oral mucosa clean, moist, intact
2. Monitor vital signs closely, including neurologic checks: a. Monitor hemodynamics. b. Monitor abdominal girth. c. Monitor urine output.	2. Identifies signs of hemorrhage/shock as soon as possible	
3. Avoid medications that interfere with platelet function if possible (e.g., aspirin, nonsteroidal anti-inflammatory drugs, beta-lactam antibiotics).	3. Decreases problems with platelet aggregation and adhesion	
4. Avoid rectal probes, rectal medications.	4. Decreases risk of rectal bleeding	
5. Avoid intramuscular injections.	5. Decreases risk of intramuscular bleeding	
6. Monitor amount of external bleeding carefully: a. Monitor number of dressings, percentage of dressing saturated; time to saturate a dressing is more	6. a. Provides accurate, objective assessment of extent of bleeding	

objective than "dressing saturated a moderate amount." b. Assess suction output, all excreta for frank or occult blood. c. Monitor pad counts in women with vaginal bleeding. d. Women may receive progesterone to prevent menses. 7. Use low pressure for any necessary suctioning. 8. Administer oral hygiene carefully. a. Avoid lemon-glycerin swabs, hydrogen peroxide, commercial mouthwashes. b. Use sponge-tipped swabs, salt/baking soda (bicarbonate of soda) mouth rinses. 9. Avoid dislodging any clots, including those around IV sites and injection sites.	b. Identifies presence of or quantifies extent of bleeding c. Quantifies extent of bleeding d. Decreases risk of bleeding from gynecologic source 7. Prevents excessive trauma that can cause additional bleeding 8. Prevents excessive trauma that can cause bleeding. Glycerin and alcohol (in commercial mouthwashes) dry the mucosa, increasing risk for bleeding. 9. Reduces risk for excessive bleeding from sites	

NURSING DIAGNOSIS: Risk for impaired skin integrity associated with ischemia or bleeding

GOAL: Skin integrity remains intact; oral mucosa remains intact

Nursing Interventions	Rationale	Expected Outcomes

1. Assess skin, with particular attention to bony prominences, skin folds.	1. Prompt identification of any area of risk for skin breakdown or showing early signs of breakdown can prompt early intervention and reduce complications.	• Skin integrity remains intact; skin is warm, and of normal color. • Oral mucosa is intact, pink, moist, without bleeding.
2. Reposition carefully; use pressure-reducing mattress.	2–4. Meticulous skin care and use of measures to prevent pressure on bony prominences decreases risk of skin trauma.	
3. Perform careful skin care every 2 hours, emphasizing dependent areas, all bony prominences, and perineum.		
4. Use lamb's wool between digits, around ears, as needed.		
5. Use prolonged pressure (at least 5 minutes) after injection or procedure when such measures must be performed.	5. Initial platelet plug is very unstable and can be easily dislodged, which can lead to increased bleeding.	
6. Perform oral hygiene carefully (see previous discussion).	6. Meticulous care is needed to decrease trauma, bleeding, and risk of infection.	

NURSING DIAGNOSIS: Fluid imbalance associated with excessive blood and/or factor component replacement

GOAL: Absence of edema; absence of crackles; intake not greater than output

Nursing Interventions	Rationale	Expected Outcomes
1. Auscultate breath sounds every 2–4 hours.	1. Crackles can develop quickly.	• Breath sounds clear

2. Monitor extent of edema. 3. Monitor volume of IV fluids, blood products; decrease volume of IV medications if indicated. 4. Administer diuretics as prescribed.	Fluid may extend 2. beyond intravascular space. 3. Helps prevent fluid overload 4. Decreases excess fluid volume	• Absence of edema • Intake does not exceed output • Weight stable

NURSING DIAGNOSIS: Risk for injury associated with microthrombi
GOAL: Neurologic status remains intact; absence of hypoxemia; peripheral pulses remain intact; skin integrity remains intact; urine output remains ≥0.5 mL/kg/h over 6 hours and >400 mL in 24 hours

Nursing Interventions	Rationale	Expected Outcomes
1. Assess neurologic, pulmonary, integumentary systems. 2. Monitor response to heparin therapy. 3. Assess extent of bleeding. 4. Monitor fibrinogen levels. 5. Stop aminocaproic acid, if prescribed, if symptoms of thrombosis occur.	1. Initial signs of thrombosis may be subtle. 2. Assure anticoagulation effectiveness that may prevent formation of additional thromboses. 3. Objective measurements of all sites of bleeding are crucial to accurately assess extent of blood loss. 4. Response to heparin is most accurately reflected in fibrinogen level. 5. Aminocaproic acid should be used only in the setting of extensive hemorrhage not	• Arterial blood gases, O_2 saturation, pulse oximetry, LOC within normal limits • Breath sounds clear • Absence of edema • Intake does not exceed output • Weight stable

	responding to replacement therapy.	
NURSING DIAGNOSIS: Anxiety associated with uncertain prognosis and risk for death **GOAL:** Feelings identified/verbalized; realistic hope maintained		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Identify previous coping mechanisms, if possible; encourage patient to use them as appropriate. 2. Explain all procedures and their rationale in terms that the patient and family/significant others can understand. 3. Assist family in supporting patient. 4. Use services from behavioral health, chaplain as needed.	1. Identifying previous stressful situations can aid in recall of successful coping mechanisms. 2. Decreased knowledge and uncertainty can increase anxiety. 3. Family/significant others can be valuable in assisting the patient to use coping strategies and to maintain hope. 4. An interdisciplinary approach may be warranted, particularly when coping strategies are maladaptive or ineffective. The spiritual dimension of care may be especially important in a crisis.	• Previously used coping strategies are identified and utilized, to the extent the patient is able to do so. • Patient and family indicate understanding of procedures as situation permits.

LOC, level of consciousness.

Thrombotic disorders require anticoagulation therapy; the duration of therapy varies with the location and extent of thrombosis, precipitating events (e.g., trauma, immobility), and any concurrent risk factors (e.g., use of oral

contraceptives, obesity, tobacco use, integrity of blood vessels, previous thrombotic events; see Table 29-6). Conditions that may result from thrombosis include ACS (see Chapter 23), ischemic stroke (see Chapter 62), and occlusive peripheral arterial disease (see Chapter 26). With some conditions, or with repeated thrombosis, lifelong anticoagulation may be required.

TABLE 29-6 Risk Factors for Thrombosis

Acquired	Inherited	Mixed/Unknown
Advanced age	Antithrombin deficiency	Activated protein C resistance
Antiphospholipid antibody syndrome	Factor V Leiden	↑ Factor VII
Atrial fibrillation	Factor XII deficiency	↑ Factor VIII
Diabetes	Protein C deficiency	↑ Factor IX
Drugs (e.g., cocaine, ergot)	Protein S deficiency	↑ Factor XI
Estrogen therapy	Prothrombin 20210[a]	↓ Fibrinolytic activity
Hypertension		↑ Homocysteine
Inflammatory bowel disease		
Immobility		
Lupus anticoagulant		
Major surgery		
Myeloproliferative disease		
Nephrotic syndrome		
Obesity		
Paralysis		
Pregnancy/postpartum period		
Prior stroke		
Prior superficial vein thrombosis		
Smoking		
Trauma/fracture		
Vascular access devices		

Note: Risk factors for first, unprovoked venous thromboembolism. Note that the factor levels that are increased are procoagulant proteins.

↑, increased; ↓, decreased.

Adapted from Koupenova, M., Kehrel, B. E., Corkerey, H. A., & Freedman, J. E. (2016). Thrombosis and platelets: An update. *European Heart Journal*, *38*(11), 785–791.

Hyperhomocysteinemia

Homocysteine is known to promote platelet aggregation. When hyperhomocysteinemia is present, the endothelial lining of blood vessels are denuded, which can lead to thrombus formation, specifically VTE (e.g., DVT, PE) and arterial thrombosis (e.g., ischemic stroke, ACS); however, the evidence available does not clearly identify homocysteine as a causal factor.

Research suggests that the mechanisms through which hyperhomocysteinemia causes vascular disease are more complex than an increase in homocysteine alone (Ospina-Romero, Cannegieter, den Heijer, et al., 2018).

Hyperhomocysteinemia can be hereditary but may also occur as a result of folate deficiency, and to a lesser degree, deficiency of vitamins B_6 and B_{12}. These nutrients are cofactors in homocysteine metabolism. Additionally, for reasons that are unclear, older adults and those with kidney injury may also have elevated homocysteine levels without vitamin deficiency (Ostrakhovich & Tabibzadeh, 2019). While a fasting measurement of plasma homocysteine can be useful for screening in some cases, levels may be normal or slightly elevated in people with inherited hyperhomocysteinemia or those with vitamin B_6 deficiency. A more sensitive method of measurement involves obtaining a second measurement 4 hours after consumption of methionine; hyperhomocysteinemia is found more often using this method. Supplemental use of folic acid, vitamin B_{12}, or vitamin B_6 has not been shown to be effective in reducing the recurrence of venous or arterial thromboemboli (Middeldorp & Coppens, 2016). Smoking is associated with reduced levels of vitamin B_6, vitamin $B_{12,}$ and folate, making smoking cessation an important goal for patients with known hyperhomocysteinemia.

Antithrombin Deficiency

AT is a protein that inhibits thrombin and certain coagulation factors. It may also play a role in reducing inflammation within the endothelium of blood vessels. AT deficiency can be acquired by four mechanisms: accelerated consumption of AT (as in DIC); decreased synthesis of AT (as in hepatic dysfunction); increased excretion of AT (as in nephrotic syndrome); and medication induced (e.g., estrogens) (Bunn & Bauer, 2017). However, AT deficiency is most often an inherited condition that can lead to venous thrombosis, especially when AT levels are less than 60% of normal. The most common sites of thrombosis are the deep veins in the legs and within the mesentery. Recurrent thrombosis can occur, particularly as patients age. Patients with AT deficiency may exhibit heparin resistance and therefore require greater doses of heparin to achieve adequate anticoagulation. Patients with AT deficiency should encourage their family members to be tested for the condition.

Protein C Deficiency

Protein C is a vitamin K–dependent enzyme synthesized in the liver that, when activated, inhibits coagulation. When protein C levels are low, the risk for

thrombosis increases and thrombosis may occur spontaneously. People with protein C deficiency are often asymptomatic until they reach adulthood; the risk for thrombosis then increases with age. A rare but important complication for patients with protein C deficiency receiving warfarin for anticoagulation is warfarin-induced skin necrosis. This condition is believed to be a result of progressive thrombosis of capillaries in the skin. The degree of necrosis can be quite extensive (Bunn & Bauer, 2017). Prompt recognition of the problem with immediate cessation of the warfarin, along with treatment with vitamin K, heparin, and fresh-frozen plasma infusions are needed to arrest the pathophysiologic process and reverse the effects of warfarin. Treatment with purified protein C concentrate may be necessary.

Protein S Deficiency

Protein S is another natural anticoagulant normally produced by the liver. APC requires protein S to inactivate certain clotting factors. When the level of protein S is deficient, this inactivation process is diminished and the risk of thrombosis increases. As with protein C deficiency, patients with protein S deficiency have a greater risk for recurrent venous thrombosis early in life, including risk for PE (Bunn & Bauer, 2017).

Thromboses frequently occur in axillary, mesenteric, and cerebral veins. Warfarin-induced skin necrosis is also possible with protein S deficiency. A number of conditions may lead to acquired protein S deficiency including pregnancy, DIC, liver disease, nephritic syndrome, HIV infection, and the use of L-asparaginase.

Activated Protein C Resistance and Factor V Leiden Mutation

APC resistance is a common condition that can occur with other hypercoagulable states. APC is an anticoagulant, and resistance to APC increases risk for venous thrombosis. A defect in the factor V gene has been identified in 90% of patients with APC resistance. This factor V Leiden mutation is the most common cause of inherited hypercoagulability in Caucasians; its incidence appears to be much lower in other ethnic groups (Bunn & Bauer, 2017; Middeldorp & Coppens, 2016). The risk of thrombosis significantly increases when factor V Leiden mutation is paired with other risk factors (e.g., increased age, use of oral contraceptives, hyperhomocysteinemia). People who are homozygous for factor V Leiden mutation are at extreme risk for thrombosis and therefore require lifelong anticoagulation. In contrast, those who are heterozygous for the mutation have

a lower risk for developing a thrombus. The duration of anticoagulation is based on the coexistence of other risk factors for thrombus formation.

Antiphospholipid Antibody Syndrome

Antibodies to phospholipids are common causes of thrombophilia; up to 5% of the general population may have this disorder. These antibodies reduce levels of annexin V, a protein that binds to phospholipids and has anticoagulant activity. The most common of the antiphospholipid antibodies are lupus and anticardiolipin antibodies, or an antibody to beta-2 glycoprotein (Rand & Wolgast, 2016). Antiphospholipid antibody syndromes are classified as primary or secondary, with a reaction secondary to a preexisting autoimmune disease, with systemic lupus erythematosus being most frequently implicated. Primary antiphospholipid antibody syndrome is associated with a number of infections including hepatitis C, HIV, syphilis and malaria as well as certain medications (e.g., antibiotics, quinine, hydralazine, procainamide); a genetic predisposition to this syndrome has been postulated but has not been proven. Antiphospholipid antibodies are associated with multiple miscarriages and are strongly associated with stroke (Heuser & Branch, 2019). Most thromboses are venous, but arterial thrombosis is also possible in up to one third of patients with this syndrome. Recurrent thromboses tend to occur in the same fashion, with recurrent venous thrombosis after an initial venous presentation and recurrent arterial thromboses after an initial arterial thrombosis. Thrombi typically occur in large vessels. Therapy varies depending on the type of syndrome (e.g., secondary forms caused by autoimmune disorders may be treated with immunosuppressive therapy), history of prior thrombosis, and location of the thrombus (venous or arterial). Arterial thrombosis is often treated by adding low-dose aspirin to some form of heparin therapy (see later discussion).

Malignancy

Cancers, particularly stomach, pancreatic, lung, and ovarian cancers, are often associated with thrombophilia with significant risk for VTE. VTE contributes to morbidity and mortality of patients with cancer, with a fatal PE being three times more common in patients with cancer than in those without cancer. Patients with cancer have a five- to sevenfold increased risk of developing VTE, and those who develop VTE at diagnosis of cancer or within a year of diagnosis tend to have a significantly worse prognosis than patients with cancer without VTE. A diagnosis of VTE is a serious complication of cancer that adversely affects a patient's quality of life and reduces overall survival.

Anticoagulation may be difficult to manage and thromboses can progress despite adequate doses of anticoagulants. LMWH may be more effective than warfarin in treating this group of patients (Razak, Jones, Bhandari, et al., 2018).

Medical Management

The primary treatment for thrombotic disorders is anticoagulation. However, when to treat and how long to treat with anticoagulant medications is controversial. Anticoagulation therapy is not without risk, with the most significant risk of bleeding. Anticoagulant medications used to treat a variety of thromboses are discussed in Chapter 26.

Nursing Management

Patients with thrombotic disorders should be counseled to avoid activities that lead to circulatory stasis (e.g., immobility, crossed legs). Exercise, especially ambulation, should be performed frequently throughout the day, especially during long trips by car or plane. Anti-embolism stockings may be prescribed and patients often need instruction in how to use them properly. Surgery increases risk for thrombosis significantly.

Medications that alter platelet aggregation, such as low-dose aspirin or clopidogrel, may be prescribed. Some patients require lifelong anticoagulation therapy.

Patients with thrombotic disorders, particularly those with thrombophilia, should be evaluated for concurrent risk factors for thrombosis and should avoid them whenever possible. For example, products containing tobacco and nicotine should be avoided, blood pressure should be controlled, and alcohol consumption limited. In some instances, younger patients with thrombophilia may not need prophylactic anticoagulation, but when concomitant risk factors (e.g., pregnancy), increasing age, or subsequent thrombotic events are present, prophylactic or long-term anticoagulation therapy may be needed. Being able to provide the health care provider with an accurate health history can be extremely useful and help in guiding the selection of the appropriate interventions. Patients need to be aware of risk factors for thrombosis and how they can be reduced or eliminated, such as avoiding tobacco, using alternative forms of contraception, avoiding immobility, and maintaining a healthy weight. Patients with hereditary disorders should encourage their siblings and children to be tested for the disorder.

When a patient with a thrombotic disorder is hospitalized, frequent assessment should be performed to promote early recognition of signs and symptoms of thrombus formation, particularly in the legs (DVT) and lungs (PE). Ambulation or range-of-motion exercises as well as anti-embolism

stockings or sequential compression devices are used to decrease venous stasis.

CRITICAL THINKING EXERCISES

1 pq A 72-year-old man presents to the emergency department complaining of acute shortness of breath and chest pain. He reports increasing fatigue, exertional dyspnea, dull abdominal pain, and weight loss over the last few months. His CBC reveals a normal WBC count and platelet count; however, the hemoglobin is 7.2 mg/dL and the hematocrit is 22.3%. The MCV is reduced. Iron deficiency anemia is suspected. What are your priority interventions targeted at relieving the patient's symptoms? What other medical interventions do you anticipate might be prescribed? What additional laboratory tests do you anticipate for this patient?

2 ipc A 23-year-old female patient with sickle cell disease tells you during a routine office visit that she would like to become pregnant. Her condition has been well controlled with hydroxyurea. She takes ibuprofen on a regular basis for chronic pain. What additional information should you collect in the patient history? What challenges do you anticipate in caring for this patient? What other members of the interdisciplinary team do you think should be consulted to be part of the patient's prenatal care?

3 ebp Your 44-year-old female neighbor tells you that her brother has been "nagging her" to get tested for hemochromatosis since he was diagnosed with this disease a few months ago. Her brother has periodic therapeutic phlebotomies to treat his disease, and she feels her lifestyle is too busy to support these types of treatments. She tells you that she "feels fine" and wonders how likely it is that she has hemochromatosis, and if she does, whether treatment would be needed. What are the risks for hemochromatosis? If your neighbor does have hemochromatosis, what is the strength of the evidence for best treatment options for her?

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

American Association of Blood Banks (AABB), www.aabb.org
American Hemochromatosis Society, www.americanhs.org
American Red Cross, www.redcross.org
American Society for Transplantation and Cellular Therapy, www.asbmt.org/home
Aplastic Anemia and MDS International Foundation, www.aamds.org
APS Foundation of America (antiphospholipid syndrome), www.apsfa.org
G6PD Deficiency, www.g6pd.org
National Heart, Lung, and Blood Institute, www.nhlbi.nih.gov

National Marrow Donor Program, www.bethematch.org
Platelet Disorder Support Association (PDSA), www.pdsa.org
Sickle Cell Disease Association of America (SCDAA), www.sicklecelldisease.org

30 Management of Patients with Hematologic Neoplasms

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Compare and contrast the different types of leukemias in terms of their incidence, physiologic alterations, clinical manifestations, complications, and medical and nursing management.
2. Use the nursing process as a framework for care of the patient with acute leukemia.
3. Explain the differences between the various myeloproliferative disorders in terms of their incidence, physiologic alterations, clinical manifestations, complications, and medical and nursing management.
4. Compare and contrast Hodgkin and non-Hodgkin lymphomas in terms of their incidence, physiologic alterations, clinical manifestations, complications, and medical and nursing management.
5. Discuss medical and nursing care of the patient with multiple myeloma.

NURSING CONCEPTS

Cellular Regulation
Clotting

GLOSSARY

absolute neutrophil count (ANC): a calculation of the number of circulating neutrophils, derived from the total white blood cells (WBCs) and the percentage of neutrophils counted in a microscope's visual field

angiogenesis: formation of new blood vessels

apoptosis: programmed cell death

blast cells: immature leukocytes

clone: proliferation from same cell of origin so that descendent cells are identical to the cell of origin

cytokines: proteins produced by leukocytes that are vital to regulation of hematopoiesis, apoptosis, and immune responses; also called *biochemical* or *inflammatory mediators*

erythrocyte sedimentation rate (ESR): laboratory test that measures the rate of settling of red blood cells (RBCs); elevation is indicative of inflammation; also called the *sed rate*

erythromelalgia: a burning, painful sensation and erythema in the fingers or toes

hematopoiesis: complex process of the formation and maturation of blood cells

indolent: when in reference to a neoplasm refers to a slow-growing cancer that often remains localized or causes few symptoms

leukemia: uncontrolled proliferation of WBCs, often immature

lymphadenopathy: enlargement of a lymph node or lymph nodes

lymphoid: pertaining to lymphocytes

myeloid: pertaining to nonlymphoid blood cells that differentiate into RBCs, platelets, macrophages, mast cells, and various WBCs

neutropenia: lower-than-normal number of neutrophils

pancytopenia: abnormal decrease in WBCs, RBCs, and platelets

petechiae: tiny capillary hemorrhages

phagocytosis: process of cellular ingestion and digestion of foreign bodies

reticulocytes: slightly immature RBCs, usually only 1% of total circulating RBCs

splenomegaly: enlargement of the spleen

stem cell: primitive cell, capable of self-replication and differentiation into myeloid or lymphoid stem cell

thrombocythemia: higher-than-normal platelet count that occurs without a known cause

thrombocytopenia: lower-than-normal platelet count

thrombocytosis: higher-than-normal platelet count that results because of a disease or disorder

Hematopoiesis is the process by which all blood cells develop, differentiate, and mature. This process starts with the hematopoietic stem cells (HSC) in the bone marrow. As these **stem cells** divide, they are delineated into one of two cell pathways, to become lymphoid or myeloid progenitor cells. The myeloid stem cells then differentiate into red blood cells, white blood cells (WBCs), and platelets, while the lymphoid stem cells differentiate into B and T lymphocytes. Normally, the differentiation of these progenitor cells is regulated according to the body's need. However, when the mechanisms that control the production of these cells is disrupted or impaired, the cells can proliferate uncontrollably, leading to the development of a hematologic malignancy. The pathophysiologic processes for the development of hematologic malignancies are complex. Understanding these processes and the rationale for treatments is important so that nurses may appropriately assess, monitor, educate, and intervene with patients with hematologic neoplasms.

Hematopoietic malignancies are classified by the specific blood cells involved. **Leukemia** is a neoplastic proliferation of a particular cell type (granulocytes, lymphocytes, or infrequently erythrocytes or megakaryocytes). This proliferation leads to an overcrowding in the bone marrow resulting in impaired hematopoietic cell function and can affect other organs in the body (i.e., lymph nodes, skin, and spleen) (Leukemia & Lymphoma Society, 2018b). The defect originates in the HSC, the myeloid, or the lymphoid stem cell. Lymphomas are neoplasms of lymphoid tissue, usually derived from B lymphocytes. Multiple myeloma is a malignancy of the most mature form of B lymphocyte—the plasma cell.

CLONAL STEM CELL DISORDERS

A key feature of hematologic malignancies is the increased proliferation of blood cells from an abnormal single HSC, known as clonal hematopoiesis. Despite this increase in proliferation, the clonal HSCs continue to differentiate, leading to increased myeloid cells, erythroid cells, and platelets in the peripheral blood as well as hyperplasia in the bone marrow (Leukemia & Lymphoma Society, 2018b). Figure 30-1 illustrates how hematopoietic malignancies develop and whether they are derived from the myeloid or lymphoid stem cells (Leukemia & Lymphoma Society, 2019f).

LEUKEMIA

The term *leukocytosis* refers to an increase of leukocytes (WBCs) in the circulation. Typically, only one specific cell type is increased. Because the proportions of several types of leukocytes (e.g., eosinophils, basophils, monocytes) are small, an increase in other types can be great enough to elevate the total leukocyte count, particularly the neutrophils or lymphocytes. Although leukocytosis can be a normal response to increased need (e.g., in acute infection), the elevation in leukocytes should decrease as the physiologic need decreases. A prolonged or progressively increasing elevation in leukocytes is abnormal and should be evaluated. A significant cause of persistent leukocytosis is a hematologic malignancy (i.e., leukemia).

The common feature of the leukemias is an unregulated proliferation of leukocytes in the bone marrow. In acute forms (or late stages of chronic forms), the proliferation of leukemic cells leaves little room for normal cell production. There can also be a proliferation of cells in the liver and spleen (extramedullary hematopoiesis). With acute forms, there can be infiltration of leukemic cells in other organs, such as the meninges, lymph nodes, gums, and skin. The cause of leukemia is not fully known, but exposure to radiation or chemicals, certain genetic disorders, and viral infections are known to be risk factors for certain types of leukemia. Bone marrow damage from pelvic radiation or certain types of chemotherapy drugs can cause acute leukemia, typically occurring years after treatment for another malignancy (Leukemia & Lymphoma Society, 2018b).

The leukemias are commonly classified according to the stem cell line involved, either **lymphoid** (referring to stem cells that produce lymphocytes) or **myeloid** (referring to stem cells that produce nonlymphoid blood cells). They are also classified as either acute or chronic, based on the time it takes for symptoms to evolve and the phase of cell development that is halted (i.e., with few leukocytes differentiating beyond that phase).

In acute leukemia, the onset of symptoms is abrupt, often occurring within a few weeks. Leukocyte development is halted at the blast phase, and thus most leukocytes are undifferentiated cells or blasts. Acute leukemia can progress rapidly, with death occurring within weeks to months without aggressive treatment.

In chronic leukemia, symptoms evolve over a period of months to years, and the majority of leukocytes produced are mature. Chronic leukemia progresses more slowly; the disease trajectory can extend for years.

Acute Myeloid Leukemia

Acute myeloid leukemia (AML) originates due to a series of genetic mutations in the myeloid HSC leading to clonal development of abnormal blast cells (National Comprehensive Cancer Network [NCCN], 2019a). As these **blast**

cells (i.e., immature leukocytes) continue to proliferate, they crowd out normal bone marrow production resulting in anemia, **thrombocytopenia** (i.e., low platelet count), and either low or elevated WBC counts (rarely, the WBC may be within normal range). There is also impaired development of all myeloid cells: monocytes, granulocytes (i.e., neutrophils, basophils, eosinophils), erythrocytes, and platelets.

AML is the most common form of leukemia, as well as most common cause of death from all leukemias. AML can affect any age group. However, the incidence of this disease increases with age, with the median age at time of diagnosis being about 68 years (Leukemia & Lymphoma Society, 2019a). On an annual basis, AML accounts for approximately 1% of all cancer-related deaths (NCCN, 2019a).

The exact cause of AML is unclear, but there are several known risk factors. In addition to increasing age, males have a higher incidence than females. Other risks include having been exposed to chemicals such as benzene or pesticides or exposed to ionizing radiation; and a history of prior treatment with chemotherapeutic drugs, such as alkylating agents or topoisomerase inhibitors, tobacco smoking, other blood disorders (e.g., myeloproliferative diseases), and several genetic disorders (e.g., Down syndrome, Trisomy 8, or Fanconi anemia) (Leukemia & Lymphoma Society, 2019a).

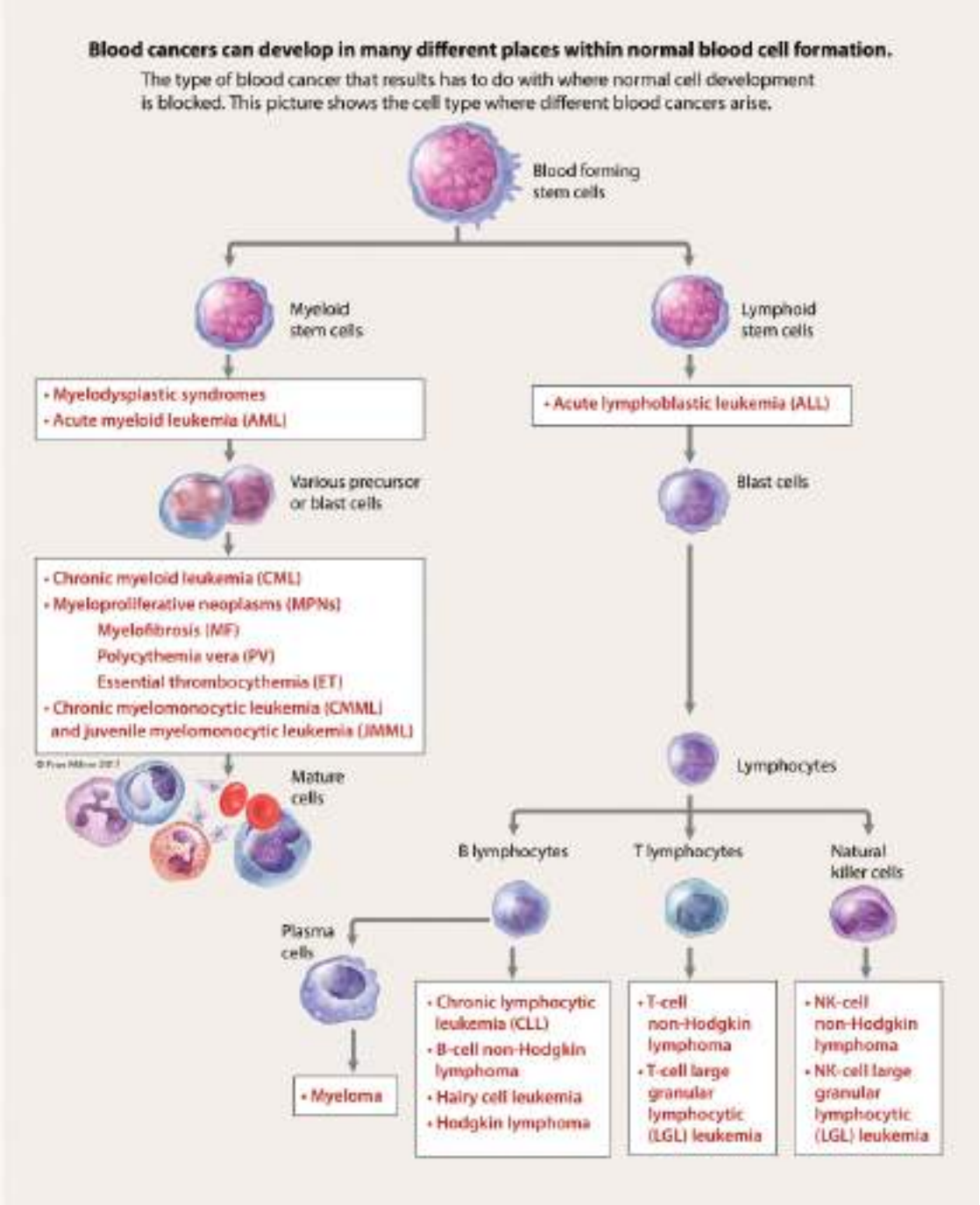

Figure 30-1 • The development of myeloid and lymphoid neoplasms. Hematologic malignancies can occur when normal cell develop is inhibited. © Fran Milner 2017.

The prognosis and survival rates are highly variable. Factors influencing a more positive outcome are younger age at diagnosis, more favorable cytogenetic alterations (which are strongly associated with younger age), and few concurrent (or mild) health problems. In contrast, patients with significant comorbidities, of older age, with cytogenetic features deemed to be adverse, or who are frail, are more likely to have a poor prognosis. AML evolving from a

preexisting clonal myeloid disease or from prior cytotoxic therapy for another malignancy or immune disease is associated with a poorer prognosis and less favorable outcomes (NCCN, 2019a).

Figure 30-2 • Gingival infiltration of leukemic cells in a patient with acute myeloid leukemia. Reprinted with permission from Greer, J. P., Foerster, J., Rodgers, G. M., et al. (2009). *Wintrobe's clinical hematology* (12th ed., Fig. 72.8, p. 1680). Philadelphia, PA: Lippincott Williams & Wilkins.

Clinical Manifestations

AML often presents, initially, as nonspecific complaints that can abruptly occur or gradually worsen over time. The signs and symptoms result from inadequate production of normal blood cells, especially as the leukemic cells increasingly crowd out the bone marrow. Symptoms due to **neutropenia** (low neutrophil count) include fever and infection. Symptoms related to anemia include pallor, fatigue, weakness, dyspnea on exertion, and dizziness. Symptoms reflective of thrombocytopenia include ecchymoses (bruises), **petechiae** (pinpoint red or purple hemorrhagic spots on the skin), epistaxis (nosebleeds), and gingival bleeding. The proliferation of leukemic cells within organs leads to a variety of additional symptoms: pain from an enlarged liver or spleen, hyperplasia of the gums, and bone pain from expansion of marrow (see Fig. 30-2). Petechiae or ecchymoses are common on the skin (see Chapter 29, Fig. 29-4); occasionally, leukemic infiltrates are also seen (see Fig. 30-3). Leukemic cells can also infiltrate the gingiva or synovial spaces of joints. **Lymphadenopathy** (enlargement of lymph nodes) or **splenomegaly**

(enlargement of the spleen) is rare. Fevers may occur and are not always due to infection.

Assessment and Diagnostic Findings

To confirm the diagnosis of AML, laboratory studies need to be performed. The complete blood count (CBC) commonly shows a decrease in both erythrocytes and platelets. Although the total leukocyte count can be low, normal, or high, the percentage of normal cells is usually vastly decreased. A bone marrow analysis shows an excess (more than 20%) of blast cells (Arber, Orazi, Hasserjian, et al., 2016); this is the hallmark of the diagnosis.

AML can be further classified into seven different subgroups, based on cytogenetics, histology, and morphology of the blasts, as well as the presence of genetic mutations. The actual prognosis varies somewhat between subgroups and with the extent of cytogenetic abnormalities and genetic mutations, yet the clinical course and treatment differ substantially with only one subtype. That is, patients with the specific AML subtype acute promyelocytic leukemia (APL, or AML-M3) have higher potential for fatal coagulopathies; however, the potential to cure this form of AML is high (NCCN, 2019a).

Figure 30-3 • Leukemia cutis. Infiltration of leukemic cells in skin on extensor surface of forearms. Reproduced with permission from Stedman's Medical Dictionary. Copyright 2008 Lippincott Williams & Wilkins.

Medical Management

The overall objective of treatment for AML is to achieve complete remission of the disease, in which there is no residual leukemic cells in the bone marrow or peripheral blood. To obtain remission, chemotherapy treatment is administered in two parts: *induction* and *consolidation*. The choice of agents for induction therapy is based on the patient's age, physical status, and history of prior antineoplastic treatment. Induction therapy typically involves high doses of cytarabine and either daunorubicin, idarubicin, or mitoxantrone; etoposide is occasionally added to the regimen. Older patients (especially those older than 70 years) or those unable to tolerate standard therapy (in poor health) may receive lower-intensity therapy (using hypomethylating agents, low doses of cytarabine, or hydroxyurea), which may extend survival without a significant increase in toxicity beyond that of the underlying disease (NCCN, 2019a).

During induction therapy, chemotherapy not only destroys leukemic cells, but also healthy cells, requiring patients to be hospitalized for several weeks (typically 4 to 6 weeks) due to severe and potentially life-threatening side effects, such as neutropenia. For some patients, an **absolute neutrophil count (ANC**; a calculation of the number of circulating neutrophils, derived from the total WBCs and the percentage of neutrophils counted in a microscope's visual field) of zero is not uncommon (see Chapter 12 for formula used to calculate the ANC). Anemia, and severe thrombocytopenia (a platelet count of less than 5000/mm^3), is also common. During this time, the patient is typically very ill, with bacterial, fungal, and occasionally viral infections; bleeding; and severe mucositis, which cause pain, diarrhea, and an inability to maintain adequate nutrition. Management consists of administering blood products (packed red blood cells [PRBCs] and platelets) and promptly treating infections. The use of granulocytic growth factors, either granulocyte colony-stimulating factor (G-CSF; filgrastim) or granulocyte-macrophage colony-stimulating factor (GM-CSF; sargramostim), may be used during the induction phase only for patients who have a life-threatening infection in order to shorten the neutropenic period (NCCN, 2019a). Patients are discharged to home once blood counts recover and the risk of infection are diminished.

When the patient has recovered from the induction therapy (i.e., the neutrophil and platelet counts have returned to normal and any infection has resolved), consolidation therapy is given to eliminate any residual leukemic cells that are not clinically detectable and to reduce the chance for recurrence of leukemia. Multiple treatment cycles of various agents are used, usually containing some form of cytarabine. Frequently, the patient receives one cycle of treatment that is almost the same as, if not identical to, the induction treatment but at lower dosages.

Allogeneic stem cell transplant is the most common form of hematopoietic stem cell transplant (HSCT) used in the treatment of AML (see Chapter 12 for discussion of HSCT). HSCT is routinely done following induction and consolidation therapy. However, in certain instances (e.g., aggressive disease), HSCT may be performed following induction. The process of HSCT requires that patients begin by receiving high-dose, aggressive chemotherapy, sometimes in tandem with radiation therapy, to destroy the hematopoietic functioning in the bone marrow and to kill any residual leukemic cells. This process is called *conditioning therapy*. Then, the patient is given human leukocyte antigen (HLA-matched) donor stems cells via intravenous (IV) infusion to reestablish bone marrow functioning and to create a new immune system (Leukemia & Lymphoma Society, 2019a). The most appropriate use and timing of HSCT remain unclear. Patients with a poorer prognosis may benefit from early HSCT; those with a good prognosis may not ever require HSCT.

While most patients with AML achieve remission after these treatments, some patients have refractory or relapsed disease, even after aggressive therapy. Approximately 10% to 40% of patients do not obtain a complete remission following induction therapy (Leukemia & Lymphoma Society, 2019a). There are several other treatment options. The induction regimen might be repeated until remission or relapse occurs. Other approaches may include treatment with enasidenib, a cytarabine-based regimen, along with other agents (e.g., cladribine, fludarabine, mitoxantrone, etoposide); palliative care; or use of a hypomethylating agent (e.g., azacitidine or decitabine).

Supportive care may be the best treatment option to consider if the patient has significant comorbidity, such as extremely poor cardiac, pulmonary, renal, or hepatic function; is older and frail; or both. In such cases, the aggressive antileukemia therapy options previously described are not indicated; occasionally, hydroxyurea or hypomethylating agents such as azacitidine may be used briefly to control the increase of blast cells. The patient's symptoms may be mitigated with antimicrobial therapy and transfusions as needed. This treatment approach provides the patient with some additional time outside the hospital; however, death frequently occurs within months, typically from infection or bleeding (refer to Chapter 13 for a discussion of palliative and end-of-life care).

Complications

Complications of AML include bleeding and infection, which are the major causes of death. The risk of bleeding correlates with the level and duration of platelet deficiency. The low platelet count can cause ecchymoses and petechiae. Major hemorrhages also may develop when the platelet count drops to less than 10,000/mm^3. The most common bleeding sources include gastrointestinal (GI), pulmonary, vaginal, and intracranial. For undetermined reasons, fever and infection also increase the likelihood of bleeding. Disseminated intravascular coagulation (DIC) is common, particularly in patients with the APL subtype (NCCN, 2019a) (see Chapter 29 for further discussion of DIC). A very high WBC count (greater than 100,000/mm^3) can cause stasis within the cerebral or pulmonary circulation.

Because of the lack of mature and normal granulocytes that help fight infection, patients with leukemia are prone to infection. The likelihood of infection increases with the degree and duration of neutropenia; neutrophil counts that persist at less than 100/mm^3 dramatically increase the risk of systemic infections. While bacterial infections commonly occur in patients with AML who are neutropenic, the risk of developing a fungal infection also increases. Fungal infections remain difficult to treat; in many cases, patients are given antifungal agents prophylactically. Granulocytic growth factors, either granulocyte colony-stimulating factor (G-CSF; filgrastim) or

granulocyte-macrophage colony-stimulating factor (GM-CSF) are used to stimulate the bone marrow to produce leukocytes, thereby shortening the period of neutropenia. These growth factors are not recommended for use in patients with APL, as differentiation syndrome (formerly known as retinoic acid syndrome), a life-threatening complication with symptoms such as unexplained fever, weight gain, hypotension, respiratory distress, and acute kidney injury can occur (NCCN, 2019a).

Massive leukemic cell destruction from chemotherapy results in the release of intracellular electrolytes and fluids into the systemic circulation. Increases in uric acid levels, potassium, and phosphate are seen; this process is referred to as tumor lysis syndrome (see Chapter 12 for further discussion of tumor lysis syndrome). The increased uric acid and phosphorus levels make the patient vulnerable to renal stone formation and renal colic, which can progress to acute kidney injury. Hyperkalemia and hypocalcemia can lead to cardiac arrhythmias; hypotension; neuromuscular effects such as muscle cramps, weakness, and spasm/tetany; and confusion; and seizures may also develop (Olsen, LeFebvre, & Brassil, 2019). Patients require a high fluid intake, and prophylaxis with allopurinol or rasburicase to prevent crystallization of uric acid and subsequent stone formation.

GI problems may result from the infiltration of abnormal leukocytes into the abdominal organs and from the toxicity of the chemotherapeutic agents. Anorexia, nausea, vomiting, diarrhea, and severe mucositis are common. Because of the profound myelosuppressive effects of chemotherapy, significant neutropenia and thrombocytopenia typically result in serious infection and increased risk of bleeding.

Nursing Management

Nursing management of the patient with acute leukemia, including AML, is presented at the end of the discussion of leukemia in this chapter.

Chronic Myeloid Leukemia

Chronic myeloid leukemia (CML) arises from a mutation in the myeloid stem cell. Normal myeloid cells continue to be produced, but there is a pathologic increase in the production of forms of blast cells. Therefore, a wide spectrum of cell types exists within the blood, from blast forms to mature neutrophils. Because there is an uncontrolled proliferation of cells, the marrow expands into the cavities of long bones, such as the femur, and cells are also formed in the liver and spleen (extramedullary hematopoiesis), resulting in enlargement of these organs that is sometimes painful.

CML results from a chromosomal translocation, where a section of deoxyribonucleic acid (DNA) is shifted from chromosome 22 to chromosome 9, forming what is known as a "fusion gene" that is abnormal. The specific fused gene found in all patients with CML is the *BCR-ABL* gene, which occurs when the *BCR* gene from chromosome 22 switches places with the *ABL* gene from chromosome 9 (Leukemia & Lymphoma Society, 2019b). Normally, the *ABL* gene signals the cells when to make tyrosine kinase; however, the abnormal *BCR-ABL* gene (known as the Philadelphia chromosome) signals cells to produce too many leukocytes and is responsible for converting normal cells into leukemic cells.

CML accounts for 15% of all new cases of leukemia (NCCN, 2019b). The average age of a patient at time of diagnosis is 67 years, but CML can occur at any age. Risk factors include increasing age, being male, having a history of smoking, and being exposed to high doses of radiation (e.g., atomic bomb survivors).

Clinical Manifestations

The clinical picture of CML varies, based upon phase of disease. There are three stages in CML that include chronic, accelerated, and blast crisis (Leukemia & Lymphoma Society, 2019b). During the chronic phase, patients have few symptoms, leukocytosis is detected by a CBC performed for some other reason, and complications from the disease itself are rare.

The accelerated phase can be insidious or rapid; it marks the process of evolution (or transformation) to the acute form of leukemia (blast crisis). In the accelerated phase of disease, blood counts begin to worsen, new chromosomal changes may be seen on analysis, and symptoms consistent with leukemia may start to appear, such as fatigue, anemia, splenomegaly, or dyspnea (NCCN, 2019b). The patient may complain of bone pain and may report fevers (without any obvious sign of infection) and weight loss.

Blast crisis or blast phase of CML is the most advanced phase. Patients in this phase exhibit signs and symptoms that are more like AML than a chronic disease. Some patients present with leukocytosis, with the WBC count exceeding 100,000/mm^3 (NCCN, 2019b). Patients with extremely high leukocyte counts may be dyspneic or slightly confused because of decreased perfusion to the lungs and brain from leukostasis (the excessive volume of leukocytes inhibits blood flow through the capillaries). The patient may have an enlarged, tender spleen, and occasionally the liver may also be enlarged and tender. Some patients have insidious symptoms, such as malaise, anorexia, and weight loss. Lymphadenopathy is uncommon, but if present, indicates late disease and a poor prognosis (NCCN, 2019b).

Medical Management

The goal of treatment for CML is to control the disease, either by obtaining remission or by keeping the patient in the chronic phase for as long as possible. CML is not considered to be curable among older adults despite advances in understanding the pathophysiology of the disease and the advent of new agents. However, the use of tyrosine kinase inhibitors (TKIs) has significantly improved treatment and long-term survival for patients with CML (Leukemia & Lymphoma Society, 2019b). Medical management is based upon the patient's age, general health, calculation of risk-score (based upon stage of disease and prognosis), and phase of disease.

TKIs work by blocking the signals within the leukemic cells that express the *BCR-ABL* protein. This inhibition prevents a series of chemical reactions that cause the cells to grow and divide, thus inducing complete remission at the cellular level. The TKI imatinib mesylate is considered to be standard of care for patients with CML. Newer, alternative TKIs approved for first-line (primary) therapy for patients in the chronic phase of CML include dasatinib or nilotinib (NCCN, 2019b). Each of these TKIs has a different toxicity profile. For example, periorbital edema is common with long-term use of imatinib; dasatinib is very myelosuppressive, and its use carries a significant risk for pleural effusion and for causing a prolonged QT interval; and nilotinib has cardiotoxic effects. Other TKIs approved for second-line therapy (when patients do not respond satisfactorily to the first-line agents) are bosutinib and ponatinib. All TKIs are metabolized by the cytochrome P450 pathway, which means that drug-to-drug interactions are common. Drugs that may decrease the effects of the TKI are corticosteroids, antiseizure medications, antacids, and St. John's wort. Drugs that may increase the effects of the TKI include grapefruit juice, certain antibiotics (e.g., clarithromycin), and azole antifungals (e.g., clotrimazole, ketoconazole).

CML is a disease that can potentially be cured with allogeneic HSCT in otherwise healthy patients who are younger than 65 years. However, with the development of TKIs, the timing of transplant has come into question. Approximately 90% of patients who receive allogeneic HSCT during the chronic phase of CML are disease free for 5 years or more (Leukemia & Lymphoma Society, 2019b).

In the acute form of CML (blast crisis), treatment may resemble induction therapy for acute leukemia, using the same medications as for AML or acute lymphocytic leukemia (ALL; see later discussion). Patients whose disease evolves into a "lymphoid" blast crisis are more likely to be able to reenter a chronic phase after induction therapy. For those whose disease evolves into AML, therapy has been largely ineffective in achieving a second chronic phase. Life-threatening infections and bleeding occur frequently in this phase.

Nursing Management

Most TKIs are oral agents; therefore, their effectiveness is dependent upon the patient's ability and motivation to adhere to the prescribed treatment regimen. These drugs may cause side effects that the patient may find difficult to manage, such as fatigue, asthenia (weakness), pruritus (itching), headache, skin rash, and oropharyngeal pain. A study conducted in Germany of patients with CML treated on an outpatient basis revealed an adherence rate of 51% to oral TKIs (Hefner, Csef, & Kunzmann, 2017), which is consistent with prior studies. In this study, forgetting to take the drug or delays of 2 or more hours from the prescribed time were the most common reported reasons for decreased adherence. Another study examining challenges to oral agent adherence conducted by Gborogen and Polek (2018) reported that over half of nurse participants reported nonadherence to oral agents among their patients. Reasons for nonadherence ranged from patient forgetfulness to perceptions of inadequate support. It is extremely important for the nurse to educate the patient about the medication regimen, how to manage side effects, drug interactions, and safe handling (Olsen et al., 2019) (see Nursing Interventions in Table 30-1). The nurse should also monitor the patient for adverse signs and symptoms of therapy, such as decreased urinary output, changes in the electrocardiogram (ECG; TKIs can cause arrhythmias and prolonged QT intervals), and myelosuppression (e.g., fevers, chills, changes in the CBC).

Acute Lymphocytic Leukemia

ALL results from an uncontrolled proliferation of immature cells (lymphoblasts) derived from the lymphoid stem cell. The cell of origin is the precursor to the B lymphocyte in approximately 75% of ALL cases; T-lymphocyte ALL occurs in approximately 25% of cases. The *BCR-ABL* translocation (see previous discussion in CML section) is found in 20% of ALL blast cells (NCCN, 2019c). ALL can occur at any age, but 75% to 80% of all cases are found in children, with the median age at diagnosis being 15 years (NCCN, 2019c). Boys are affected more often than girls; the peak incidence is 4 years of age. After 15 years of age, it is relatively uncommon, until age 45 when the incidence again rises (Leukemia & Lymphoma Society, 2018a). For those over age 45, risk factors for ALL include older age (especially over 70 years), prior exposure to chemotherapy or radiation therapy, having certain genetic conditions (e.g., especially Down syndrome; also neurofibromatosis, Klinefelter syndrome, and Fanconi anemia) (NCCN, 2019c). In the last several decades, advances in understanding the pathophysiology and molecular genetics, as well as the incorporation of targeted therapy and HSCT, have resulted in improved cure rates and overall longer survival in patients with ALL.

Clinical Manifestations

For some patients with ALL, the clinical manifestations may be nonspecific while others have no symptoms initially. The disease is commonly found incidentally with routine laboratory studies or physical exam for another condition. At the time of diagnosis, the leukocyte counts may be either higher or lower than normal, with a high proportion of immature lymphoblasts. Immature lymphocytes proliferate in the marrow and impede the development of normal myeloid cells. As a result, normal hematopoiesis is inhibited, resulting in reduced numbers of granulocytes, erythrocytes, and platelets. Manifestations of leukemic cell infiltration into other organs are more common with ALL than with other forms of leukemia and include pain from an enlarged liver or spleen as well as bone pain. The central nervous system (CNS) is frequently a site for leukemic cells; thus, patients may exhibit cranial nerve palsies or headache and vomiting because of meningeal involvement. Other extranodal sites include the testes and breasts.

TABLE 30-1 Risk Factors Associated with Lower Adherence to Oral Therapy for Chronic Myeloid Leukemia (CML)

Risk Factor Category	Risk Factor	Nursing Interventions
Patient Characteristics	Lower education level (below high school)	
	Higher self-report of functional status	
	Low self-efficacy regarding medication administration[a]	Explore with patient perceived barriers related to medication administration
	Taking medication independent of meals[a]	Develop medication administration schedule with patient; use timer/watch alarm to alert patient when to take medication
	Lack of knowledge regarding disease and treatment[a]	Provide relevant information in format understandable to patient
Social Characteristics	Living alone[a]	Evaluate need for phone follow-up, initiation of home care
	Low levels of social support	
	Low socioeconomic status	
Disease and Treatment Characteristics	Farther time from diagnosis	Monitor patient closely for side effects Monitor patient closely for complications Provide patient with information on clinical trial enrollment eligibility as advisable
	Higher rates of treatment-related side effects[a]	
	Higher number of cancer-related complications[a]	
	Not participating in a clinical trial[a]	

[a]Indicates risk factor amenable to nursing intervention.

Adapted from Gborogen, R., & Polek, C. (2018). Oral agents: Challenges with self-administered medication adherence in clinical trials. *Clinical Journal of Oncology Nursing*, *22*(3), 333–339; Olsen, M., LeFebvre, K., & Brassil, K. (2019). *Chemotherapy and immunotherapy guidelines and recommendations for practice*. Pittsburgh, PA; Oncology Nursing Society.

Medical Management

The goal of treatment is to obtain remission without excess toxicity and with a rapid hematologic recovery so that additional therapy can be given if needed. Because of the heterogeneity of the disease, treatment plans are based on genetic markers of the disease as well as risk factors of the patient, primarily age. Similar to treatment for AML, treatment for ALL can be grouped into induction, consolidation, and maintenance phases. Because ALL frequently invades the CNS, preventive intrathecal chemotherapy or, less frequently, cranial irradiation, are also a key part of the treatment plan (NCCN, 2019c).

Treatment protocols for ALL tend to be complex, using a wide variety of chemotherapeutic agents and complicated administration schedules. The expected outcome of treatment is complete remission. Despite its complexity, treatment can be provided in the outpatient setting in some circumstances until severe complications develop. TKIs (e.g., imatinib) are effective in patients with Philadelphia chromosome-positive ALL; these drugs can be used alone or in combination with conventional chemotherapy (Leukemia & Lymphoma Society, 2018a).

Lymphoid blast cells are typically very sensitive to corticosteroids and to vinca alkaloids; therefore, these medications are an integral part of the initial induction therapy (NCCN, 2019c). The corticosteroid dexamethasone is preferred to prednisone, as it is more toxic to lymphoid cells and has better CNS penetration. Typically, an anthracycline is included, sometimes with asparaginase. Once a patient is in remission, special testing (immunophenotyping, immunoglobulin gene rearrangements, T-cell receptor genes, molecular testing) is done to look for residual leukemic cells; these tests can detect as few as a single ALL cell among 10,000 to 100,000 normal cells. This minimal residual disease testing is useful as a prognostic indicator. Based on these results and the rapidity in which remission is achieved, a consolidation regimen ensues, using different combinations and dosages of the drugs used in induction therapy; the goal of consolidation is to improve outcomes in those patients at high risk for relapse. For patients with relapsed or refractory B-cell precursor ALL, agents such as blinatumomab or inotuzumab ozogamicin have been found to be effective (NCCN, 2019c).

Patients with ALL can experience some unique adverse effects from treatment. The use of corticosteroids to treat ALL increases the patient's susceptibility to infection; viral infections are common. Avascular necrosis can occur in patients treated with corticosteroid-based chemotherapy, as well as with transplantation. Patients treated with asparaginase are at increased risk for thrombosis. Hepatic toxicity is also common and may necessitate cessation of supportive drugs, such as proton pump inhibitors and certain antibacterial and antifungal drugs.

Allogeneic HSCT may be considered during initial remission if disease features and testing suggest the risk of relapse is high (NCCN, 2019c; Leukemia & Lymphoma Society, 2018a). The development of chimeric

antigen receptor (CAR) T cells has significantly improved treatment outcomes and overall survival in patients with ALL (NCCN, 2019c). CAR-T therapy utilizes the patient's own immune system to fight disease; the patient's own T cells are collected, modified, and reinfused back into the patient. Treatment with CAR-T can serve as a bridge prior to transplant and has qualified patients for HSCT who were formerly ineligible. In the context of average-risk disease, HSCT may be postponed until the time of relapse, should it occur. HSCT can improve long-term disease-free survival; however, this potential benefit must be weighed with the risks associated with the procedure, including death and long-term morbid complications.

Nursing Management

Nursing management of the patient with acute leukemia, including ALL, is presented at the end of the leukemia section in this chapter.

Chronic Lymphocytic Leukemia

Chronic lymphocytic leukemia (CLL) is a common malignancy of older adults, and the most prevalent type of adult leukemia in the Western world (NCCN, 2019d). The average age at diagnosis is 71 years (Leukemia & Lymphoma Society, 2019c). CLL is rarely seen in Native Americans and infrequently among people of Asian descent. Unlike other forms of leukemia, a strong familial predisposition exists with CLL; the disease can occur in 10% of those with a first- or second-degree relative with the same diagnosis. Veterans of the Vietnam War who were exposed to Agent Orange may be at risk for developing this disease (see the following section), but there is no definitive link to other pesticides or exposure to chemicals. While many patients will have a normal life expectancy, others will have a very short life expectancy due to the aggressive nature of the disease.

Veterans Considerations

Agent Orange was an herbicide used as a defoliant by the U.S. military in Vietnam from 1962 until 1975, when American involvement in the Vietnam War ended. Since that time, dioxin, a chemical used in Agent Orange, has been found to be carcinogenic. In particular, there is sufficient evidence that CLL, Hodgkin lymphoma, non-Hodgkin lymphomas (NHLs), and monoclonal gammopathy of undetermined significance (MGUS) are associated with Agent Orange exposure, while there is also evidence that suggests that Agent Orange exposure may be linked to multiple myeloma (American Cancer Society [ACS], 2020a). Approximately 3 million American veterans could have been

exposed to the harmful effects of Agent Orange related to their military service in Vietnam. The U.S. Department of Veteran Affairs (VA) has administered an *Agent Orange Registry* since 1978. Qualified veterans who enroll in the registry are eligible for health care benefits and consultations. Those veterans who develop cancers secondary to exposure to Agent Orange may be eligible for VA disability benefits (see Resources for additional information for veterans exposed to Agent Orange) (ACS, 2020a).

Pathophysiology

CLL is typically derived from a malignant clone of B lymphocytes. A **clone** proliferates from a cell of origin so that descendent cells are identical to the cell of origin. In contrast to the acute forms of leukemia, most leukemic cells in CLL are fully mature. One possible mechanism that explains this oncogenesis is that these cells can escape **apoptosis** (programmed cell death), resulting in an excessive accumulation of the cells in the marrow and circulation. CLL is characterized by the progressive accumulation of leukemic cells in the bone marrow, blood, and lymphoid tissues (NCCN, 2019d).

Because the lymphocytes are small, they can easily travel through the small capillaries within the circulation, and the pulmonary and cerebral complications of leukocytosis seen with myeloid leukemias are not typically found in CLL. However, these cells often accumulate within the lymph nodes and spleen. When it takes less than 12 months for the absolute number of lymphocytes to double (lymphocyte doubling time), a more aggressive disease course may ensue.

Immunophenotyping of the circulating B cells is critical to establish the diagnosis by identifying the presence of a malignant clone of these cells; it is also used to gauge the prognosis (NCCN, 2019d). Other special cytogenetic and molecular analyses (e.g., fluorescence in situ hybridization [FISH]) are also used to guide prognosis and therapy. Beta-2 microglobulin, a protein found on the surface of lymphocytes, can be measured in the serum; an elevated level correlates with a more advanced clinical stage and poorer prognosis.

Autoimmune complications can occur at any stage, as either autoimmune hemolytic anemia or idiopathic thrombocytopenic purpura. In the autoimmune process, the reticuloendothelial system destroys the body's own erythrocytes or platelets. Patients with CLL also have a greater risk for developing other cancers. Approximately 2% to 10% of patients with CLL will experience transformation of their disease to a very aggressive lymphoma, known as Richter's transformation (NCCN, 2019d); this transformation results in markedly increased lymphadenopathy, splenomegaly, B symptoms (see **Chart 30-1**), and survival of only a few months despite treatment. Second cancers typically involve the skin, colon, lung, breast, prostate, and kidney.

Chart 30-1 RISK FACTORS

B Symptoms

These symptoms include the following:

- Fever of at least 100.4° F (38°C) that may come and go over several weeks that is not explained by an underlying infection
- Drenching night sweats
- Unintentional loss of at least 10% body weight over the past 6 months

Overview: B symptoms:

- Are constitutional symptoms, meaning that they affect multiple systems
- Can manifest with many types of hematopoietic malignancies, including chronic lymphocytic leukemia (CLL), Hodgkin lymphoma, and non-Hodgkin lymphomas (NHLs)
- Are associated with worst prognoses in patients with CLL, Hodgkin lymphoma and NHL than in patients who do not report B symptoms

Adapted from Leukemia & Lymphoma Society. (2018c). Hodgkin lymphoma. Retrieved on 7/10/2019 at: www.lls.org/sites/default/files/file_assets/PS57_Hodgkin_Lymphoma2018.pdf

Clinical Manifestations

Many patients are asymptomatic and are diagnosed incidentally during routine physical examinations or during treatment for another disease. Lymphocytosis (an increased lymphocyte count) is always present. The erythrocyte and platelet counts may be normal or, in later stages of the illness, decreased. Lymphadenopathy is common; this can be severe and sometimes painful (see Fig. 30-4). Splenomegaly may also occur.

Patients with CLL can develop B symptoms (see **Chart 30-1**) which portends a worsening prognosis. T-cell function is impaired and may be the cause of tumor progression and increased susceptibility to second malignancies and infections. Life-threatening infections are particularly common with advanced disease, and account for over half of all deaths in this patient population. Viral infections, such as herpes zoster, can become widely

disseminated. Defects in the complement system are also seen, which results in increased risk of developing infection with encapsulated organisms (e.g., *Haemophilus influenzae*). Patients should receive an annual comprehensive skin examination (as the incidence of skin cancer is higher in this group), and screening guidelines for other cancers should be followed, such as for breast, colorectal, lung, and prostate cancer (NCCN, 2019d) (see Chapter 12, Table 12-3, for cancer screening guidelines).

Figure 30-4 • Massive lymphadenopathy in a patient with chronic lymphocytic leukemia. Note the enlarged liver and spleen as well. Reprinted with permission from Tkachuk, D. C., & Hirschman, J. V. (2007). *Wintrobe's atlas of clinical hematology* (Fig. 5.1, p. 154). Philadelphia, PA: Lippincott Williams & Wilkins.

Medical Management

For patients with no symptoms at the time of diagnosis, the traditional "watch-and-wait" approach is often used until progression of disease is noted (which could be months to years). However, with the advent of newer treatment modalities (i.e., targeted therapies and immunotherapy), treatment may be initiated sooner in the illness trajectory (NCCN, 2019d). Additionally, clinical trials are ongoing to assess for an advantage in survival with newer agents. Various parameters are considered when treatment is selected, including the clinical stage of the disease, disease-associated symptoms, the functional status of the patient, genetic risk, and the extent and efficacy of any prior treatment. Functional status is a complex consideration; in this context, it incorporates the individual's life expectancy independent of CLL (due to other health problems), the ability to tolerate aggressive therapy (e.g., creatinine clearance is particularly important), and the ability to perform activities of daily living (Leukemia & Lymphoma Society, 2019c; NCCN, 2019d). Patients with good functional status can typically tolerate aggressive therapy and often achieve a lasting complete remission. In contrast, the objective of treatment in those with more impaired physical status focuses on controlling bothersome symptoms (e.g., drenching night sweats, painful lymphadenopathy).

Treatment for CLL is variable and can consist of a single immunotherapy agent administered in combination with chemotherapeutic agents, such as an immunotherapeutic antibody against the B-lymphocyte antigen CD20 (e.g., rituximab, ofatumumab, obinutuzumab) with chemotherapeutic agents (e.g., fludarabine, cyclophosphamide, bendamustine, chlorambucil) as initial therapy. The most commonly prescribed first-line chemotherapeutic agent is fludarabine. When the disease is accompanied by a deletion of the *TP53* gene or a mutation of this gene, TKIs such as ibrutinib or idelalisib may be used as either monotherapy or in combination with other agents (NCCN, 2019d). Depending upon the age of the patient (less than or greater than 65 years of age) and whether or not the patient has comorbidities, patients with relapsed or refractory disease may also receive newer agents such as venetoclax, duvelisib, or acalabrutinib (NCCN, 2019d).

The major side effect of fludarabine is prolonged bone marrow suppression, manifested by prolonged periods of neutropenia, lymphopenia, and thrombocytopenia, which puts patients at risk for such infections as *Pneumocystis jiroveci, Listeria,* mycobacteria, herpes viruses, and cytomegalovirus (CMV). The monoclonal antibody (MoAb) alemtuzumab is often used in combination with other chemotherapeutic agents when the disease is refractory to fludarabine, the patient has very poor prognostic markers, or it is necessary to eradicate residual disease after initial treatment. Alemtuzumab targets the CD52 antigen commonly found on CLL cells, and it is effective in clearing the marrow and circulation of these cells without

affecting the stem cells. Because CD52 is present on both B and T lymphocytes, patients receiving alemtuzumab are at significant risk for infection; prophylactic use of antiviral agents and antibiotics (e.g., trimethoprim–sulfamethoxazole) is important and needs to continue for several months after treatment ends. CMV infection is also common with alemtuzumab, idelalisib, and duvelisib, and prophylaxis is important; among commonly prescribed antiviral agents, vancyclovir is more effective than acyclovir for treating CMV (NCCN, 2019d).

Patients receiving idelalisib or duvelisib have an increased risk of hepatotoxicity, severe diarrhea, colitis, and pneumonitis. TKIs have been found to increase the risk of cardiovascular toxicities, including hypertension, prolonged QT interval, left ventricular dysfunction, and heart failure (Olsen et al., 2019). Ongoing periodic assessment of the CBC, blood chemistries, ECG, blood pressure, and bowel habits are important parameters to monitor among patients taking these various agents.

Because of the older age of most patients with CLL, allogeneic HSCT may not be an option, particularly if significant comorbidities exist. However, allogeneic HSCT might be considered for some patients with *TP53* deletions or mutations who otherwise have a poor prognosis. Morbidity and mortality rates remain high (20%); thus, this treatment modality may be reserved for those patients with high-risk disease, younger age, and high degree of match from the donor (NCCN, 2019d).

Nursing Management

Virtually all patients with CLL have reduced levels of immunoglobulins, and bacterial infections are common, independent of treatment. IV treatment with immunoglobulin (IVIG) may be given to select patients with recurrent infection. While studies have not demonstrated improved survival, the rate of developing major infections is reduced (NCCN, 2019d). Patients with CLL should receive both pneumonia and flu vaccinations as indicated. Live vaccines should be avoided. The patient with CLL is at increased risk of a host of infections; nursing interventions focused on diminishing these risks are summarized in Chapter 12, Chart 12-6.

For the procedural guidelines for managing immunoglobulin therapy, go to thepoint.lww.com/Brunner15e.

NURSING PROCESS

The Patient with Acute Leukemia

Assessment

Although the clinical picture varies with the type of leukemia as well as with the treatment implemented, the health history may reveal a range of subtle symptoms reported by the patient before the problem is detectable on physical examination. If the patient is hospitalized, assessments should be performed daily, or more frequently as warranted. Because the physical findings may be subtle initially, a thorough, systematic assessment incorporating all body systems is essential. For example, a dry cough, mild dyspnea, and diminished breath sounds may indicate a pulmonary infection. However, the infection may not be seen initially on the chest x-ray; the absence of neutrophils delays the inflammatory response against the pulmonary infection, thus delaying radiographic changes. When serial assessments are performed, current findings are compared with previous findings to evaluate improvement or worsening. Specific body system assessments are delineated in the neutropenic and bleeding precautions found in Chapter 12, Chart 12-6.

The nurse also must closely monitor the results of laboratory studies, including tracking the leukocyte count, ANC, hematocrit, platelet, creatinine and electrolyte levels, and coagulation and hepatic function tests. Culture results need to be reported immediately so that appropriate antimicrobial therapy can begin or be modified.

Diagnosis

NURSING DIAGNOSES

Based on the assessment data, major nursing diagnoses may include:

- Risk for infection, haemorrhaging, or both
- Impaired oral mucous membrane integrity due to changes in epithelial lining of the GI tract from chemotherapy or prolonged use of antimicrobial medications
- Impaired nutritional status associated with hypermetabolic state, anorexia, mucositis, pain, and nausea
- Acute pain associated with mucositis, leukocyte infiltration of systemic tissues, fever, and infection
- Fatigue and activity intolerance associated with anemia, infection, inadequate nutrition, and deconditioning
- Fluid imbalance associated with renal dysfunction, diarrhea, bleeding, infection, increased metabolic rate, hypoproteinemia, and need for multiple intravenous medications and blood products

- Impaired ability to perform hygiene, impaired ability to dress, and impaired self toileting due to fatigue and malaise
- Anxiety and grief due to uncertainty about future, anticipatory loss, and altered role functioning
- Risk for spiritual distress
- Lack of knowledge about disease process, treatment, complication management, and self-care measures

Collaborative Problems/Potential Complications

Potential complications may include the following (see Chapter 12 for further discussion):

- Infection
- Bleeding/DIC
- Renal dysfunction
- Cardiac toxicity
- Infertility
- Tumor lysis syndrome

Planning and Goals

The major goals for the patient may include absence of complications and pain, attainment and maintenance of adequate nutrition, activity tolerance, ability to provide self-care and to cope with the diagnosis and prognosis, positive body image, and an understanding of the disease process and its treatment.

Nursing Interventions

Preventing or Managing Infection and Bleeding

The nursing interventions related to diminishing the risk of infection and bleeding are delineated in Chapter 12, Chart 12-6.

Managing Mucositis

Although emphasis is placed on the oral mucosa, the entire GI mucosa can be altered, not only by the effects of chemotherapy but also from prolonged administration of antibiotics. See Chapter 12 for assessment and management of mucositis.

Improving Nutritional Intake

The disease process can increase the patient's metabolic rate and nutritional requirements. Nutritional intake is often reduced because of pain and discomfort associated with stomatitis. Encouraging or providing mouth care before and after meals and administering analgesic agents before eating can help increase intake. If oral anesthetic agents are used, the patient must be warned to chew with extreme care to avoid inadvertently biting the tongue or buccal mucosa.

Nausea should not interfere with nutritional intake, because appropriate antiemetic therapy is highly effective. However, nausea can result from antimicrobial therapy, so some antiemetic therapy may still be required after the chemotherapy has been completed.

Small, frequent feedings of foods that are soft in texture and moderate in temperature may be better tolerated. Low-microbial diets may be prescribed (avoiding uncooked fruits or vegetables and those without a peelable skin), although there is little evidence to support this intervention (Olsen et al., 2019). Nutritional supplements are frequently used. Daily body weight (as well as intake and output measurements) is useful in monitoring fluid status. Both calorie counts and more formal nutritional assessments are often useful. Parenteral nutrition may be required to maintain adequate nutrition.

Easing Pain and Discomfort

Recurrent fevers are common in acute leukemia; at times, they are accompanied by shaking chills (rigors), which can be severe. Myalgias and arthralgias can result. Acetaminophen is typically given to decrease fever, but it also increases diaphoresis. Sponging with cool water may be useful, but cold water or ice packs should be avoided because the heat cannot dissipate from constricted blood vessels. Bedclothes need frequent changing as well. Gentle back and shoulder massage may provide comfort.

Mucositis can also cause significant discomfort. In addition to oral hygiene practices, patient-controlled analgesia can be effective in controlling the pain (see Chapter 9). With the exception of severe mucositis, less pain is associated with acute leukemia than with many other forms of cancer. However, the amount of psychological suffering that the patient endures can be immense. Patients often benefit from active listening and possible referral for professional counseling.

Decreasing Fatigue and Activity Intolerance

Fatigue is a common and oppressive symptom. Nursing interventions should focus on assisting the patient to establish a balance between activity and rest. Patients with acute leukemia need to maintain some physical activity and exercise to prevent the deconditioning that results from inactivity. The use of a high-efficiency particulate air (HEPA) filter mask can permit the patient to ambulate outside the room despite severe neutropenia. Stationary bicycles may also be set up in the room; however, many patients lack the motivation or stamina to use them. At a minimum, patients should be encouraged to sit up in a chair while awake rather than staying in bed; even this simple activity can improve the patient's tidal volume and enhance circulation. Physical therapy can also be beneficial. Patients with acute leukemia may require hospitalization for extensive nursing care (either during induction or consolidation therapy or during

resultant complications); sleep deprivation frequently results. Nurses need to implement creative strategies that permit uninterrupted sleep for at least a few hours while still administering necessary medications on schedule (see Nursing Research Profile, Chart 30-2).

Chart 30-2 **NURSING RESEARCH PROFILE**

Fatigue and Sleep Disturbances in Adults with Acute Leukemia

Bryant, A., Gosselin, T., Coffman, E., et al. (2018). Symptoms, mobility, and function, and quality of life in adults with acute leukemia during initial hospitalization. *Oncology Nursing Forum, 45*(5), 653–664.

Purpose

Patients newly diagnosed with acute leukemia require hospitalization, typically for 4 to 6 weeks, for managing aggressive induction therapy and its toxicities. These symptoms can greatly impact the patient's quality of life and ability to perform activities of daily living. The purpose of this study was to evaluate global, physical, and mental health symptoms in adults with newly diagnosed acute leukemia.

Design

This was a prospective, longitudinal study with a total of 49 adult participants, including 36 males and 13 females. Data were collected at time of hospitalization (baseline), then weekly until discharge from hospital. Evaluation tools for data included: the Patient-Reported Outcomes Measurement Information System (PROMIS) to determine several self-reported quality-of-life measures such as fatigue, anxiety, depression, pain, sleep disturbances, and global physical and mental health; the Functional Assessment of Cancer Therapy-Leukemia (FACT-Leu) to measure symptom concerns that are leukemic specific; Karnofsky Performance Status Scale (KPS) to measure function; and the Timed UP and Go Test (TUG) to measure physical mobility.

Findings

This study was the largest, to date, to evaluate the symptoms and quality of life of patients newly diagnosed with acute leukemia during hospitalization. All participants had one or more comorbidities, as well as a group mean body mass index of 30.8 (SD = 6.7), indicative of being overweight or having obesity, at time of hospitalization. No significant differences were seen in global mental health, pain, or KPS during hospitalization. There were significant decreases in fatigue ($p < 0.001$), anxiety ($p < 0.001$), depression ($p = 0.004$), and sleep disturbance ($p = 0.005$) from baseline to hospital discharge. Also significant were a decrease in leukemic symptoms ($p < 0.001$), indicating improved leukemic outcomes, which is the goal of therapy.

Nursing Implications

Nurses need to be aware of factors that can impact sleep in patients with cancer, both during and following treatment. As fatigue plays a major role in sleep disturbances, the nurse needs to assess for and develop strategies to address both concerns, especially while the patient is in the hospital. Poor sleep, fatigue, and pain can all contribute to the increased

risk for falls, so safety issues should also be addressed with the patient and the patient's family. The nurse should encourage the patient to exercise and have some physical activity as part of the daily routine, to decrease fatigue while enhancing sleep. Additionally, the nurse should have a good understanding of the symptoms common to patients with leukemia and interventions to manage them as they occur.

Maintaining Fluid and Electrolyte Balance

Febrile episodes, bleeding, and inadequate or overly aggressive fluid replacement can alter the patient's fluid status. Similarly, persistent diarrhea and vomiting that occur with certain chemotherapy and immunotherapy agents, and long-term use of certain antimicrobial agents can cause significant deficits in electrolytes. Intake and output need to be measured accurately, and daily weights should also be monitored. The patient should be assessed for signs of dehydration as well as fluid overload, with particular attention to pulmonary status and the development of dependent edema. Laboratory test results, particularly electrolytes, blood urea nitrogen, creatinine, and hematocrit, should be monitored and compared with previous results. Replacement of electrolytes, particularly potassium and magnesium, is commonly required. Patients receiving amphotericin or certain antibiotics are at increased risk for electrolyte depletion.

Improving Self-Care: Bathing, Dressing, and Toileting

Because hygiene measures are so important in this patient population, they must be performed by the nurse when the patient cannot do so. However, the patient should be encouraged to do as much as possible to preserve mobility and function as well as self-esteem. Patients may have negative feelings because they can no longer care for themselves. Empathetic listening is helpful, as is realistic reassurance that these deficits are temporary. As the patient recovers, the nurse assists them to resume more self-care. Patients are usually discharged from the hospital with a vascular access device (e.g., Hickman catheter, peripherally inserted central catheter [PICC]), and coordination with appropriate home care services is needed for catheter management.

Managing Anxiety and Grief

Being diagnosed with acute leukemia can be extremely frightening. In many instances, the need to begin treatment is emergent, and the patient has little time to process the fact that they have the illness before making decisions about therapy. Providing emotional support and discussing the uncertain future are crucial. The nurse also needs to assess how much information the patient wants to have regarding the illness, its treatment, and potential complications. This desire should be reassessed at intervals, because needs and interest in information change throughout the course of the disease and treatment. Priorities must be identified so that procedures,

assessments, and self-care expectations are adequately explained even to those who do not wish extensive information.

Many patients exhibit depressive symptoms and begin to grieve for their losses, such as normal family functioning, professional roles and responsibilities, and social roles, as well as physical functioning. The nurse can assist the patient to identify the source of the grief and encourage them to allow time to adjust to the major life changes produced by the illness. Role restructuring, in both family and professional life, may be required. It is essential to encourage the patient to identify options and to take time in making important decisions.

The patient's physical condition can deteriorate quickly and it is not often easy to discern if the patient may recover or will die from complications. Providing emotional support to both the patient and the family is critical and equally as important as is rendering expert physical care.

Discharge from the hospital can also provoke anxiety. Although most patients are eager to go home, they may lack confidence in their ability to manage potential complications and to resume their normal activity. Close communication between nurses across care settings can reassure patients that they will not be abandoned.

Encouraging Spiritual Well-Being

Because acute leukemia is a serious, potentially life-threatening illness, the nurse may offer support to enhance the patient's spiritual well-being. The patient's spiritual and religious practices should be assessed and pastoral services offered. Throughout the patient's illness, the nurse assists the patient to maintain hope. However, that hope should be realistic and will certainly change over the course of the illness. For example, the patient may initially hope to be cured, but with repeated relapses and a change to hospice or palliative care, the same patient may hope for a quiet, dignified death. (Refer to Chapter 13 for a discussion of palliative and end-of-life care.)

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care. Most patients cope better when they understand what is happening to them. Based on their health literacy level, and interest, educating the patient and family should begin with a focus on the disease (including some pathophysiology), its treatment, and certainly the resulting significant risk of infection and bleeding (see Chapter 29, Charts 29-7 and 29-8).

Although management of a vascular access device can be taught to most patients or family members, this care is typically performed by a home care

agency or outpatient clinic nursing staff. Patients and family members do need basic education regarding management of the vascular access device, particularly with regard to prevention of infections.

Continuing and Transitional Care. For patients who are clinically stable but require parenteral antibiotics or blood products, these procedures are most often performed in an outpatient setting. Nurses in these settings must communicate regularly. They need to inform the patient about parameters that are important to monitor, how to monitor them, and to give the patient-specific instructions about when to seek care from the physician or other health care provider.

The patient and family need to have a clear understanding of the disease, the prognosis, and how to monitor for complications or recurrence. The nurse ensures that this information is provided. Should the patient no longer respond to therapy, it is important to respect the patient's choices about treatment and end-of-life care. Advance directives or other method should be used for patients to state their end-of-life preferences (see Chapter 13, Chart 13-5). In patients with acute leukemia, death typically occurs from infection or, less frequently, from bleeding. Family members need to have information about these complications and the measures to take should either occur. Many family members cannot cope with the care required when a patient begins to bleed actively. It is important to delineate alternatives to keeping the patient at home, such as inpatient hospice units.

Evaluation

Expected patient outcomes may include:

1. Shows no evidence of infection
2. Experiences no bleeding
3. Has intact oral mucous membranes
   a. Participates in oral hygiene regimen
   b. Reports no discomfort in mouth
4. Attains optimal level of nutrition
   a. Maintains weight with increased food and fluid intake
   b. Maintains adequate protein stores (e.g., albumin, prealbumin)
5. Reports satisfaction with pain and comfort levels
6. Has less fatigue and increased activity
7. Maintains fluid and electrolyte balance
8. Participates in self-care
9. Copes with anxiety and grief
   a. Discusses concerns and fears

b. Uses stress management strategies appropriately
c. Participates in decisions regarding end-of-life care

10. Reports sense of spiritual well-being
11. Absence of complications

MYELODYSPLASTIC SYNDROMES (MDSS)

The MDSs are a group of clonal disorders of the myeloid stem cell that cause dysplasia (abnormal development) in one or more types of cell lines. These disorders commonly result in cytopenias (low blood cell counts), with the tendency to develop into acute leukemia (Sockel & Platzbecker, 2018). A common feature of MDS is anemia due to dysplasia of the erythrocytes, although leukocytes (particularly neutrophils) and platelets can also be affected. Although the bone marrow is actually hypercellular, many of the cells within it die before being released into the circulation. Therefore, the actual number of cells in the circulation is typically lower than normal. In MDS, the affected cells do not function normally. The neutrophils have diminished ability to destroy bacteria by **phagocytosis** (cellular ingestion and digestion of foreign bodies); platelets are less able to aggregate and are less adhesive than usual. The result of these defects is an increased risk of infection and bleeding, even when the actual number of circulating cells may not be excessively low.

This disease is primarily seen in older adults (median age at diagnosis is 65 to 70 years), is idiopathic in nature due to HSC damage, and occurs more often in males than females (Montalban-Bravo & Garcia-Manero, 2017; Sockel & Platzbecker, 2018). In addition, about 10% to 15% of patients will develop MDS following exposure to alkylating agents, radiotherapy, or chemicals (e.g., benzene), and/or have an inherited genetic disorder, such as Fanconi anemia or trisomy 21 (Sockel & Platzbecker, 2018). Genetic syndromes account for about 50% of cases (e.g., Down syndrome, trisomy 8 syndrome, neurofibromatosis type 1) (Leukemia & Lymphoma Society, 2019d; NCCN, 2019e).

Clinical Manifestations

The manifestations of MDS can vary widely. Some patients are asymptomatic, with the illness being discovered incidentally when a CBC is performed for other purposes. Other patients have profound symptoms and complications from the illness. Because MDS tends to occur in older adults, other concurrent chronic health conditions may exacerbate symptoms associated with the disease. Fatigue is often present, with varying levels of intensity and

frequency. Neutrophil dysfunction puts the patient at risk for recurrent pneumonias and other infections. Because platelet function can also be altered, bleeding can occur. These problems may persist in a fairly steady state for months, even years. Over time, the marrow may fail to provide enough cells despite support with transfusion or growth factors; this is called *bone marrow failure*. MDS may also progress over time; as the dysplasia evolves into a leukemic state, the complications increase in severity. However, it is important to note that the majority of patients with MDS succumb to complications from the disease itself or from other comorbidities, and not to those from acute leukemia (Leukemia & Lymphoma Society, 2019d).

Assessment and Diagnostic Findings

The CBC typically reveals a macrocytic anemia; leukocyte and platelet counts may be diminished as well. Other potential causes for cytopenia, which may include vitamin deficiencies, viral infection, GI bleeding, autoimmune disease, splenomegaly, and liver dysfunction, should be excluded. Serum erythropoietin levels may be variable and the **reticulocyte** count (immature RBCs) may be inappropriately low. The presence of blast cells on the CBC may be indicative of disease progression to acute leukemia. To help rule out other causes of anemia, other laboratory studies may include folate, serum vitamin B_{12}, ferritin, total iron-binding capacity (TIBC), iron, and thyroid-stimulating hormone (TSH).

The official diagnosis of MDS is based on the results of a bone marrow aspiration (to assess dysplasia) and biopsy (to assess characteristics of the affected cells). These tests help in determining prognosis, risk of leukemic transformation, and in some patients, the most effective therapy (Montalban-Bravo & Garcia-Manero, 2017); thus, the nurse must understand the risk stratification category of each patient. Those patients with low-risk disease have a much longer survival (as much as 10 years) compared with untreated patients with high-risk disease (where survival is usually less than 9 months) (NCCN, 2019e) (see Chapter 28 for discussion of bone marrow aspiration and biopsy).

Medical Management

Medical management strategies for MDS are based on risk stratification to determine stage of disease and prognosis. The most commonly used tool is the International Prognostic Scoring System (IPSS) that evaluates cytopenia, transfusion needs, percent of blast cells in the bone marrow, and cytogenetic characteristics (Montalban-Bravo & Garcia-Manero, 2017). Most patients with MDSs are diagnosed as having low-risk disease; for these patients, the objective of therapy is to maintain or restore quality of life, improve cytopenia,

and decrease transfusion requirements. Some patients with mild symptoms may only require periodic monitoring of laboratory studies indicative of hematologic function (e.g., CBC, reticulocyte count, folate, ferritin, iron). Approximately two thirds of patients diagnosed as low risk have cytopenic-related complications at the time of diagnosis, however, and may require blood transfusions and/or an erythropoiesis-stimulating agent.

Patients who are at low to intermediate risk and transfusion dependent are typically treated with a hypomethylating agent (e.g., azacitidine, decitabine). These agents work by inhibiting the abnormal genes regulating methylation, promoting tumor suppression genes, and permitting myeloid differentiation within the bone marrow (NCCN, 2019e). Neither drug has been shown to modify the natural trajectory of low-risk MDS; therefore, hypomethylating agents are not typically used until erythroid-stimulating agents are no longer effective in controlling transfusion dependence (NCCN, 2019e). These agents can improve cytopenia, reduce transfusion requirements, reduce the likelihood of transformation to AML, and improve overall survival.

For the patient at high risk the goals of therapy are to delay leukemic transformation and prolong life expectancy (NCCN, 2019e; Sockel & Platzbecker, 2018). Allogeneic HSCT continues to be the only potential option of cure for MDS, but is not often a viable option for most patients, as many are of advanced age with significant comorbidities. Allogeneic HSCT is recommended for patients who have hypoplastic MDS, are younger, or those who have not responded satisfactorily to other treatment options (Montalban-Bravo & Garcia-Manero, 2017; NCCN, 2019e).

Lenalidomide (a thalidomide analog) is the standard of care for patients with the chromosomal abnormality deletion 5q, are considered low risk, and are not thrombocytopenic (NCCN, 2019e). Treatment with lenalidomide may cause neutropenia and thrombocytopenia, which may necessitate treatment delays or dose reduction (NCCN, 2019e). Other immunosuppressive therapies that have shown some efficacy in the treatment of MDS are antithymocyte globulin (ATG), with or without cyclosporine, and corticosteroids. These agents are used in a subset of patients with MDS who have weakened immune responses (e.g., have neutropenia) (Montalban-Bravo & Garcia-Manero, 2017).

Patients frequently need repeated transfusions (PRBCs, platelets, or both) throughout the illness trajectory to maintain adequate hemoglobin and platelet levels (termed *transfusion dependence*). Attempts to improve anemia and decrease RBC transfusion are often successful with the use of erythroid-stimulating agents (epoetin alfa or darbopoetin alfa). Higher-than-normal doses may be required to achieve an adequate improvement in hemoglobin. Adding myeloid growth factors such as G-CSF or GM-CSF can boost responsiveness to these agents (NCCN, 2019e). The median duration of response to this therapy is 2 years; transfusion requirements typically increase by this point.

Thrombocytopenia is a challenge to manage among patients with MDS. Severe thrombocytopenia is difficult to manage because patients can quickly develop refractoriness to platelet transfusions due to alloimmunization (Leukemia & Lymphoma Society, 2019d). Moreover, bleeding can develop even when the platelet level is not excessively low, due to poor platelet function. The cause of thrombocytopenia appears to be increased apoptosis and premature marrow destruction of the platelets prior to their release into the circulation (NCCN, 2019e). The recombinant thrombopoietin receptor agonists romiplostim and eltrombopag have been developed to stimulate the proliferation and differentiation of megakaryocytes into platelets within the bone marrow. Both drugs have demonstrated the ability to significantly raise platelet counts in this population, but their duration of action may not be long. Increased rates of marrow fibrosis and AML evolution seem to be ameliorated by discontinuing the drug, but additional study is needed (NCCN, 2019e).

Iron overload is another significant problem for patients with MDS, especially in patients who routinely receive PRBC transfusions (transfusion dependent). Surplus iron is deposited in cells within the reticuloendothelial system, and later in parenchymal organs (e.g., liver). While a true cause-and-effect has not yet been established, there is significant concern that patients with transfusion-dependent MDS are at high risk for developing cardiac disorders, particularly heart failure, as well as hepatic and endocrine dysfunction (NCCN, 2019e). Excess iron, and the resultant increased oxidative stress, is also associated with pancreatic dysfunction, the development of diabetes, increased rates of infection, and decreased hematopoiesis.

To prevent or reverse the complications of iron overload, iron chelation therapy is commonly implemented. Patients with preexisting liver disease, including cirrhosis, should not receive oral iron chelators. There are studies that have found that iron overload may play a role in increased mortality and morbidity in early-stage MDS due to hepatic, cardiac, and endocrine dysfunction (NCCN, 2019e). It is recommended that all patients with MDS who have regular transfusion needs have serum ferritin levels along with the number of PRBC transfusions routinely monitored to determine iron stores and possible overload. The ferritin level should be maintained at less than 1000 mcg/L. Iron is bound to the chelating agent and then excreted in the urine. Because chelation therapy removes only a small amount of iron with each treatment, patients with chronic iron overload from RBC transfusions need to continue chelation therapy as long as the iron overload exists. Oral iron chelation with deferasirox has replaced the need for the former standard therapy, which consisted of subcutaneous infusions of deferoxamine. However, adherence remains a challenge, largely due to toxicity associated with the drug.

Infection rates are high among patients with MDS, who frequently require hospitalization. Severe neutropenia, coexisting chronic obstructive pulmonary disease (COPD) or autoimmune disease, and history of other malignancy are

associated with higher risk for developing infection, whereas the extent of thrombocytopenia, age, MDS therapy, or diabetes are not (Leukemia & Lymphoma Society, 2019d; NCCN, 2019e). Pneumonia is the most common type of infection in this patient population; bacteria (both gram negative and gram positive) are the predominant pathogens.

The administration of myeloid growth factors alone may be useful in some patients with infections and severe neutropenia, but they are not typically used to prevent infection. Prophylactic antibiotics are not routinely used so that resistant organisms do not develop, but prompt initiation of antimicrobial therapy is crucial at the onset of infection to diminish the risk of increased mortality.

Nursing Management

Caring for patients with MDS can be challenging because the illness is unpredictable. As with other hematologic disorders, some patients (especially those with no symptoms) have difficulty perceiving that they have a serious illness that can place them at risk for life-threatening complications. At the other extreme, many patients have tremendous difficulty coping with the uncertain trajectory of the illness and fear that the illness will evolve into AML. Thus, it is important for patients to understand their unique risk of the disease transforming to AML and to recognize that, for most patients, MDS is a chronic illness. It is imperative that the nurse recognizes any concurrent health problems the patient may have. This knowledge will help the nurse better plan and manage the patient's care. For example, a patient with underlying heart failure or COPD may not tolerate anemia well, nor a more rapid rate of red blood cell transfusion.

Patients with MDS need extensive education about infection risk, measures to avoid it, signs and symptoms of developing infection, and appropriate actions to take should such symptoms occur. Education should also be provided regarding the risk of bleeding. Patients need to be encouraged to serve as their own health advocate, by informing other health care providers, including dentists, that they have MDS, and their risks for infection and bleeding. Patients with MDS who are hospitalized may require neutropenic precautions.

Fatigue is often a debilitating symptom for the patient with MDS and significantly interferes with quality of life. It can impair the patient's ability to function in the work or home setting and to engage in meaningful activities, and affect the patient's overall cognitive function (Leukemia & Lymphoma Society, 2019d; NCCN, 2019e). Patients may benefit from anticipatory guidance in learning how to live with this symptom, and creative strategies may be required.

Laboratory values need to be monitored closely to anticipate the need for transfusion and to determine response to treatment with growth factors. Patients with chronic transfusion requirements often benefit from the insertion of a vascular access device for this purpose. Those patients receiving chemotherapy need extensive education regarding treatment side effects (and how to manage them) and treatment schedules. Patients receiving growth factors need education about these medications, administration schedules, and side effects.

Chelation therapy is a process that is used to remove excess iron acquired from chronic transfusions. Side effects from oral chelators commonly include diarrhea and abdominal cramping. Educating the patient to take the medication in the evening prior to dinner and gradually increasing the dosage over time may diminish these side effects. Skin rash is usually mild and rarely warrants temporarily stopping the drug. Monitoring renal function is important as a rise in serum creatinine is common. The dosage should be reduced if the serum creatinine rises by more than one third of baseline. Patients with preexisting liver disease, including cirrhosis, should not receive oral iron chelators.

MYELOPROLIFERATIVE NEOPLASMS

Myeloproliferative neoplasms originate in the HSC and are characterized by clonal proliferation of one or more myeloid cell types (Arber et al., 2016; Spivak, 2018). These Philadelphia chromosome-negative myeloproliferative disorders include polycythemia vera, essential thrombocythemia, and primary myelofibrosis.

Polycythemia Vera

Polycythemia vera (sometimes called *P vera* or primary polycythemia) is the most common of the three Philadelphia chromosome-negative myeloproliferative disorders. In polycythemia vera the bone marrow is hypercellular, and the erythrocyte, leukocyte, and platelet counts in the peripheral blood are often elevated. Erythrocyte elevation predominates; the hematocrit can exceed 60% in some cases (Tefferi & Barbui, 2019). The median age at the onset is 60 years; median survival is typically 14 to 20 years (Fowlkes, Murray, Fulford, et al., 2018a; Tefferi & Barbui, 2019).

Clinical Manifestations

Clinical manifestations are variable. Some patients at the time of initial diagnosis may be asymptomatic (Spivak, 2018). If symptoms are present, they

tend to be related to erythrocytosis, with or without leukocytosis and/or **thrombocytosis** (i.e., higher-than-normal platelet count that occurs from a disease or disorder; in this instance, the disease is polycythemia vera). This increase in blood cell mass increases blood viscosity leading to (Fowlkes et al., 2018b; Harrison, Koschmieder, Foltz, et al., 2017; Spivak, 2018):

- neurologic symptoms such as headache, dizziness, vision changes, and transient ischemic attacks (TIAs);
- abdominal symptoms such as early satiety, abdominal discomfort/pain (that can also be associated with splenomegaly);
- cardiovascular symptoms including ruddy complexion, angina, claudication, dyspnea, hypertension, and thrombophlebitis; and
- constitutional symptoms such as fatigue and night sweats.

Another common symptom is pruritus, which may be caused by histamine released from an increased number of basophils. **Erythromelalgia**, characterized by a burning, painful sensation, and erythema in the fingers or toes, may also occur. Uric acid may be elevated as well, resulting in gout and renal stones formation.

Assessment and Diagnostic Findings

Diagnosis is based upon the evaluation of clinical symptoms and laboratory findings as well as the presence of a mutation of the *JAK2* gene (Arber et al., 2016). Assessment should include palpation of the spleen, and finding if the patient has a history of thrombotic events or has ever received a blood transfusion or medications associated with causing erythrocytosis (e.g., recombinant erythropoietin), as well as assessment of cardiovascular risk factors (e.g., obesity, smoking, and poorly controlled hypertension, diabetes, or hyperlipidemia; see later discussion of thrombotic risks under Complications). Some patients with the *JAK2* mutation who do not meet the criteria for a diagnosis of polycythemia vera are identified as having "masked polycythemia vera" (McMullin, Harrison, Ali, et al., 2019; Spivak, 2018). These patients are more likely to transform to myelofibrosis (see later discussion) or AML and have a poorer overall rate of survival (McMullin et al., 2019; Spivak, 2018).

Complications

Patients with polycythemia vera are at increased risk for thromboses that may be either venous or arterial. Thrombosis can result in strokes or myocardial infarctions; thrombotic complications are the most common cause of death. Patients older than 60 years of age, those with a prior history of thrombosis, or those with an elevated platelet count (exceeding 1 million/mm^3) are at greater risk for developing thrombotic complications (Tefferi & Barbui, 2019).

Patients with enlarged spleens are also at increased risk for thrombosis. Cardiovascular risk factors thought to increase thrombotic risk include obesity, smoking, and poorly controlled hypertension, diabetes, or hyperlipidemia (Barbui, Vannucchi, Carobbio, et al., 2017).

Bleeding may also be a complication of polycythemia vera and its treatment. The bleeding can be significant and can occur in the form of nosebleeds, ulcers, frank GI bleeding, hematuria, or intracranial hemorrhage. If the patient with polycythemia vera has a bleeding complication and is taking aspirin, the aspirin should be held until the bleeding is resolved (NCCN, 2019f).

Medical Management

The objectives of management are to reduce the risk of thrombosis without increasing the risk of bleeding, reduce the risk of evolution to myelofibrosis or AML, and ameliorate symptoms associated with the disease (McMullin et al., 2019) (see Table 30-2). Specific therapy is based on an established risk stratification. Patients less than age 60 and no prior history of thrombosis are considered "low risk"; those age 60 or older, or with a history of thrombosis, or both, are considered to be "high risk" (NCCN, 2019f).

TABLE 30-2 Common Constitutional Symptoms Associated with Myeloproliferative Neoplasms

Symptoms vary between the three myeloproliferative neoplasms, both in frequency and severity. Nurses should assess these patients frequently for the presence of these symptoms and initiate appropriate measures to ameliorate them.

Symptom	P Vera (%)	ET (%)	Myelofibrosis (%)
Fatigue	85	84	94
Concentration	62	58	68
Early satiety	60	56	74
Night sweats	52	47	63
Pruritus	62	46	52
Abdominal discomfort	48	48	65
Bone pain	48	45	53
Weight loss	33	28	47
Fever	19	17	24

ET, essential thrombocythemia; P vera, polycythemia vera.

Adapted from Geyer, H. L., & Mesa, R. A. (2014). Therapy for myeloproliferative neoplasms: When, which agent, and how? *Hematology American Society of Hematology Education Program*, *2014*(1), 277–286.

Phlebotomy is considered the mainstay of therapy and is used to maintain the hematocrit level at less than 45% (Spivak, 2018) (see Fig. 30-5). It involves removing enough blood (initially 500 mL once or twice weekly) to reduce blood viscosity and to deplete iron stores, thereby rendering the patient iron deficient and consequently unable to continue to manufacture excessive RBCs. Low-dose aspirin prevents vascular thrombosis without increasing the risk of bleeding and is recommended for all patients with polycythemia vera, regardless of risk (Leukemia & Lymphoma Society, 2019e; NCCN, 2019f).

Cytoreductive therapy should be considered in patients at low risk who are symptomatic due to progressive splenomegaly, leukocytosis, thrombocytosis, or have poor tolerance to phlebotomy, or whose disease has progressed to myelofibrosis or AML (McMullin et al., 2019; NCCN, 2019f). In patients at high risk, cytoreductive therapy is considered first-line treatment and might be pursued in addition to or in place of phlebotomy. Hydroxyurea, also known as hydroxycarbamide, can be used to suppress bone marrow function, thereby controlling blood counts. It has also been associated with preventing thrombotic complications (Tefferi & Barbui, 2019). Interferon-alfa is another first-line cytoreductive agent that can be selected; it is indicated in patients younger than 60 years of age, or in patients who are pregnant or intolerant of hydroxyurea (NCCN, 2019e). Interferon-alfa can also reduce splenomegaly, prevent thrombosis, and decrease pruritus. However, it may be difficult for patients to tolerate because of its side effects (e.g., flulike symptoms, depression); it is also very costly.

Figure 30-5 • Phlebotomy can markedly reduce the plethora seen in polycythemia vera. This is evidenced here by a marked reduction in facial rubor in a patient with polycythemia vera. Reprinted with permission from Turgeon, M. L. (2012). *Clinical hematology: Theory & procedures* (5th ed., Fig. 21.10, p. 373). Philadelphia, PA: Lippincott Williams & Wilkins.

Ruxolitinib is a *JAK2* inhibitor; it is used in patients who are resistant or unable to tolerate hydroxyurea and for whom interferon-alfa is not indicated (e.g., patients older than 60 years of age). This drug has been shown to reduce splenomegaly, decrease symptoms, and improve quality of life (Fowlkes et al., 2018a; McMullin et al., 2019). Common side effects of ruxolitinib include dose-dependent anemia and thrombocytopenia.

Additional cytoreductive drugs, including busulfan, pipobroman, and anagrelide, have been shown to be effective in controlling blood counts; however, these agents have been linked to an increased risk for leukemic transformation and have significant side effects. These drugs are reserved for patients who are refractory to other cytoreductive agents or with limited life expectancy (McMullin et al., 2019).

Nursing Management

Fatigue is the most commonly reported symptom in patients with polycythemia vera. It is not always correlated to disease severity. The degree of fatigue may vary, but can become so debilitating that it impairs the patient's quality of life. There are many causes of fatigue, including a release of proinflammatory **cytokines** (proteins produced by leukocytes that are vital to

regulation of hematopoiesis, apoptosis, and immune responses), impaired hematopoiesis, depression, inactivity, and the effects of certain medications (e.g., antihypertensive medications, antihistamines) (Fowlkes et al., 2018b; NCCN, 2019e). Management of fatigue can include pharmacologic agents (e.g., erythropoiesis-stimulating agents, antidepressant drugs, stimulants such as caffeine or amphetamines) and nonpharmacologic treatments (e.g., exercise, yoga, and optimizing sleep).

Another common symptom in patients is pruritus, described as strong itching, stinging, or burning. The exact etiology is not known but is thought to be related to proinflammatory cytokines. Pruritus can be triggered by contact with water of any temperature. Other causes include consuming alcohol or caffeine, having dry skin, experiencing changes in temperature, and sweating after exercise (Fowlkes et al., 2018b; Tefferi & Barbui, 2019). Antihistamines, emollient lotion, and selective serotonin reuptake inhibitors (SSRIs) are not particularly effective in controlling pruritus. Interferon-alfa and narrow band ultraviolet B phototherapy (which uses ultraviolet light for a prescribed length of time to decrease symptoms) may be used in severe cases. As the efficacy of pharmacologic strategies may not be optimal, it is important to individualize therapy and monitor for effectiveness. The nurse may recommend bathing in tepid water, avoiding vigorous toweling off after bathing, and using cocoa butter or oatmeal-based lotions.

Potentially life-threatening complications from the disease are thrombosis or hemorrhage. Risk factors for thrombotic complications, particularly a prior history of thrombosis, smoking, obesity, and poorly controlled hypertension, diabetes, and hyperlipidemia should be assessed, and patients should be encouraged to modify their cardiovascular risk factors. Adopting or maintaining a healthy lifestyle should be encouraged. Patients should be educated about the signs and symptoms of thrombosis. To reduce the likelihood of deep vein thrombosis (DVT), sedentary behavior, crossing the legs, and wearing tight or restrictive clothing (particularly stockings) should be discouraged. Patients with a history of significant bleeding are usually advised to avoid high-dose aspirin and aspirin-containing medications, because these medications alter platelet function. Minimizing alcohol intake should also be emphasized to further diminish the risk of bleeding. Patients should be counseled about the signs of bleeding. The patient needs to be instructed to avoid iron supplements, including those in over-the-counter multivitamin supplements, because the iron can further stimulate RBC production.

Essential Thrombocythemia

Essential thrombocythemia, also called primary thrombocythemia, is a rare, chronic, Philadelphia chromosome-negative myeloproliferative disorder

characterized by an increased production of megakaryocytes. A marked increase in platelet production occurs, with the platelet count consistently greater than 450,000/mm³. The platelet count can exceed 1 to 2 million/mm³. Occasionally, the **thrombocythemia** (increase in platelets without a known cause) is accompanied by an increase in erythrocytes, leukocytes, or both; however, these cells are not increased to the extent they are in polycythemia vera or myelofibrosis (see later discussion).

The exact underlying cause of essential thrombocythemia is idiopathic (i.e., unknown). Approximately 50% to 60% of patients have the *JAK2* gene mutation, and 25% of patients have the *CALR* gene mutation (Fowlkes et al., 2018a; Tefferi & Barbui, 2019). This disease affects women twice as often as men and tends to occur later in life (median age at diagnosis is 65 to 70 years). Median survival is about 20 to 33 years (Haider, Gangat, Lasho, et al., 2016); overall survival does not differ from the general population. However, survival rates vary based upon the type of gene mutation present. For example, patients with the *CALR* mutation have fewer thrombotic events and higher survival rates compared to those with the *JAK2* mutation (Tefferi & Barbui, 2019).

Clinical Manifestations

Many patients with essential thrombocythemia are asymptomatic; the illness is frequently diagnosed as the result of an incidental finding of an elevated platelet count on a CBC. Symptoms occur most often when the platelet count exceeds 1 million/mm³; however, they do not always correlate with the extent to which the platelet count is elevated. When symptoms do occur, they primarily result from vascular occlusion. This occlusion can occur in large arterial vessels (cerebrovascular, coronary, or peripheral arteries) and deep veins, as well as in the microcirculation; inflammation that may occur in the vascular endothelium may result in erythromelalgia. More common forms of venous thromboembolism (VTE), including DVT and pulmonary embolism (PE), can also occur.

One of the most common neurologic symptoms of essential thrombocythemia is headaches. Other neurologic manifestations that may be related to compromised blood flow include dizziness; lightheadedness; paresthesias; visual changes, such as diplopia; and TIAs (Fowlkes et al., 2018b; Harrison et al., 2017). Other symptoms can include tinnitus and chest pain.

Because the platelets can be dysfunctional, minor or major hemorrhage may occur. Bleeding is commonly limited to recurrent minor manifestations (e.g., ecchymoses, hematomas, epistaxis, gum bleeding), although significant GI bleeding and intracranial hemorrhage are both possible and considered major hemorrhagic events. Bleeding typically does not occur unless the platelet count

exceeds 1.5 million/mm^3. It results from a deficiency in von Willebrand factor as the platelet count increases (NCCN, 2019f).

Assessment and Diagnostic Findings

The diagnosis of essential thrombocythemia is made by ruling out other potential disorders—either other myeloproliferative disorders or underlying illnesses that cause a reactive or secondary thrombocytosis (see later discussion). Iron deficiency should be excluded, because a reactive increase in the platelet count often accompanies this deficiency. The diagnosis is typically based upon both an evaluation of clinical manifestations and laboratory findings. The CBC will show markedly enlarged and abnormal platelets, as well as a persistently elevated platelet count (greater than 450,000/mm^3). A bone marrow examination (i.e., aspirate or biopsy) can help distinguish between true essential thrombocythemia and other myelofibrotic diseases (Tefferi & Barbui, 2019).

Complications

Complications include inappropriate formation of thrombi and hemorrhage. Patients with cardiovascular risk factors (e.g., obesity, smoking, and poorly controlled hypertension, diabetes, hyperlipidemia) are at higher risk for thrombotic complications (Tefferi & Barbui, 2019). Patients older than 60 years and those with a history of prior thrombosis are at higher risk for complications. Major bleeding tends to occur when the platelet count is very high (greater than 1.5 million/mm^3) and there is a prior history of major bleeding. Cause of death in patients is often the result of thrombosis or major bleeding (collectively called thrombohemorrhagic events) or transformation to AML or myelofibrosis (Haider et al., 2016).

Medical Management

The goals of management are to minimize the risk of thrombohemorrhagic events and to control symptoms (see Table 30-2). Treatment for essential thrombocythemia is based upon a patient's risk stratification (NCCN, 2019f). Patients at low risk are less than 60 years of age, without the *JAK2* mutation, and without a prior history of thrombosis. Typical treatment for these patients includes ongoing monitoring for new thrombosis and acquired von Willebrand factor deficiency and disease-related major bleeding; management of cardiovascular risk factors (e.g., obesity, smoking, and poorly controlled hypertension, diabetes, or hyperlipidemia); and daily low-dose aspirin as long as the patient remains asymptomatic. Patients should be monitored every 3 to 6 months for signs and symptoms of disease progression. Patients at

intermediate risk are those older than age 60, without the *JAK2* mutation, and with no prior history of thrombosis. As long as the patient has not any thrombohemorrhagic events, the treatment remains the same as for low-risk patients.

A patient is deemed high risk when there is a history of thrombosis at any age or is age 60 or older or with the *JAK2* mutation. Besides use of aspirin, treatment may also include prescribing hydroxyurea, interferon-alfa, or anagrelide (see previous discussion in polycythemia vera section), all of which are effective in decreasing platelet counts to a level below 400,000/mm^3 and reducing risk for developing arterial thrombosis and hemorrhage. However, the side effects of these agents may be intolerable. As previously noted, anagrelide has been associated with disease progression to myelofibrosis or AML (McMullin et al., 2019).

Patients who develop arterial or venous thrombosis require additional treatment. Anticoagulant therapy may be useful for patients with active thrombosis (see Chapter 26 for further discussion of anticoagulation therapy) and platelet apheresis may be used in patients with acute life-threatening thrombosis or major bleeding (see Chapter 28, Table 28-3) (NCCN, 2019f).

Nursing Management

It is important to assess patients for a history of prior thrombohemorrhagic events, because these are the primary cause of morbidity and mortality. Patients with essential thrombocythemia should be educated on signs and symptoms of hemorrhage and thrombosis, particularly the neurologic manifestations, such as visual changes, numbness, tingling, and weakness. Patients should be encouraged about medication adherence and management of side effects. In particular, patients taking aspirin should be informed about the importance of taking this medication as well as the increased risk of bleeding. Those patients taking hydroxyurea should have their CBCs monitored regularly; the dosage is adjusted based on the platelet and WBC count. Patients taking interferon-alfa may be taught to self-administer the medication and how to manage its side effects.

Cardiovascular risk factors associated with thrombotic complications should be assessed, such as obesity, smoking, and poorly controlled hypertension, diabetes, or hyperlipidemia. Measures should be identified and encouraged to reduce these risks. Additionally, patients who are at risk for bleeding should be educated about medications (e.g., aspirin, nonsteroidal anti-inflammatory agents [NSAIDs]) and other substances (e.g., alcohol, certain herbal therapies) that can alter platelet function.

Primary Myelofibrosis

Primary myelofibrosis, also known as agnogenic myeloid metaplasia or myelofibrosis with myeloid metaplasia, is the rarest of the Philadelphia chromosome-negative myeloproliferative disorders; it arises from neoplastic transformation of an early HSC. This disease is characterized by bone marrow fibrosis or scarring, extramedullary hematopoiesis (typically involving the spleen or liver), leukocytosis, thrombocytosis, elevated lactic dehydrogenase (LDH), and anemia. Some patients have **pancytopenia** (i.e., diminished leukocyte, platelet, and erythrocyte counts). Patients with primary myelofibrosis have increased **angiogenesis** (formation of new blood vessels) within the marrow. Immature forms of blood cells, including nucleated RBCs and megakaryocyte fragments, are frequently found in the circulation.

The actual etiology for primary myelofibrosis is still unknown. As with polycythemia vera and essential thrombocythemia, mutations of the *JAK2* or *CALR* gene are frequently seen; prognosis is worse in those without genetic mutations. Myelofibrosis may also be secondary in nature, evolving from polycythemia vera, or less frequently, from essential thrombocythemia. In these instances, the disease progression is then called *secondary myelofibrosis* (Harrison et al., 2017).

Primary myelofibrosis is a disease of the older adult, with a median age of diagnosis at approximately 65 to 70 years of age, and is more common in males (Leukemia & Lymphoma Society, 2019e). Another risk factor is exposure to chemicals (e.g., benzene). Average survival ranges from 2 to 14 years. Common causes of death are due to cardiovascular disease, liver failure, leukemic transformation, and consequences of marrow failure (e.g., infection or bleeding).

Approximately 90% of patients present at the time of diagnosis with splenomegaly, causing abdominal discomfort and early satiety. Many patients also experience constitutional symptoms such as fatigue, night sweats, and fever, as well as pruritus, bone pain, weight loss, cachexia, thrombosis, and bleeding (see Fig. 30-6) (Tefferi, 2018). Arterial or venous thrombosis can occur but is less frequent than that found in polycythemia vera or essential thrombocythemia. Anemia occurs due to impaired erythropoiesis.

Medical Management

The goals of therapy are based upon reducing the burden of disease (by decreasing symptoms and splenomegaly) and improving blood counts (NCCN, 2019f). Treatment is based upon a patient's risk stratification; risks are increased in patients older than 65 years of age, with WBC counts above 25,000/mm^3, with hemoglobin levels less than 10 g/dL, with blast cells present in the peripheral blood, and with presence of constitutional symptoms (e.g., pruritus, night sweats, weight loss; see Table 30-2) (NCCN, 2019f).

For patients who are at low risk and asymptomatic, observation and monitoring every 3 to 6 months is recommended. Patients at intermediate risk may be started on the *JAK2* inhibitor ruxolitinib if symptomatic (see previous discussion in Polycythemia Vera), or may be considered for allogeneic HSCT. HSCT is a useful treatment modality in younger, otherwise healthy patients; it is the only current therapy that can reverse the fibrosis within the marrow (NCCN, 2019f).

Splenectomy may be performed to control potential or actual complications of an enlarged spleen. However, a reactive thrombocytosis and leukocytosis can develop because the platelets and leukocytes are no longer sequestered by the spleen and enter the circulation. Careful considerations of the advantages and disadvantages of a splenectomy should be discussed with the patient as the procedure is not without risk.

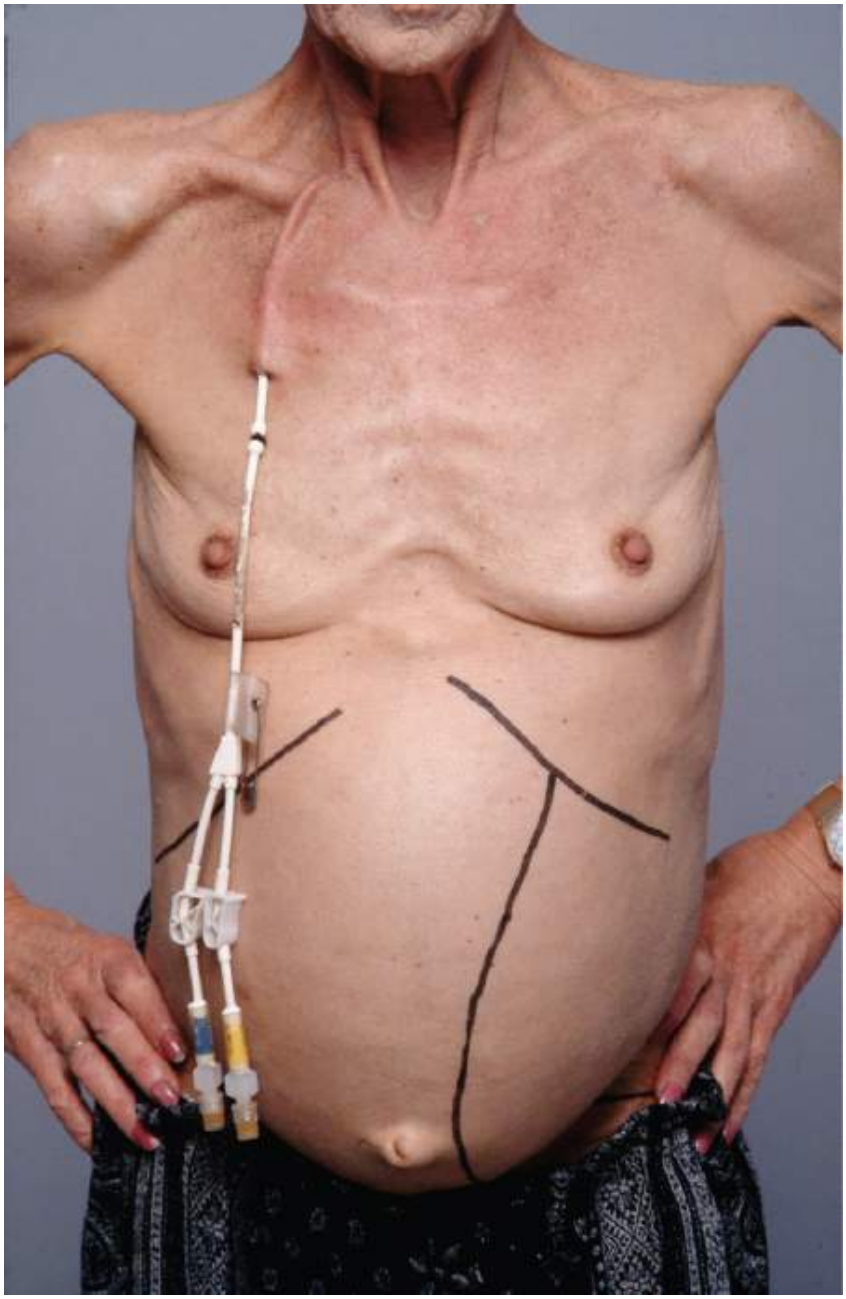

Figure 30-6 • Cachexia, severe wasting, and massively enlarged liver and spleen (hepatosplenomegaly) are seen in advanced myeloproliferative disorders, particularly myelofibrosis. (Note also the lack of adequate dressing over the patient's vascular access device.) Reprinted with permission from Tkachuk, D. C., & Hirschman, J. V. (2007). *Wintrobe's atlas of clinical hematology* (Fig. 4.1, p. 111). Philadelphia, PA: Lippincott Williams & Wilkins.

Anemia is most commonly managed with PRBC transfusions. Erythroid-stimulating agents (e.g., recombinant erythropoietin) may improve anemia to the extent that transfusion requirements are reduced. Other pharmacologic agents are used to diminish splenomegaly and improve blood counts. Hydroxyurea is often used to control high leukocyte and platelet counts and to

reduce the size of the spleen. Angiogenic inhibitors such as thalidomide or pomalidomide may be useful in improving anemia and reducing an enlarged spleen.

Nursing Management

Splenomegaly can be profound in patients with myelofibrosis, with enlargement of the spleen that may extend to the pelvic rim. This condition is extremely uncomfortable and can severely limit nutritional intake. Analgesic agents are usually ineffective. Splenomegaly, coupled with the hypermetabolic state that ensues with having an active neoplasm, results in significant weight loss, muscle wasting, and weakness. Patients benefit from small, frequent meals of foods that are high in calories and protein. Fatigue has been reported in up to 94% of patients with primary myelofibrosis (Geyer & Mesa, 2014). The nurse should educate patients about appropriate energy conservation methods. Table 30-3 identifies useful strategies at managing fatigue.

TABLE 30-3 Fatigue in Patients with Myeloproliferative Neoplasms

Self-reported strategies used to ameliorate fatigue by patients with myeloproliferative neoplasms. Data obtained from online surveys ($N = 1788$) gathered via myeloproliferative neoplasm Web sites.

Strategy	% Patients Reported Use
Setting priorities	75%
Postponing nonessential activities	74%
Exercise	73%
Naps	70%
Walking	66%
Socializing	65%
Nutrition	64%
Reading	62%
Scheduling activity during peak energy periods	62%
Pacing activities	58%
Structured daily routine	54%
Delegation	52%

Adapted from Scherber, R. M., Kosiorek, H. E., Senyak, Z., et al. (2016). Comprehensively understanding fatigue in patients with myeloproliferative neoplasms. *Cancer*, *122*(3), 477–485.

The patient needs to be educated about signs and symptoms of infection, bleeding, and thrombosis, as well as appropriate interventions if these occur. Ensuring that the patient takes steps to decrease cardiovascular risk factors

associated with developing thrombosis (e.g., obesity, smoking, and poorly controlled hypertension, diabetes, or hyperlipidemia) is also important.

LYMPHOMA

The lymphomas are neoplasms of cells of lymphoid origin. These tumors usually start in lymph nodes but can involve lymphoid tissue in the spleen, GI tract (e.g., the wall of the stomach), liver, or bone marrow (see Chapter 31, Fig. 31-1). They are often classified according to the degree of cell differentiation and the origin of the predominant malignant cell. Lymphomas are broadly classified into two categories: Hodgkin lymphoma and NHL.

Hodgkin Lymphoma

Hodgkin lymphoma is a relatively rare malignancy that has a high cure rate. It is somewhat more common in males than in females and has two peaks of incidence: one from ages 15 to 34 and the other after 60 years of age (Leukemia & Lymphoma Society, 2018c). The cause of Hodgkin lymphoma is unknown. However, several risk factors have been identified, which include age, a history of viral infections (particularly the Epstein–Barr virus, human immune deficiency virus [HIV], or human herpesvirus 8 [HHV8]), having a family history, and being exposed to cytotoxic agents. Additionally, Hodgkin lymphoma is seen more commonly in patients receiving long-term immunosuppressive therapy (e.g., organ transplant recipients) and in veterans who were exposed to the herbicide Agent Orange (see Veterans Considerations section in CLL) (Leukemia & Lymphoma Society, 2018c). The 5-year survival rate for Hodgkin lymphoma is about 92% to 94% for localized/regional disease (stage I or II) and 78% for those with distant disease (stage IV) (ACS, 2019a).

Pathophysiology

Unlike other lymphomas, Hodgkin lymphoma is unicentric in origin, meaning that it initiates in a single node. The disease spreads by contiguous extension along the lymphatic system. The malignant cell of Hodgkin lymphoma is the Reed–Sternberg cell, a gigantic tumor cell that is morphologically unique and thought to be of immature lymphoid origin. These cells arise from the B lymphocyte. They may have more than one nucleus and often have an owl-like appearance (see Fig. 30-7). The presence of Reed–Sternberg cells is the pathologic hallmark and essential diagnostic criterion.

The World Health Organization (WHO) has classified Hodgkin lymphoma into five subtypes based on pathologic analyses that reflect the natural history of the disease and suggest the prognosis (NCCN, 2019g). Four of these subtypes of Hodgkin lymphoma are recognized as being consistent with classical disease (Leukemia & Lymphoma Society, 2018c; Spinner, Varma, & Advani, 2018):

- *Nodular sclerosis*: This is the most common form of Hodgkin lymphoma, accounting for about 70% of all cases. It is seen most often in the young; among these patients, the lymph node contains elements of fibrous (sclerotic) tissue; approximately 40% of patients have B symptoms (see **Chart 30-1**). This type of Hodgkin lymphoma is highly curable.

Figure 30-7 • Reed–Sternberg cell. Reed–Sternberg cells are large, abnormal lymphocytes that may contain more than one nucleus. These cells are found in Hodgkin lymphoma. Adapted with permission from Rubin, R., Strayer, D. S., & Rubin, E. (2011). *Rubin's pathology* (6th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

- *Mixed cellularity*: This is the second most common form of Hodgkin lymphoma, accounting for 20% to 25% of all cases. This subtype is more common in older adults and in males; it is frequently seen in patients with HIV infection, and B symptoms are frequently reported.
- *Lymphocyte-depleted:* This form of Hodgkin lymphoma is rare; it is characterized by involved lymph node(s) with few normal

lymphocytes but numerous Reed–Sternberg cells. B symptoms are commonly reported.

- *Lymphocyte-rich*: This type of Hodgkin lymphoma is also an uncommon form of the disease; the lymph node(s) has numerous normal lymphocytes and Reed–Sternberg cells and B symptoms are rare.
- *Nodular lymphocytes predominant Hodgkin lymphoma* (NLPHL): This is the lone type of Hodgkin lymphoma that is not considered of the classical type. In NLPHL there are few Reed–Sternberg cells; rather, there is a predominance of lymphocyte cells called "popcorn" cells. Furthermore, there is minimal involvement of the lymph nodes as compared to the subtypes that fall under the four classical Hodgkin types. NLPHL is seen more often in males than females and the age at diagnosis is more often between 30 and 50 years. Patients tend to present with peripheral adenopathy and with early-stage disease. NLPHL is slow growing and highly curable, but some patients can relapse while others can transform to an aggressive NHL (see later discussion).

Clinical Manifestations

Hodgkin lymphoma usually begins as an enlargement of one or more lymph nodes on one side of the neck. The individual nodes are painless and firm but not hard. The most common sites for lymphadenopathy are the cervical nodes. However, other nodes that can be affected include the supraclavicular and mediastinal nodes; involvement of the iliac or inguinal nodes or spleen is much less common (Leukemia & Lymphoma Society, 2018c). A mediastinal mass may be seen on chest x-ray; occasionally, the mass is large enough to compress the trachea and cause dyspnea. B symptoms, if present, are indicative of more advanced disease (see **Chart 30-1**). These symptoms are found in about 40% of patients with Hodgkin lymphoma and are used in determining stage and prognosis (NCCN, 2019g).

All organs are vulnerable to invasion by tumor cells. Clinical manifestations result from compression of organs by the tumor, such as cough and pulmonary effusion (from pulmonary infiltrates), jaundice (from hepatic involvement or bile duct obstruction), abdominal pain (from splenomegaly or retroperitoneal adenopathy), or bone pain (from skeletal involvement). A mild anemia is the most common hematologic finding. The leukocyte count may be elevated or decreased. The platelet count is typically normal, unless the tumor has invaded the bone marrow, suppressing hematopoiesis. Laboratory tests that may be assessed to detect disease activity include the serum copper level, which may be elevated, and the **erythrocyte sedimentation rate** (ESR). The ESR

measures the rate of settling of RBCs; elevation is indicative of inflammation; it is also called the *sed rate.*

Figure 30-8 • Herpes zoster is a common complication in patients with lymphoproliferative disease, such as Hodgkin lymphoma here. Zoster infections are also common in patients on chronic steroid use for hematologic conditions and some chemotherapy regimens. Reprinted with permission from Tkachuk, D. C., & Hirschman, J. V. (2007). *Wintrobe's atlas of clinical hematology* (Fig. 5.152, p. 207). Philadelphia, PA: Lippincott Williams & Wilkins.

Other symptoms seen in patients with Hodgkin lymphoma are pruritus, which is common and can be extremely distressing, fatigue, decreased appetite, abdominal pain, splenomegaly, and although rare, occasional pain in affected lymph node after drinking alcohol (Leukemia & Lymphoma Society, 2018c). Patients may also have impaired cellular immunity, as evidenced by an absent or decreased reaction to skin sensitivity tests (i.e., Candida, mumps) and increased susceptibility to infections, particularly herpes zoster (see Fig. 30-8).

Assessment and Diagnostic Findings

Because many manifestations are similar to those occurring with infection, diagnostic studies are performed to rule out an infectious origin of the disease. The diagnosis is made by means of an excisional lymph node biopsy and the presence of Reed–Sternberg cells. Once the diagnosis is confirmed and the histologic type is established, it is necessary to assess the stage of the disease.

During the health history, the patient is assessed for any B symptoms (see **Chart 30-1**). Physical examination requires a careful, systematic evaluation of all palpable lymph node chains (see Chapter 28, Fig. 28-4), as well as the size of the spleen and liver. A chest x-ray and a computed tomography (CT) scan of the chest, abdomen, and pelvis are crucial to identify the extent of lymphadenopathy within these regions. A positron emission tomography (PET) scan is the most sensitive imaging test and is recommended for initial staging to help determine the extent of disease as well as later for evaluation of response to treatment (NCCN, 2019g). Laboratory tests include CBC with differential; serum electrolytes, blood urea nitrogen (BUN) and creatinine; ESR; liver and renal function studies; immunohistochemistry and cytogenetic evaluation; HIV testing; and hepatitis B and C testing. A multiple-gated acquisition (MUGA) scan and/or ECG should be performed prior to the start of therapy if the patient is to receive an anthracycline-based treatment regimen, as these chemotherapeutic agents are associated with adverse cardiovascular effects. Bone marrow biopsies are not routinely performed unless cytopenias are present and the PET scan is negative (NCCN, 2019g).

Medical Management

The goal in the treatment of Hodgkin lymphoma is cure, as the overall cure rate is about 90% (ACS, 2019a). Treatment is determined primarily by stage of disease, not histologic type, utilizing the Ann Arbor staging system (see Fig. 30-9).

Treatment guidelines for classical Hodgkin lymphoma (NCCN, 2019g) divide patients into groups. Patients with early disease (stage I-II) may receive one of the following combination chemotherapy regimens: ABVD (doxorubicin [trade name ***A***driamycin], ***b***leomycin, ***v***inblastine, and ***d***acarbazine) or Stanford V (doxorubicin, vinblastine, mechlorethamine, etoposide, vincristine, bleomycin, and prednisone) (see Chapter 12, Table 12-7, for further discussion of specific categories of chemotherapeutic/antineoplastic agents). Radiation therapy may or may not be included as part of the treatment regimen.

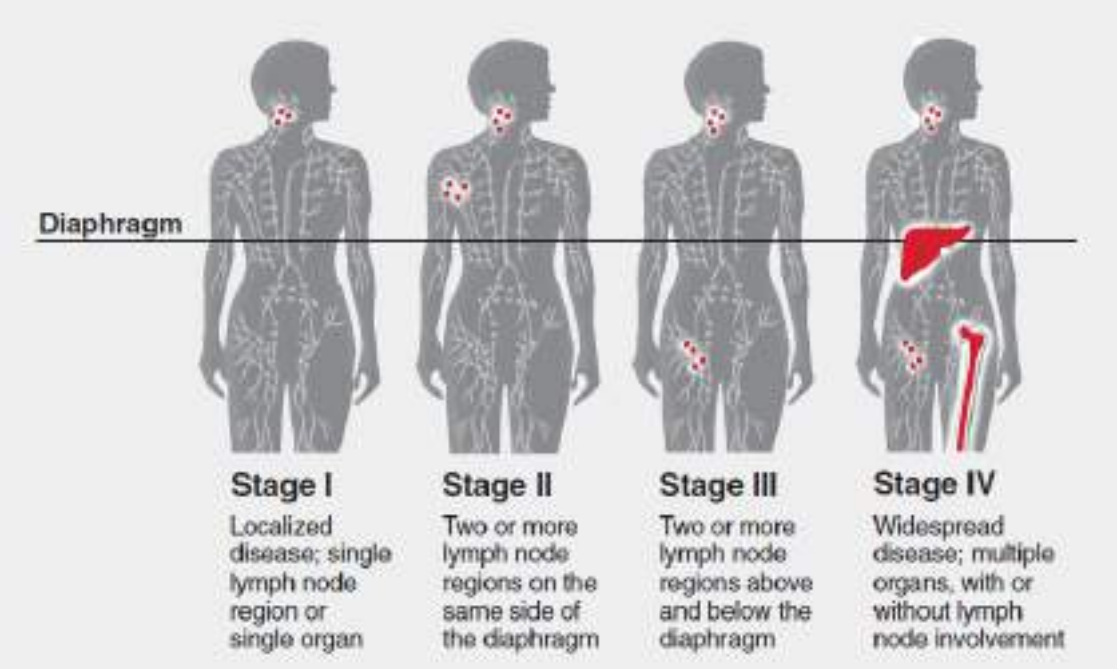

Figure 30-9 • Stages of Hodgkin lymphoma based upon the Ann Arbor staging system. Each category is subdivided and assigned to one of the following categories: Category A indicates no symptoms are present. Category B indicates the presence of B symptoms (see Chart 30-1). Category E indicates involvement of organs or tissues beyond the lymphatic system. Category S indicates involvement of the spleen. Image used with permission of The Leukemia & Lymphoma Society (Hodgkin Lymphoma, 2020).

The standard treatment for patients with advanced disease (stages III to IV) and those with B symptoms is also ABVD chemotherapy, although these patients typically receive additional cycles of chemotherapy treatment. Other combinations of chemotherapy may be used; however, these options have more toxic effects.

When a patient has a suspected relapse of disease, a biopsy and a PET scan are performed to confirm the diagnosis and stage of disease. Treatment options for patients with refractory or relapsed disease include immunotherapeutic agents, such as a monoclonal antibody (MoAb) (e.g., everolimus, brentuximab), or a checkpoint inhibitor (e.g., nivolumab, pembrolizumab) (see discussion of MoAbs and checkpoint inhibitors in Chapter 12) (Leukemia & Lymphoma Society, 2018c; NCCN, 2019g).

Treatment for patients with NLPHL in the early stage of disease may include radiation therapy only. In a few instances (patients who are stage IA), observation rather than any therapy may be an option (Spinner et al., 2018). Patients with stage IB to IIB disease may receive ABVD, CHOP (***c***yclophosphamide, doxorubicin [also less commonly called ***h***ydroxydaunorubicin], vincristine [trade name of ***O***ncovin], and ***p***rednisone),

or CVP (***c***yclophosphamide, ***v***incristine, and ***p***rednisone) regimens in combination with rituximab. Those with advanced stage disease are treated with these same regimens but with radiation therapy added.

Patients typically feel better following therapy. Late effects of treatment, which may occur months to years following treatment, include development of a secondary malignancy, or cardiovascular disease, hypothyroidism, and infertility (Leukemia & Lymphoma Society, 2018c; NCCN, 2019g). Secondary malignancies (most common are lung and breast) often develop more than 10 years following completion of therapy. This is especially true in females who received radiation therapy to the chest or axillary areas (NCCN, 2019g).

Cardiovascular disease (e.g., coronary artery disease, arrhythmias, and cardiomyopathy) is also seen 10 years posttreatment and tends to occur in patients who received mediastinal radiation or an anthracycline-based chemotherapeutic agent (e.g., daunorubicin, doxorubicin). Hypothyroidism may occur in about 50% of long-term survivors of Hodgkin lymphoma, particularly in those who received neck or upper mediastinal radiation (NCCN, 2019g). The use of some chemotherapy combinations can lead to infertility in both males and females. For instance, females of childbearing years may experience premature menopause following treatment with alkylating agents (e.g., cyclophosphamide, dacarbazine, mechlorethamine). Other organ dysfunction is also well documented, including that of the endocrine system. Persistent fatigue is common in survivors and can be exacerbated by depression and other treatment-related comorbidities (ACS, 2019a; Leukemia & Lymphoma Society, 2018c; NCCN, 2019g). Potential long-term complications associated with chemotherapy are listed in Chapter 12, Chart 12-4.

Nursing Management

The potential development of a second malignancy should be addressed with the patient when initial treatment decisions are made. However, patients need to be informed that Hodgkin lymphoma is often curable. The nurse should encourage patients to reduce factors that increase the risk of developing second cancers, such as use of tobacco and alcohol and exposure to environmental carcinogens and excessive sunlight. Screening for late effects of treatment, such as chemotherapy (see Chapter 12, Chart 12-4), is necessary. In addition, the nurse should provide education about relevant self-care strategies and disease management. See also the Nursing Management Section for Non-Hodgkin Lymphoma.

Non-Hodgkin Lymphomas

The NHLs are a heterogeneous group of cancers that originate from the neoplastic growth of lymphoid tissue. Similar to CLL, the neoplastic cells are thought to arise from a single clone of lymphocytes; however, in NHL, the cells may vary morphologically. In contrast to Hodgkin lymphoma, the lymphoid tissues involved are largely infiltrated with malignant cells. The spread of these malignant lymphoid cells occurs unpredictably; true localized disease is uncommon. Lymph nodes from multiple sites may be infiltrated, as may sites outside the lymphoid system (i.e., extranodal tissue; see Fig. 30-10).

Figure 30-10 • Any extranodal location can be a site for diffuse B-cell lymphoma, such as the thyroid, as shown here. Reprinted with permission from Tkachuk, D. C., & Hirschman, J. V. (2007). *Wintrobe's atlas of clinical hematology* (Fig. 5.87, p. 183). Philadelphia, PA: Lippincott Williams & Wilkins.

TABLE 30-4 Select Types of Lymphomas

Indolent	Aggressive
Cutaneous T cell	Anaplastic large cell
Follicular	AIDS associated
Gastric MALT	Burkitt
Lymphoplasmacytic: Waldenstrom macroglobulinemia	Diffuse large B cell
Marginal zone B cell	Mantle cell
Small-cell lymphocytic	Peripheral T cell

AIDS, acquired immune deficiency syndrome; MALT, mucosa-associated lymphoid tissue.

Adapted from Leukemia & Lymphoma Society. (2016). NHL subtypes. Retrieved on 5/14/2020 at: www.lls.org/lymphoma/non-hodgkin-lymphoma/diagnosis/nhl-subtypes

Approximately 85% of NHLs involve malignant B-cell lymphocytes, with the remaining 15% involving T-cell lymphocytes or natural killer cells (NCCN, 2019h). NHL is the seventh most common type of cancer diagnosed in the United States, accounting for about 4% to 5% of all new cancer cases each year. It occurs more commonly in males (NCCN, 2019h). The incidence increases with each decade of life; the median age at diagnosis is 66 years (Leukemia & Lymphoma Society, 2018d). The natural course of the disease is variable and dependent upon the type of lymphoma. NHLs can be categorized as **indolent** (i.e., a slow-growing cancer that often remains localized or causes few symptoms) or aggressive (i.e., a fast-growing cancer that spreads rapidly and causes significant morbidity) (see Table 30-4). For example, the 5-year survival rate for diffuse large B-cell lymphoma is 72%; for follicular lymphoma it is about 90% (96% localized disease and 85% for distant disease) (ACS, 2019b).

Although no common etiologic factor has been identified, the incidence of NHL is increased in patients who have immune deficiencies or autoimmune disorders; had prior treatment for cancer; been an organ transplant recipient; had a history of viral infections (e.g., Epstein–Barr virus, HIV, HHV8); and been exposed to herbicides, pesticides, solvents, dyes, and defoliating agents, such as Agent Orange (see Veterans Considerations section in CLL) (ACS, 2019b).

Clinical Manifestations

Symptoms of NHL are highly variable, reflecting the diverse nature of the disease. Similar to Hodgkin lymphoma, NHL may start as a painless swelling in one or more lymph nodes in the neck, axillary region, or groin. If the lymphoma is indolent in nature, symptoms may be absent or very minor.

Indolent disease accounts for about 40% of all NHL cases (Leukemia & Lymphoma Society, 2018d). However, the majority of patients are not diagnosed until the disease has progressed to a later stage, when they have become symptomatic. About one third of patients with NHL have B symptoms (see **Chart 30-1**) at the time of diagnosis (Leukemia & Lymphoma Society, 2018d).

Other symptoms depend upon enlarged lymph node site and size, which can compress organs, compromising function. For example, a mass in the mediastinum can cause cough, shortness of breath, and chest pain that may lead to cardiovascular or respiratory distress. An abdominal mass may compromise the bowel or ureters, leading to acute kidney injury or bowel obstruction. Splenomegaly can cause abdominal pain, nausea, early satiety, and weight loss.

Assessment and Diagnostic Findings

Similar to Hodgkin lymphoma, an incisional or excisional lymph node biopsy is required for immunophenotyping and cytogenetic analysis testing (NCCN, 2019h). The specific histopathologic type of the disease is used to differentiate the subtype of NHL; it also has important prognostic implications and is used to determine appropriate treatment (Leukemia & Lymphoma Society, 2018d). Flow cytometry is commonly performed to determine the specific antigen on the malignant cell. Another test that may be performed is fluorescence in situ hybridization (FISH), which analyzes the DNA and RNA of the biopsy or blood sample for chromosomal abnormalities.

Laboratory studies mirror those done for a patient with Hodgkin lymphoma (see that previous discussion). In addition, there may be testing for viruses (e.g., Epstein–Barr, HHV8, hepatitis B); polymerase chain reaction (PCR); CT scans of the chest, abdomen, and pelvis; PET scan; MUGA or ECG (if patient is to receive anthracycline-based regimen); and bone marrow biopsy and aspirate (if marrow involvement is suspected).

Although the stage of disease is important, often it is not an accurate predictor of prognosis. Two prognostic classification systems are used: the International Prognostic Index (IPI) and, for follicular lymphomas, the Follicular Lymphoma International Prognostic Index (FLIPI). Age, performance status, lactate dehydrogenase levels, stage of disease, and extranodal involvement are scored to determine risk of failure or death from disease (ACS, 2020b).

Medical Management

The goal of treatment for NHL is to obtain remission of disease by killing as many of the malignant cells as possible; in contrast, the goal is cure for

Hodgkin lymphoma. Treatment for NHL is based upon the specific subtype of lymphoma and the stage of disease. Other factors that impact treatment decisions include the patient's age, functional status, laboratory values (especially renal, hepatic, and cardiac), comorbid conditions, and presence of extranodal involvement (i.e., presence of cancer cells outside of the lymph nodes) (Leukemia & Lymphoma Society, 2016). If the disease is indolent and localized, the treatment of choice may be radiation therapy alone. "Watchful waiting" may also be a choice for patients with an indolent form of NHL, such as stage I follicular lymphoma, who have no or few symptoms at time of diagnosis.

For aggressive subtypes of NHL, combination chemotherapy is typically indicated. One of the most common combinations is CHOP. A MoAb (e.g., rituximab, obinutuzumab) may be given along with the chemotherapy (NCCN, 2019h). Radiation therapy may or may not be added to the treatment regimen. In some cases, a MoAb may be conjugated with a radioactive isotope and used for treatment (e.g., ibritumomab tiuxetan). CNS involvement is common with some aggressive forms of NHL; in this situation, cranial radiation or intrathecal chemotherapy is used in addition to systemic chemotherapy.

When NHL has relapsed or is refractory to standard treatments, other single agent or combination chemotherapy regimens may be used. For instance, the ICE regimen (i.e., ***i***fosfamide, ***c***arboplatin, and ***e***toposide) may be implemented; or agents such as bendamustine, brentuximab vedotin, romidepsin, or axicabtagene may be tried (NCCN, 2019h). Autologous HSCT (AuHSCT) is another treatment option for relapsed or refractory NHL, particularly in patients younger than 60 years (see Chapter 12 for further discussion of AuHSCT).

A rare but potentially life-threatening complication of chemotherapy is tumor lysis syndrome. Tumor lysis syndrome occurs when the intracellular content of the malignant cell breaks down and is released into the peripheral blood and typically occurs 12 to 72 hours after initiation of therapy (NCCN, 2019h). Patients with NHL at highest risk for the development of tumor lysis syndrome are those with large bulky disease and/or deemed to have high-risk or aggressive NHL (e.g., Burkitt's or diffuse large B-cell lymphoma [DLBCL]). See Chapter 12, Table 12-13, for a discussion of manifestations of and treatment for tumor lysis syndrome.

Reactivation of hepatitis B virus may be seen in patients with NHL who become immunosuppressed following chemotherapy. For example, hepatitis B reactivation can occur in patients treated with rituximab-containing regimens, even if the patient had tested negative for hepatitis B prior to start of treatment (Leukemia & Lymphoma Society, 2018d). Preemptive treatment is recommended, including antiviral therapy (i.e., lamivudine or entecavir) and close surveillance in patients at high risk.

Another rare but potentially life-threatening complication is progressive multifocal leukoencephalopathy, which may occur in patients with NHL who are severely immunocompromised and treated with chemotherapeutic agents (Leukemia & Lymphoma Society, 2018d; NCCN, 2019h). Symptoms include confusion, motor weakness or poor motor coordination, and visual and possibly speech changes. Currently, there is no effective treatment for this complication. The fatality rate is 90% and tends to occur within 2 months after the diagnosis is confirmed (NCCN, 2019h).

Nursing Management

Lymphoma is a highly complex constellation of diseases. When caring for patients with lymphoma, it is extremely important for the nurse to know the specific disease type, stage of disease, treatment history, and current treatment plan. Most of the care for patients with Hodgkin lymphoma or NHL takes place in the outpatient setting, unless complications occur (e.g., infection, respiratory compromise due to mediastinal mass). The most commonly used treatment methods are chemotherapy (often combined with a MoAb) and radiation therapy. Chemotherapy causes systemic side effects (e.g., myelosuppression, nausea, hair loss, risk of infection), whereas radiation therapy causes specific side effects that are limited to the area being irradiated. For example, patients receiving abdominal radiation therapy may experience nausea and diarrhea but not hair loss. Regardless of the type of treatment, all patients may experience fatigue (see Chapter 12, Chart 12-6, Fatigue).

The risk of infection is significant for these patients, not only from treatment-related myelosuppression but also from the defective immune response that results from the disease itself. Patients need to be educated to minimize the risks of infection, to recognize signs of possible infection, and to contact their primary provider if such signs develop (see Chapter 12, Chart 12-6, Infection).

Many lymphomas can be cured with current treatments. However, as survival rates increase, the incidence of second malignancies, particularly AML or MDS, also increases. Therefore, survivors should be screened regularly for the development of second malignancies. Survivors of both Hodgkin lymphoma and NHL may be faced with managing persistent fatigue, depression, anxiety, and cardiac and pulmonary toxicity (ACS, 2019b). Therefore, survivors should be encouraged to have regular follow-up appointments and be screened for the signs and symptoms of possible secondary malignancies. Additionally, patients should be evaluated for cardiovascular and fertility concerns with each patient visit.

The ACS (2019b) developed health behavior recommendations for cancer survivors, which include avoiding or stopping smoking, maintaining a normal body weight, practicing good nutrition habits (i.e., consuming fruits and

vegetables), and engaging in a minimum of 150 minutes of exercise per week. While many survivors do not adhere to these recommendations, those patients who do report higher health-related quality of life (ACS, 2019b).

MULTIPLE MYELOMA

Multiple myeloma is a malignant disease of the most mature form of B lymphocyte—the plasma cell. Plasma cells secrete immunoglobulins, which are proteins necessary for antibody production to fight infection. This disease accounts for approximately 1.8% of all cancers and about 17% of the hematologic malignancies in the United States (NCCN, 2019i). The etiology of multiple myeloma is not known, but risk factors are identified (see **Chart 30-3**). The incidence of multiple myeloma increases with age; the median age at diagnosis is approximately 70 years (NCCN, 2019i; Rajkumar, 2018). This disease, if left untreated, can lead to bone destruction and bone marrow failure. Due to the increased number of newer agents to fight multiple myeloma, survival of this disease has significantly improved in the last 5 years.

Pathophysiology

In multiple myeloma, the malignant plasma cells produce a specific immunoglobulin that is nonfunctional. Functional types of immunoglobulins are still produced by nonmalignant plasma cells, but in lower-than-normal quantities. The specific immunoglobulin secreted by the malignant plasma cells is referred to as the monoclonal protein, or M protein. Malignant plasma cells also secrete certain substances to stimulate angiogenesis to enhance the growth of these clusters of plasma cells. Occasionally, the malignant plasma cells infiltrate other tissue, in which case they are referred to as plasmacytomas. Plasmacytomas can occur in the sinuses, spinal cord, and soft tissues.

Chart 30-3 **RISK FACTORS**

Multiple Myeloma

- Age: rarely occurs in those less than 35 years of age; risks increase with increasing age
- African Americans have twice the risk of Whites
- Exposure to radiation, petroleum products, benzenes, and Agent Orange
- Family history, particularly among first-degree relatives (e.g., siblings, parents)
- Men have slightly higher risks than women
- Overweight or obesity
- Plasma cell disease history:
  - Monoclonal gammopathy of undetermined significance (MGUS)
  - Plasmacytoma[a]

[a]*Note*: in rare instances, may precede multiple myeloma.

Adapted from American Cancer Society (ACS). (2018). Risk factors for multiple myeloma. Retrieved on 5/15/2020 at: www.cancer.org/cancer/multiple-myeloma/causes-risks-prevention/risk-factors.html; National Comprehensive Cancer Network (NCCN). (2019i). Clinical practice guidelines in oncology: Multiple myeloma. Version 2.2019. Retrieved on 7/10/2019 at: www.nccn.org/professional/physician_gls/pdf/myeloma.pdf; Rajkumar, S. (2018). Multiple myeloma: 2018 update on diagnosis, risk-stratification, and management. *American Journal of Hematology, 93*, 1091–1110.

Multiple myeloma may evolve from a premalignant stage, known as monoclonal gammopathy of undetermined significance (MGUS) (NCCN, 2019i). Although patients with MGUS have the M protein in their blood, they generally do not have any signs and symptoms that are seen in multiple myeloma. Patients with MGUS are monitored for signs and symptoms indicative of disease progression to multiple myeloma. The rate of progression from MGUS to multiple myeloma is 0.5% to 1% per year (Rajkumar, 2018).

Clinical Manifestations

Clinical manifestations of multiple myeloma result not only from the malignant cells themselves, but also from the abnormal protein they produce. The classic clinical manifestations of multiple myeloma are referred to as the CRAB features, because they refer to the following:

- hyper***C***alcemia
- ***R***enal dysfunction
- ***A***nemia
- ***B***one destruction

Bone-related manifestations may be seen in up to 85% of patients with multiple myeloma (NCCN, 2019i). Bone pain (usually in the back or ribs) is considered to be a classic presenting symptom. Bone pain associated with multiple myeloma increases with movement and decreases with rest; patients may report that they have less pain on awakening but more during the day. In multiple myeloma, a substance secreted by the malignant plasma cells, osteoclast activating factor, and other substances, such as interleukin-6 (IL-6) stimulate osteoclasts, which break down bone matrix. In some cases, the bone breakdown or lysis can be severe enough to cause vertebral collapse and fractures, including spinal fractures, which can impinge on the spinal cord and result in spinal cord compression (see Fig. 30-11). When vertebral collapse occurs, the patient's height is reduced and kyphosis (an excessive curvature of the spine) is common.

If the bone lysis is extensive, bone lesions result and excessive ionized calcium is lost from the bone and enters the serum; hypercalcemia may therefore develop and may be manifested by excessive thirst, dehydration, constipation, altered mental status, confusion, and perhaps coma.

Quality and Safety Nursing Alert

Any older adult whose chief complaint is back pain and who has an elevated total protein level should be evaluated for possible multiple myeloma.

Renal dysfunction occurs in 33% of patients at the time of diagnosis, while 50% will experience renal dysfunction at some point during the course of the disease (Chim, Kumar, Orlowski, et al., 2018; NCCN, 2019i). The etiology of renal dysfunction is multicausal and related to: myeloma kidney as the result of Bence–Jones proteins (i.e., myeloma infiltration of the kidneys) causing obstruction in the renal tubules; hypercalcemia as the result of bone matrix lysis; amyloid deposits which may lead to renal insufficiency and/or hydronephrosis; and hyperviscosity leading to renal tubule obstruction. Other

causes of renal dysfunction in patients with multiple myeloma are infections, use of NSAIDs, and nephrotoxic agents (e.g., chemotherapy) to treat multiple myeloma (Faiman, Doss, Colson, et al., 2017).

As more malignant plasma cells are produced, the marrow has less space for erythrocyte production, and anemia may develop. If renal dysfunction is also present, anemia may also be caused by a diminished production of erythropoietin by the kidney. In the late stage of the disease, a reduced number of leukocytes and platelets may also be seen because the bone marrow is infiltrated by malignant plasma cells.

Assessment and Diagnostic Findings

All patients suspected of having multiple myeloma should have a CBC with differential, BUN, serum creatinine, creatinine clearance, serum electrolytes (especially calcium and albumin), LDH, and beta-2 microglobulin analyzed. Elevated BUN and creatinine may be indicative of renal dysfunction. The total protein level is frequently elevated because of the production of M protein. LDH and beta-2 microglobulin measure degree of tumor burden. In addition to these, a peripheral smear of the blood may reveal an abnormal stacking of RBCs (known as Rouleaux formation) due to elevated serum proteins (NCCN, 2019i). Serum protein electrophoresis or free light chain assay should be performed to detect the presence of M protein (see Fig. 30-12). This protein is elevated in patients with multiple myeloma and serves as a useful marker to monitor the extent of the disease and to gauge the patient's eventual response to therapy. Additionally, cytogenetic studies are performed to see if any of several chromosomal abnormalities typically found in patients with multiple myeloma are present. Radiographic evaluation (CT scan, MRI, and PET scan) should be performed to determine the presence of lytic bone lesions. Bone marrow aspiration and biopsy are conducted to evaluate bone marrow plasma cell abnormalities.

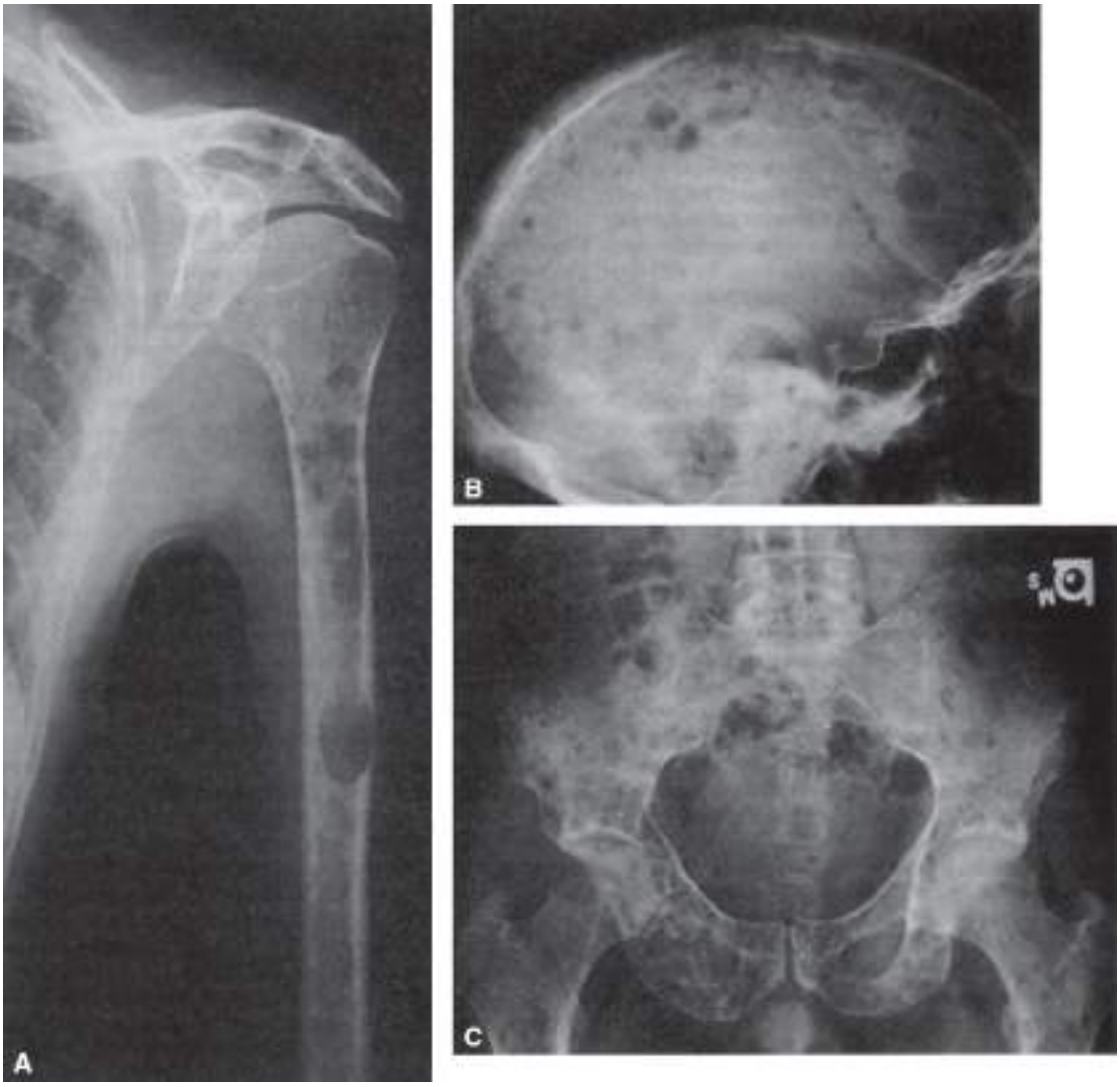

Figure 30-11 • Lytic lesions seen in the humerus and skull in patients with multiple myeloma. These lesions typically occur in the long bones, vertebrae, and skull. Long bones are susceptible to fracture when the lesion occurs near the surface of the bone; vertebrae are susceptible to collapse, resulting in loss of height and potential for spinal cord compression. Reprinted with permission from *Wintrobe's clinical hematology* (10th ed., p. 2640). Philadelphia, PA: Lippincott Williams & Wilkins.

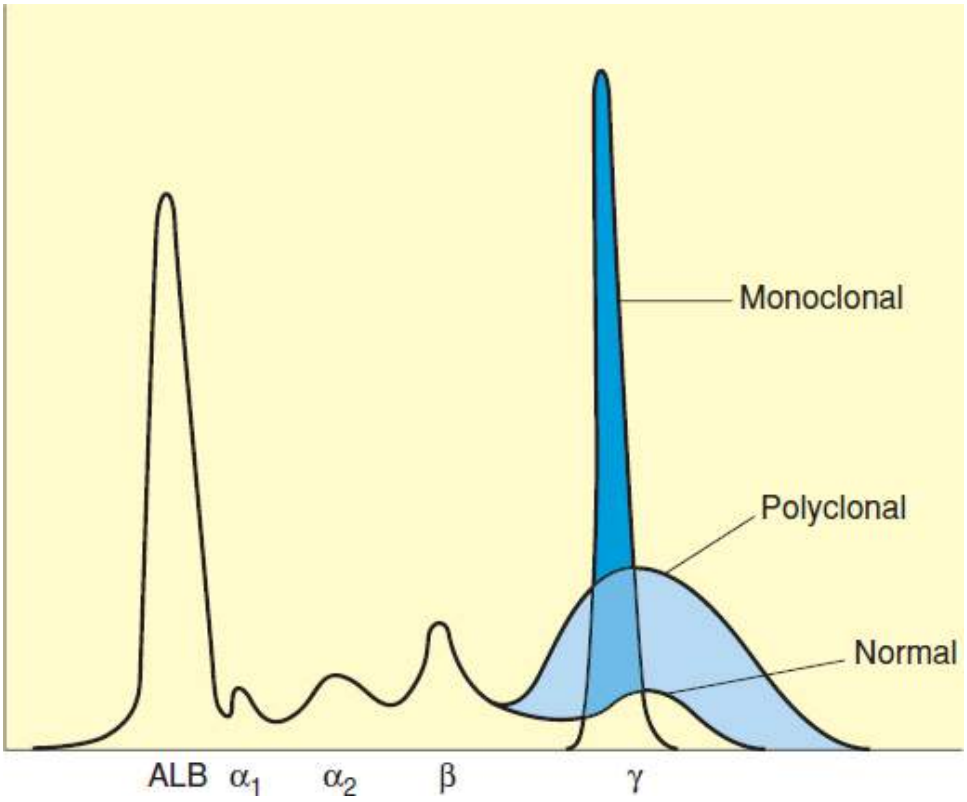

Figure 30-12 • Abnormal serum protein electrophoresis patterns contrasted with a normal pattern. Polyclonal peaks are characterized by a broad-based increase in immunoglobulin (Ig) by myriad reactive plasma cells and indicate a benign reactive process. In contrast, a narrow spike indicates homogeneity of the Ig secreted by a single clone of plasma cells. M spikes are seen in monoclonal gammopathies of undetermined significance or in plasma malignancies (myeloma, Waldenstrom macroglobulinemia). Reprinted with permission from Turgeon, M. (2012). *Clinical hematology theory & procedures* (5th ed., Fig. 20.7, p. 347). Philadelphia, PA: Lippincott Williams & Wilkins.

Diagnosis and staging of multiple myeloma was traditionally based on the CRAB criteria, and included:

- hypercalcemia (>11.5 mg/dL)
- renal insufficiency (creatinine >2 mg/dL or creatinine clearance of less than 40 mL/min)
- anemia (hemoglobin less than 10 g/dL or 2 g/dL less than normal)
- the presence of bony lesions.

The International Myeloma Working Group (IMWG) recently revised the metrics used to define the disease to include specific biomarkers (clonal plasma cells on bone marrow biopsy of 60% or greater, involved/uninvolved serum free light chain ratio of 100 or greater, and/or more than one focal lesion on MRI that is at least 5 mm or greater in size) in addition to any one or more

of the CRAB criteria (NCCN, 2019i; Rajkumar, 2018). This revision is believed to facilitate earlier diagnosis and implementation of treatment (NCCN, 2019i).

Medical Management

There is no cure for multiple myeloma; the aims of treatment are to reduce symptoms and to prolong disease progression. Therapy has changed substantively for multiple myeloma, and has resulted in impressive increases in duration of survival. Importantly, patients not only live longer, the new treatment modalities provide the opportunity for enhanced quality of life. Management of multiple myeloma depends upon whether the patient has smoldering (asymptomatic) or active (symptomatic) disease. Smoldering multiple myeloma is similar to MGUS as patients do not report any symptoms; however, there are higher levels of M protein than seen in MGUS and malignant plasma cells are present.

For most patients with smoldering multiple myeloma, observation with close surveillance for the possibility of transforming to symptomatic disease every 3 to 6 months is the standard of care (NCCN, 2019i; Rajkumar, 2018). Patients who present with symptomatic disease are evaluated for eligibility for an autologous HSCT (AuHSCT), based on age, presence of comorbidities, and risk stratification (Rajkumar, 2018).

Primary treatment for patients who are eligible for AuHSCT includes several cycles of a combination of different pharmacologic agents before stem cells are procured. These drugs all target the disease via different mechanisms than do conventional chemotherapeutic agents. Combinations of two or three drugs are commonly used with the goal of reducing the tumor burden as much as possible. These frequently include either one of the following two regimens (Rajkumar, 2018):

- Proteasome inhibitor–based bortezomib regimen, which commonly includes an immunomodulatory drug (e.g., lenalidomide, pomalidomide, or thalidomide) and the corticosteroid dexamethasone.
- MoAb-based daratumumab regimen, which commonly includes either an immunomodulatory drug (e.g., lenalidomide, pomalidomide, or thalidomide) or a proteasome inhibitor (e.g., bortezomib, carfilzomib, or ixazomib) and the corticosteroid dexamethasone.

Other agents that may be part of these regimens include doxorubicin, cyclophosphamide, cisplatin, or etoposide (see Table 30-5).

AuHSCT is considered to be the standard of care for patients with multiple myeloma following primary therapy (NCCN, 2019i), as it has demonstrated improved response rates, improved quality of life, and increased overall

survival. AuHSCT may also be indicated in patients with relapsed and refractory multiple myeloma. Single AuHSCT and tandem AuHSCT (with two AuHSCT within a 6-month period) are possible options. Another option could be an allogeneic HSCT; however, this is considered an inferior option to AuHSCT as it is associated with increased morbidity and mortality (Rajkumar, 2018).

Lenalidomide is recommended as maintenance therapy for patients following an AuHSCT and after the initial 8 to 12 cycles of primary therapy for patients who have not received an HSCT. Bortezomib may be used as an alternative maintenance treatment in patients who are intermediate to high risk.

Patients who are not candidates for AuHSCT might be prescribed the three-drug, bortezomib-based regimen, as this regimen is associated with a better response rate. For older adults or frail patients, two-drug regimens may be given (e.g., lenalidomide and dexamethasone) (Rajkumar, 2018). The regimen for patients with renal dysfunction includes bortezomib, cyclophosphamide, and dexamethasone (NCCN, 2019i).

In addition to these agents, all patients with multiple myeloma should be prescribed a bisphosphonate, such as pamidronate or zoledronic acid (NCCN, 2019i). Bisphosphonates have been shown to strengthen bone by diminishing survival of osteoclasts, thus controlling bone pain and potentially preventing bone fractures. These agents are also effective in managing and preventing hypercalcemia by preventing excessive bone resorption. Some evidence suggests that bisphosphonates may activate an antimyeloma immune response, inducing myeloma cell death, acting synergistically with antineoplastic drugs, and enhancing immune surveillance (Faiman et al., 2017) (see Chapter 36, Table 36-1, for further discussion of bisphosphonates).

Complications

Infection is a potential complication of multiple myeloma and a frequent cause of morbidity and mortality. In contrast to other hematologic malignancies, the incidence of infection does not appear to be related to the extent of neutropenia in patients with multiple myeloma. Rather, the lack of adequate levels of normal immunoglobulins, as well as other alterations of the immune system, renders the patient at increased risk for developing infection, particularly due to *Streptococcus pneumoniae* or *H. influenzae*. Therapy for the disease also predisposes the patient for acquiring infections, particularly when corticosteroids are used in treating the disease; herpes zoster and *Pneumocystis* are common causative organisms in this context (NCCN, 2019i). Infection prophylaxis with antiviral agents and antibiotics (e.g., trimethoprim–sulfamethoxazole) is important to decrease infection risk.

When plasma cells secrete excessive amounts of immunoglobulin, the serum viscosity can increase. Hyperviscosity may be manifested by bleeding

from the nose or mouth, headache, visual changes such as blurred vision or diplopia, paresthesias, or heart failure. The incidence of hyperviscosity is rare but does have the potential to be lethal. It is considered to be an oncologic emergency and as such, requires immediate intervention with aggressive hydration and plasmapheresis or therapeutic phlebotomy to reduce immunoglobulin and protein levels and to decrease symptoms (see Chapter 28, Table 28-3, for further discussion of plasmapheresis).

Neurologic complications can also occur. Spinal cord compression is the most common (see Chapter 12, Table 12-13, for discussion of manifestations and management of spinal cord compression), and other neurologic symptoms may be present, particularly peripheral neuropathy. Peripheral neuropathy may occur in as many as 75% of patients with multiple myeloma either due to infiltration of malignant plasma cells into the peripheral nerves or due to neurotoxic agents prescribed to treat the disease (e.g., bortezomib and thalidomide) (Faiman et al., 2017). Symptoms of peripheral neuropathy can range from mild discomfort to severe impairment and even paralysis and may lead to dose reduction or discontinuation of therapy.

VTE may occur in patients with myeloma; the incidence is thought to be as high as 10% (NCCN, 2019i). The risk increases substantially when high doses of corticosteroids and immumodulatory drugs (e.g., thalidomide, lenalidomide, or pomalidomide) are used to treat the disease (see Chapter 26 for further discussion of VTE management).

TABLE 30-5 Select Pharmacologic Agents for Multiple Myeloma[a]

Medication	Adverse Effects	Nursing Considerations
CHEMOTHERAPY		
Alkylating Agents Mechanism of Action: Bond with DNA, RNA, and protein molecules leading to impaired DNA replication, RNA transcription, and cell functioning; all resulting in cell death; cell cycle nonspecific		
Cisplatin Cyclophosphamide	Alopecia Bone marrow suppression (e.g., anemia, leukopenia, thrombocytopenia) Electrolyte disturbances Hemorrhagic cystitis[b] Hypersensitivity reaction Nausea and vomiting Peripheral neuropathy Renal toxicity[c] Second cancers SIADH Stomatitis	Monitor blood counts, blood chemistries and creatinine Monitor hydration status; encourage 2–3 L of fluid intake daily May premedicate patient to avoid or minimize risk for hypersensitivity reaction (e.g., dexamethasone, diphenhydramine, famotidine) and/or with antiemetics
Antitumor Antibiotic (Anthracycline-Based) Mechanism of Action: Interfere with DNA synthesis by binding DNA; prevent RNA synthesis; cell cycle nonspecific		
Doxorubicin	Alopecia Bone marrow suppression (e.g., anemia, leukopenia, thrombocytopenia) Cardiotoxicity (e.g., cardiomyopathy, arrhythmias) Diarrhea Nausea and vomiting Red urine Stomatitis	Drug is a vesicant and should be administer via central venous access. Patients should have ECG, MUGA scan to evaluate cardiac function prior to initiation of treatment. Educate patient to understand that urine will be red in color as drug is excreted.
Topoisomerase II Inhibitor Mechanism of Action: Induce breaks in the DNA strand by binding to enzyme topoisomerase, preventing cells from dividing; specific to the S phase of the cell cycle		
Etoposide	Alopecia Anorexia Bone marrow suppression (e.g., anemia, leukopenia, thrombocytopenia) Diarrhea Hypotension Hypersensitivity reaction Nausea and vomiting Stomatitis	Monitor blood counts. Monitor vital signs (especially blood pressure) prior to, during, and following administration. May premedicate patient to avoid or minimize risk for hypersensitivity reaction (e.g., dexamethasone, diphenhydramine, famotidine) and/or with antiemetics
CORTICOSTEROID		

Mechanism of Action: Induce apoptosis in myeloma cells and markedly decrease bone pain		
Dexamethasone	Cataract formation Dental caries Fluid retention Immunosuppression Increased appetite, weight gain Insomnia Osteoporosis Peptic ulcers Pseudodiabetes Psychosis Venous thromboembolism	Monitor blood counts Monitor blood glucose levels Monitor intake and output, assess for peripheral edema Assess daily weights Assess stools for occult blood Educate patient on methods to decrease risk for infection (e.g., flu vaccine, antibiotic prophylaxis as indicated) Educate patient to follow-up with dental and eye examinations Risk for venous thromboembolism is increased in patients concomitantly taking immunomodulators
IMMUNOMODULATORS Mechanism of Action: Display broad antimyeloma effects by inhibiting angiogenesis and by mitigating the effects of the cytokines interleukin-6 and tumor necrosis factor (both support myeloma cell growth)		
Lenalidomide Pomalidomide Thalidomide	Arthralgia[d] Bone marrow suppression (e.g., anemia, leukopenia, thrombocytopenia)[d,e] Constipation[f] Fatigue, dizziness, sedation[f] Fetal birth defects Peripheral neuropathy[f] Rash, dry skin Venous thromboembolism	Pregnancy test prior to initial therapy; repeat every 4 wk in women of childbearing age Male patients should be educated to use strict methods of contraception Patients must be educated about the teratogenic effects of therapy Excreted by the kidneys; therefore, monitor renal function, including urine output and serum creatinine and urea nitrogen Patient may be prescribed antithrombotic prophylaxis (e.g., aspirin, DOAC, LMWH, warfarin) (see Chapter 26 for further discussion of these drugs and nursing interventions) Risk for venous thromboembolism is increased in patients concomitantly taking corticosteroids Monitor blood counts in patients taking lenalidomide and pomalidomide Assess for peripheral neuropathy in patients taking thalidomide (see Table 30-6)
MONOCLONAL ANTIBODIES		

Mechanism of Action: Antibodies made from clonal immune cells that target specific antigens found on the surface of multiple myeloma cells; various agents target different antigenic receptors and therefore, adverse effects may differ		
Daratumumab	Back pain, arthralgia Bone marrow suppression (e.g., anemia, leukopenia, thrombocytopenia) Constipation or diarrhea Fatigue Herpes zoster reactivation Hypersensitivity reaction: most common with first infusions; manifestations include dyspnea, bronchospasm, cough, rhinitis Injection site reaction Insomnia Nausea and vomiting	May premedicate patient to avoid or minimize risk for hypersensitivity reaction (e.g., acetaminophen, diphenhydramine, methylprednisolone) and/or with antiemetics Monitor blood counts. Prophylactic antiviral agents may be considered in patients with history of herpes zoster. Female patients should avoid becoming pregnant or breastfeeding while on drug, as risks to fetus are unknown
Elotuzumab	Anorexia Bone marrow suppression (e.g., anemia, leukopenia, thrombocytopenia) Bradycardia or tachycardia Constipation or diarrhea Fatigue Hypersensitivity reaction: include dyspnea, bronchospasm, cough, rhinitis Peripheral neuropathy	May premedicate patient to avoid or minimize risk for hypersensitivity reaction (e.g., acetaminophen, diphenhydramine, dexamethasone, famotidine) Monitor blood counts Assess for peripheral neuropathy (see Table 30-6)
PROTEASOME INHIBITORS Mechanism of Action: Proteasomes process and clear the excess mis/unfolded protein that accumulates within malignant plasma cells; inhibiting this process causes an excess accumulation of these proteins that results in apoptosis of malignant cells		
Bortezomib Carfilzomib Ixazomib	Bone marrow suppression (e.g., anemia, leukopenia, thrombocytopenia) Cardiovascular events, such as heart failure, ischemia, arrhythmias (*more common with carfilzomib*) Constipation or diarrhea Fatigue Fetal birth defects Herpes zoster reactivation Metabolized via the cytochrome P450 system[g]	Monitor blood counts Patients should have ECG, MUGA scan to evaluate cardiac function prior to initiation of treatment, particularly with carfilzomib. Female patients should avoid becoming pregnant or breastfeeding. Prophylactic antiviral agents may be considered in patients with history of herpes zoster For patients prescribed bortezomib, advocate for SQ rather than IV administration, to diminish

	Nausea and vomiting Peripheral neuropathy (*more common with bortezomib)* Renal dysfunction Reversible posterior leukoencephalopathy syndrome (RPLS), evidenced by seizures, visual disturbances, delirium, and hypertension Transient thrombocytopenia[h]	likelihood of peripheral neuropathy (see Table 30-6 for further discussion) Monitor urine output and blood creatinine and urea nitrogen If RPLS suspected, discontinue treatment and call primary provider Monitor platelet counts in patients taking bortezomib; assess for signs of occult bleeding (e.g., black tarry stools, petechiae formation) Monitor for drug-to-drug interactions in patients taking ixazomib Ixazomib may be taken orally; administer at least 1 h prior to or 2 h post meal

[a]Refer to Chapter 12 for additional nursing interventions to mitigate adverse effects of antineoplastic therapy.

[b]Specific to cyclophosphamide.

[c]Specific to cisplatin.

[d]Specific to lenalidomide.

[e]Specific to pomalidomide.

[f]Specific to thalidomide.

[g]Specific to ixazomib.

[h]Specific to bortezomib.

DOAC, direct oral anticoagulant; ECG, electrocardiogram; LMWH, low-molecular-weight heparin; MUGA, multiple-gated acquisition; SIADH, syndrome of inappropriate antidiuretic hormone.

Adapted from National Comprehensive Cancer Network (NCCN). (2019i). Clinical practice guidelines in oncology: Multiple myeloma. Version 2.2019. Retrieved on 7/10/2019 at: www.nccn.org/professional/physician_gls/pdf/myeloma.pdf; Olsen, M., LeFebvre, K., & Brassil, K. (2019). *Chemotherapy and immunotherapy guidelines and recommendations for practice*. Pittsburgh, PA: Oncology Nursing Society; Rajkumar, S. (2018). Multiple myeloma: 2018 update on diagnosis, risk-stratification, and management. *American Journal of Hematology*, *93*, 1091–1110.

Gerontologic Considerations

Historically, aggressive multiple myeloma therapy, particularly HSCT, was limited to patients younger than age 65, but this approach has changed. Patients older than age 65 who have excellent organ function (i.e., renal, hepatic, cardiopulmonary) and who have fewer comorbidities may tolerate more intense treatment, including AuHSCT (Faiman et al., 2017; NCCN, 2019i). Determining an older adult patient's ability to tolerate therapy *a priori* is important. In addition to chronologic age, organ function, and comorbidity, the ability to independently perform activities of daily living is another

important factor. A comprehensive assessment of all these factors is useful to better determine the level of "fitness" in a given patient. Patients categorized as frail may develop more severe toxicity associated with therapy and consequently are more likely to discontinue that treatment.

The older adult patient may have different goals of care from that of younger patients. Effective symptom control, preserving cognitive function, and maintaining independence are often viewed as higher priority than survival in the older adult. Discussing these goals of care as well as the patient's physical and social needs can provide a more personalized approach to treating the older adult with multiple myeloma. Using lower doses of agents and focusing on side effect management are important treatment strategies. Side effects should be managed without additional medications to reduce the burden of polypharmacy. Incorporating the expertise of a palliative care clinician may be extremely beneficial, not only in devising an appropriate treatment plan, but also in managing symptoms and side effects more effectively.

Nursing Management

Pain management is very important in patients with multiple myeloma. NSAIDs can be very useful for mild pain or can be given in combination with opioid analgesics. Because NSAIDs can cause gastritis and renal dysfunction, renal function must be carefully monitored and patients assessed for GI complications; many patients are unable to use NSAIDs due to concurrent or newly developed renal insufficiency. Long-acting opioids are often prescribed to afford adequate pain relief.

Nursing care should focus on assessing for signs and symptoms of hypercalcemia. Common presenting symptoms include polyuria and GI problems (nausea, constipation, anorexia). Patients progressively become more dehydrated, with possible confusion and stupor as well as decreased renal function as the hypercalcemia worsens. Treatment for hypercalcemia includes aggressive hydration, bisphosphonates, and/or corticosteroids. See Chapter 12, Table 12-13, for a discussion of manifestations of and treatment for hypercalcemia.

Patient education should include methods to prevent and minimize the risk of infection, reportable signs and symptoms, medication side effects, and pain management. Any new complaint or worsening of pain requires immediate intervention. Another key nursing responsibility is to assess for and provide emotional/psychological support. Educating patients about effective coping skills to aid in dealing with multiple myeloma and its treatment is a key intervention.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

The patient needs to be educated about activity restrictions (e.g., lifting no more than 10 lb, the use of proper body mechanics) to reduce the risk of pathologic fracture. Braces are occasionally needed to support the spinal column, but may be uncomfortable and hamper adherence. Bisphosphonate therapy has markedly reduced the severity and extent of bone pain. However, patients need to understand the importance of comprehensive oral hygiene and good dental care to diminish the likelihood of developing osteonecrosis of the jaw that may arise from bisphosphonate therapy.

Renal function must be monitored closely. Kidney injury can become severe, and dialysis may be needed. Maintaining high urine output (3 L/day) can be very useful in preventing or limiting this complication, as is treating the underlying disease. The patient also needs to be educated about the signs and symptoms of hypercalcemia. While hypercalcemia usually occurs at the onset of the disease, it can also develop at the time of disease progression or when multiple myeloma becomes refractory to therapy. Maintaining mobility and hydration are important to diminish exacerbations of this complication.

Because antibody production is impaired, infections, particularly bacterial infections, are common and can be life-threatening. The patient needs education regarding appropriate infection prevention measures and should be advised to contact the primary provider immediately if fever or other signs and symptoms of infection develop. The patient should receive pneumococcal and influenza vaccines. Prophylactic antibiotics, such as trimethoprim–sulfamethoxazole, are often used, particularly when patients are treated with corticosteroid-containing regimens to prevent *Pneumocystis jirovecii* pneumonia (NCCN, 2019i). The antiviral agent acyclovir may be prescribed when patients are treated with bortezomib-based regimens to diminish the potential development of viral infection, such as herpes zoster. The patient must be educated about the indications for these prophylactic measures.

Continuing and Transitional Care

Many medications prescribed to treat multiple myeloma, particularly the immunomodulatory drugs (e.g., lenalidomide, thalidomide), are associated with higher risks of VTE formation, particularly when used concurrently with high doses of corticosteroids or erythropoietin. Other VTE risk factors include decreased mobility, obesity, prior thromboembolic events, diabetes, cardiac or renal disease, and the presence of a vascular access device (e.g., PICC). It is important to maintain mobility and to use strategies that enhance venous return (e.g., anti-embolism stockings, avoid crossing the legs). For patients without additional risk factors, VTE can be prevented by taking low-dose aspirin.

Those patients with additional risk factors for developing VTE should receive anticoagulation therapy (see Chapter 26 for further discussion).

Peripheral neuropathy is a frequent issue for patients with multiple myeloma, affecting over 50% at the time of diagnosis (Faiman et al., 2017). It is particularly commonplace in patients who are prescribed thalidomide or bortezomib. Painful neuropathy can be quite disabling and may interfere with the patient's ability to perform normal activities of daily living (Olsen et al., 2019) (see Table 30-6). The nurse needs to carefully assess for symptoms related to peripheral neuropathy and make assessments of the home for safety. Sensation (touch, temperature, pain, vibration, proprioception), ankle reflexes, distal muscle strength, and blood pressure should be evaluated. Other risk factors for peripheral neuropathy (e.g., diabetes, vitamin deficiencies, viral infection, or excessive alcohol consumption) should be aggressively managed. Patients should be educated to report any symptoms of peripheral neuropathy and to not minimize such symptoms, because prompt cessation of therapy or reducing the dose can prevent the neuropathy from progressing. Resuming treatment with a lower dosage and at a longer interval between dosing may diminish the worsening of peripheral nerve damage. Recovery can occur over time, although it may be incomplete. Gabapentinoids (e.g., gabapentin, pregabalin), tricyclic antidepressants (e.g., amitriptyline, nortriptyline), and selective SSRIs (e.g., duloxetine) can be prescribed to diminish pain; opioids are fairly ineffective in this context.

TABLE 30-6 Peripheral Neuropathy Associated with Multiple Myeloma

Type of Neuropathy	Manifestations	Nursing Interventions/Patient Education
Sensory	Hypoesthesia	Warn patient to avoid extreme temperatures (e.g., bathwater) Inspect feet for trauma, potential infection Use loose-fitting stockings
	Paresthesia (tingling)	Gentle massage Gentle ROM exercises
	Hyperalgesia (pain) Toes and fingers Soles of feet/palms	Gentle massage (cocoa butter or menthol-based cream/lotion) Apply lidocaine 5% patch to affected area every 12 h Consider gabapentin, tricyclic antidepressants (e.g., amitriptyline)
Motor	Muscle cramps	Maximize hydration, ambulation (Quinine is not recommended)
	Tremor	
	↓ Strength in distal muscles	
	Gait disturbance ↓ Fine motor function (e.g., handwriting, buttoning clothes)	Encourage the use of appropriate footwear Consider ambulatory aides (e.g., walker) Remove scatter rugs; perform a home safety evaluation PT referral OT referral (if severe limitations)
Autonomic Nervous System	Orthostatic hypotension	Warn patient to avoid abrupt position change Maximize hydration Consult with primary provider about adjusting antihypertensive medications, diuretics
	Bradycardia	Assess/warn patient for impact (fatigue, impairment in function) Consult with primary provider about adjusting drugs that cause bradycardia (e.g., calcium channel blockers, beta-blockers, alpha-/beta-adrenergic blockers, digoxin). Explore the use of activity to increase heart rate
	Sexual dysfunction	Explore alternative means of sexual activity beyond penile-vaginal intercourse Consult with primary provider about the use of erectile dysfunction medication
	Constipation	Maximize fluid intake, fiber Use stool softeners, laxatives

Note: Peripheral neuropathy can be classified into three main categories. Within each category, specific manifestations are delineated as well as relevant nursing interventions. If the neuropathy is related to multiple myeloma therapy, it is crucial to promptly stop the potentially offending medication. It is also important to reduce the impact from other

predisposing factors. For example, diabetes should be well controlled and alcohol consumption reduced.

↓, decreased; OT, occupational therapy; PT, physical therapy; ROM, range of motion.

Adapted from Autissier, E. (2019). Chemotherapy-induced peripheral neuropathy. *Clinical Journal of Oncology Nursing*, *23*(4), 405–410; Olsen, M., LeFebvre, K., & Brassil, K. (2019). *Chemotherapy and immunotherapy guidelines and recommendations for practice*. Pittsburgh, PA: Oncology Nursing Society.

As many drugs used in treating multiple myeloma are given orally, the nurse must ensure that the patient fully understands how to take the medication, manage side effects, and know what steps can be taken to diminish or mitigate adverse effects (see Table 30-6).

CRITICAL THINKING EXERCISES

1 ipc You work on an inpatient oncology unit and are assigned to care for a 47-year-old woman with AML who is a week and a half post induction therapy. The multidisciplinary team is now rounding on your patient and asks you for a brief report. What complications would you anticipate the patient could experience at this time? What key information do you think you should provide the multidisciplinary team? What aspects of multidisciplinary care do you identify?

2 pq You work in an outpatient infusion center and are assigned to provide a first treatment for a 74-year-old African American man who was recently diagnosed with multiple myeloma. What key assessment and laboratory studies would you focus on and why? Are there any comorbidities that could impact this patient's treatment?

3 ebp You are caring for a 57-year-old patient with diffuse large B-cell lymphoma who is not a candidate for autologous HSCT. The patient had only a partial response to consolidation therapy and is in the hospital to manage an infection. What do you anticipate are the best treatment options available for this patient? What are the possible adverse effects that you need to monitor? What evidence-based nursing interventions would you employ to manage this patient's care?

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*Asterisk indicates nursing research.

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American Cancer Society, www.cancer.org
American College of Surgeons Commission on Cancer, www.facs.org/quality-programs/cancer/coc
American Society for Transplantation and Cellular Therapy (ASTCT), www.astct.org/home
Aplastic Anemia & MDS International Foundation, www.aamds.org
Be The Match (Bone marrow transplantation network), www.bethematch.org
Blood and Marrow Transplant Information Network, www.bmtinfonet.org
Department of Veteran Affairs, information on Agent Orange, www.publichealth.va.gov/exposures/agentorange/benefits/health-care.asp
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Myelodysplastic Syndromes Foundation (MDS Foundation), www.mds-foundation.org
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National Heart, Lung, and Blood Institute, www.nhlbi.nih.gov
Oncology Nursing Society (ONS), www.ons.org

UNIT 7 Immunologic Function

Case Study

UTILIZING A TEAM APPROACH TO CARE FOR THE PATIENT WITH HIV

You are working in a community health center with an interdisciplinary team to provide care for patients with human immune deficiency virus (HIV). The team consists of a physician,

nurse, pharmacist, social worker, mental health counselor, and a registered dietician. The team is discussing the interdisciplinary management plan for a 21-year-old Hispanic male who recently became positive for HIV infection. The goal is to develop strategies for him to treat his HIV infection and prevent progression to acquired immune deficiency syndrome (AIDS). How can you, as the sole nurse on the team, foster open communication, mutual respect, and shared decision-making within the team to achieve quality patient care?

QSEN Competency Focus: **Teamwork and Collaboration**

The complexities inherent in today's health care system challenge nurses to demonstrate integration of specific interdisciplinary core competencies. These competencies are aimed at ensuring the delivery of safe, quality patient care (Institute of Medicine, 2003). The Quality and Safety Education for Nurses project (Cronenwett, Sherwood, Barnsteiner, et al., 2007; QSEN, 2020) provides a framework for the knowledge, skills, and attitudes (KSAs) required for nurses to demonstrate competency in these key areas, which include ***patient-centered care***, ***interdisciplinary teamwork and collaboration***, ***evidence-based practice***, ***quality improvement***, ***safety***, and ***informatics.***

Teamwork and Collaboration Definition: Function effectively within nursing and interprofessional teams, fostering open communication, mutual respect, and shared decision-making to achieve quality patient care.

SELECT PRE-LICENSURE KSAs	APPLICATION AND REFLECTION
Knowledge	
Describe scopes of practice and roles of health care team members Describe strategies for identifying and managing overlaps in team member roles and accountabilities Recognize contributions of other individuals and groups in helping patient/family achieve health goals	Describe the various roles of the team in managing a patient with HIV. How does your role complement the other members of the team? Why does this patient require a variety of team members to facilitate his disease management?
Skills	
Demonstrate awareness of own strengths and limitations as a team member Initiate plan for self-development as a team member	Discuss how the team approaches the management of the laboratory findings for this patient who is newly diagnosed with HIV. Describe how each member can provide education to him regarding the antiretroviral medications and how they can be used to manage the abnormal laboratory results related to this disease process. Describe how the role of the team changes during the various phases of the disease process.
Attitudes	
Value teamwork and the relationships	After the members of the team meet with the patient, what are ways each member can advocate for this patient's needs? How can you ensure all team

upon which it is based	members are communicating and collaborating together as a team?
Value different styles of communication used by patients, families, and health care providers	

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31 Assessment of Immune Function

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the body's general immune responses and the stages of the immune response.
2. Differentiate between cellular and humoral immune responses.
3. Specify the effects of select variables on function of the immune system.
4. Use assessment parameters for determining the status of patients' immune function.

NURSING CONCEPTS

Assessment
Cellular Regulation
Immunity
Infection
Nutrition

GLOSSARY

agglutination: clumping effect occurring when an antibody acts as a cross-link between two antigens

antibody: a protein substance developed by the body in response to and interacting with a specific antigen

antigen: substance that induces the production of antibodies

antigenic determinant: the specific area of an antigen that binds with an antibody-combining site and determines the specificity of the antigen–antibody reaction

apoptosis: programmed cell death that results from the digestion of deoxyribonucleic acid by end nucleases

B cells: cells that are important for producing a humoral immune response

cellular immune response: the immune system's third line of defense, involving the attack of pathogens by T cells

complement: series of enzymatic proteins in the serum that, when activated, destroy bacteria and other cells

cytokines: generic term for nonantibody proteins that act as intercellular mediators, as in the generation of immune response

cytotoxic T cells: lymphocytes that lyse cells infected with virus; also play a role in graft rejection

epitope: any component of an antigen molecule that functions as an antigenetic determinant by permitting the attachment of certain antibodies

genetic engineering: emerging technology designed to enable replacement of missing or defective genes

helper T cells: lymphocytes that attack foreign invaders (antigens) directly

humoral immune response: the immune system's second line of defense (*synonym:* antibody response)

immune response: the coordinated response of the components of the immune system to a foreign agent or organism

immune system: the collection of organs, cells, tissues, and molecules that mediate the immune response

immunity: the body's specific protective response to a foreign agent or organism; resistance to disease, specifically infectious diseases

immunopathology: study of diseases resulting in dysfunctions within the immune system

immunoregulation: complex system of checks and balances that regulates or controls immune responses

immunosenescence: the gradual deterioration of the immune system brought on by the aging process

interferons: proteins formed when cells are exposed to viral or foreign agents; capable of activating other components of the immune system

lymphokines: substances released by sensitized lymphocytes when they come in contact with specific antigens

memory cells: cells that are responsible for recognizing antigens from previous exposure and mounting an immune response

natural killer (NK) cells: lymphocytes that defend against microorganisms and malignant cells

null lymphocytes: lymphocytes that destroy antigens already coated with the antibody

opsonization: the coating of antigen–antibody molecules with a sticky substance to facilitate phagocytosis

phagocytic cells: cells that engulf, ingest, and destroy foreign bodies or toxins

phagocytic immune response: the immune system's first line of defense, involving white blood cells that have the ability to ingest foreign particles

stem cells: precursors of all blood cells; reside primarily in the bone marrow

suppressor T cells: lymphocytes that decrease B-cell activity to a level at which the immune system is compatible with life

T cells: cells that are important for producing a cellular immune response

Immunity is the body's specific protective response to a foreign agent or organism. The **immune system** functions as the body's defense mechanism against invasion and allows a rapid response to foreign substances in a specific manner. Genetic and cellular responses result. Any qualitative or quantitative change in the components of the immune system can produce profound effects on the integrity of the human organism. Immune function is affected by a variety of factors, such as central nervous system integrity, general physical and emotional status, medications, dietary patterns, and the stress of illness, trauma, or surgery. Immune memory is a property of the immune system that provides protection against harmful microbial agents despite the timing of re-exposure to the agent. Tolerance is the mechanism by which the immune system is programmed to eliminate foreign substances such as microbes, toxins, and cellular mutations but maintains the ability to accept self-antigens. Some credence is given to the concept of surveillance, in which the immune system is in a perpetual state of vigilance, screening and rejecting any invader that is recognized as foreign to the host. The term **immunopathology** refers to the study of diseases that result from dysfunctions within the immune system. Immune system dysfunctions can occur across the lifespan; many are

genetically based, others are acquired. Disorders of the immune system may stem from excesses or deficiencies of immunocompetent cells, alterations in the function of these cells, immunologic attack on self-antigens, or inappropriate or exaggerated responses to specific antigens (Table 31-1).

Primary immunodeficiencies and acquired immune disorders affect large numbers of the population. Thus, nurses in many practice settings need to understand how the immune system functions as well as immunopathologic processes. In addition, knowledge about assessment and care of people with immunologic disorders enables nurses to make appropriate management decisions.

TABLE 31-1 Immune System Disorders

Disorder	Description
Autoimmunity	Normal protective immune response paradoxically turns against or attacks the body, leading to tissue damage
Hypersensitivity	Body produces inappropriate or exaggerated responses to specific antigens
Gammopathies	Overproduction of immunoglobulins
Immune deficiencies	
Primary	Deficiency results from improper development of immune cells or tissues; usually congenital or inherited
Secondary	Deficiency results from some interference with an already developed immune system; usually acquired later in life

Anatomic and Physiologic Overview

Accurate assessment of immune function necessitates the nurse having a good working knowledge of the anatomy and physiology of the immune system.

Anatomy of the Immune System

The immune system is composed of an integrated collection of various cell types, each with a designated function in defending against infection and invasion by other organisms. Supporting this system are molecules that are responsible for the interactions, modulations, and regulation of the system. These molecules and cells participate in specific interactions with immunogenic **epitopes** (antigenic determinants) present on foreign materials, initiating a series of actions in a host, including the inflammatory response, the lysis of microbial agents, and the disposal of foreign toxins. The major components of the immune system include central and peripheral organs, tissues, and cells (Fig. 31-1).

Bone Marrow

The white blood cells (WBCs) involved in immunity are produced in the bone marrow (Fig. 31-2). Like other blood cells, lymphocytes are generated from **stem cells** (undifferentiated cells). There are two types of lymphocytes—**B cells**, also called B lymphocytes, and **T cells**, also called T lymphocytes (Fig. 31-3).

Lymphoid Tissues

The spleen, composed of red and white pulp, acts somewhat like a filter. The red pulp is the site where old and injured red blood cells (RBCs) are destroyed. The white pulp contains concentrations of lymphocytes. The lymph nodes, which are connected by lymph channels and capillaries, are distributed throughout the body. They remove foreign material from the lymph system before it enters the bloodstream. The lymph nodes also serve as centers for immune cell proliferation. The remaining lymphoid tissues contain immune cells that defend the body's mucosal surfaces against microorganisms (Klimov, 2019).

Function of the Immune System

The basic function of the immune system is to remove foreign antigens such as viruses and bacteria to maintain homeostasis. There are two general types of immunity: natural (innate) and acquired (adaptive). Natural immunity or nonspecific immunity is present at birth. Acquired or specific immunity develops after birth. Each type of immunity has a distinct role in defending the body against harmful invaders, but the various components are usually interdependent (Klimov, 2019).

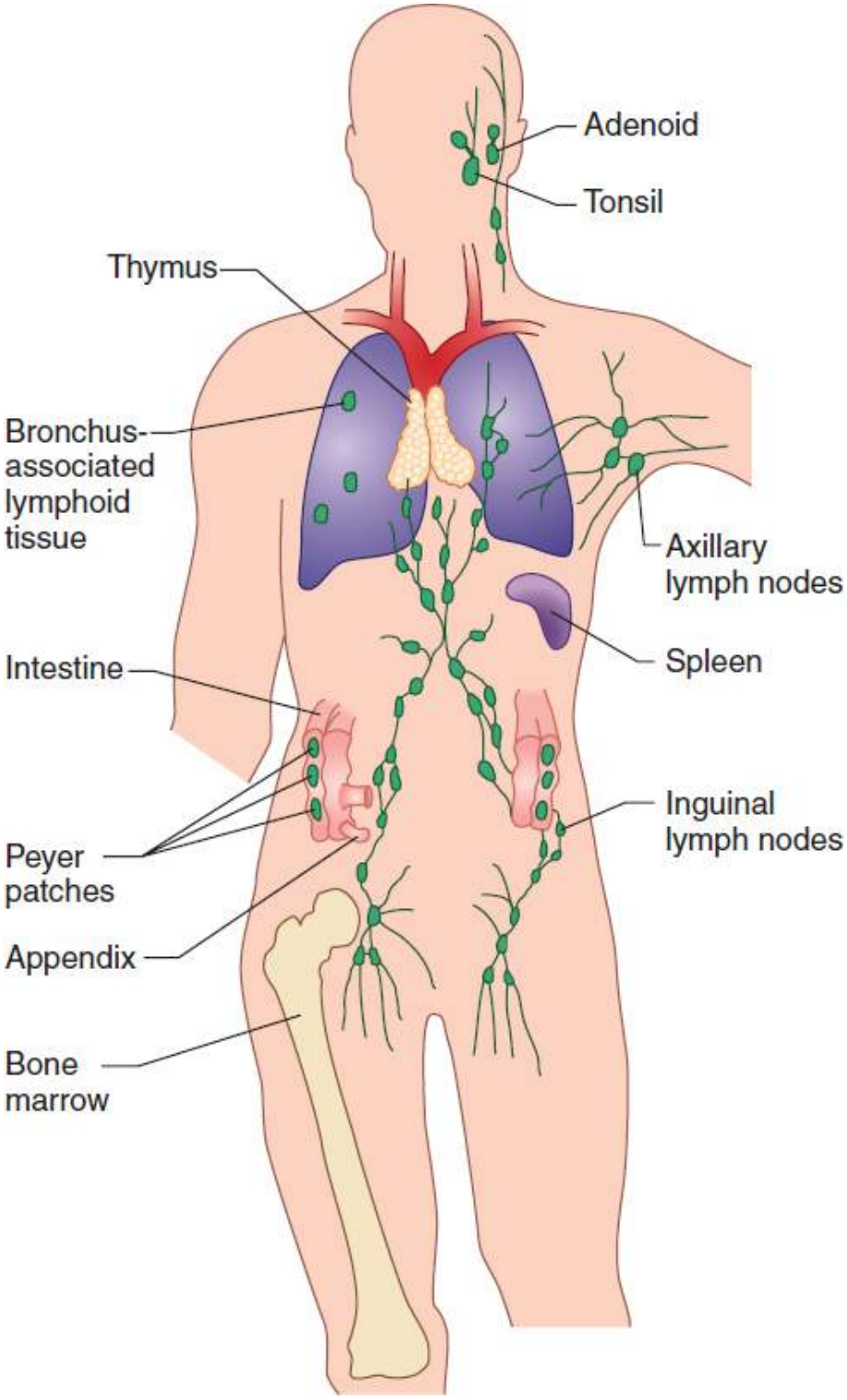

Figure 31-1 • Central and peripheral lymphoid organs, tissues, and cells. Reprinted with permission from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed., Fig. 11.12, p. 296). Philadelphia, PA: Wolters Kluwer.

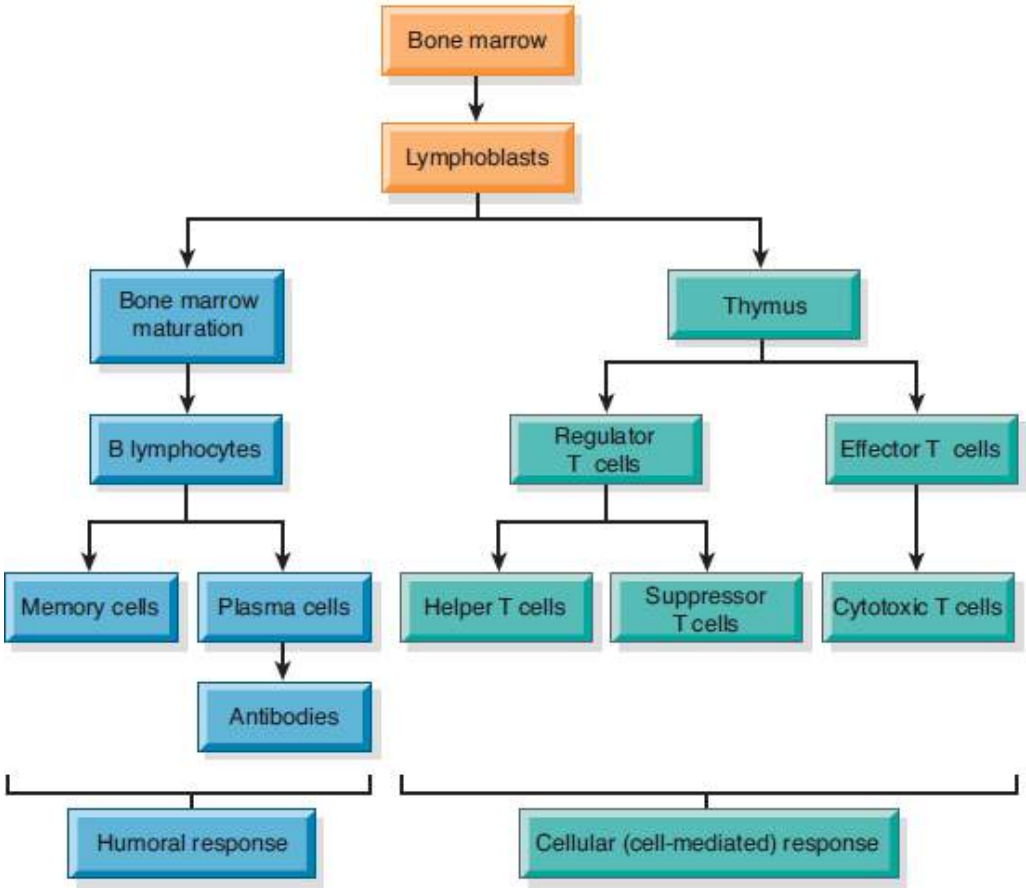

Figure 31-2 • Development of cells of the immune system.

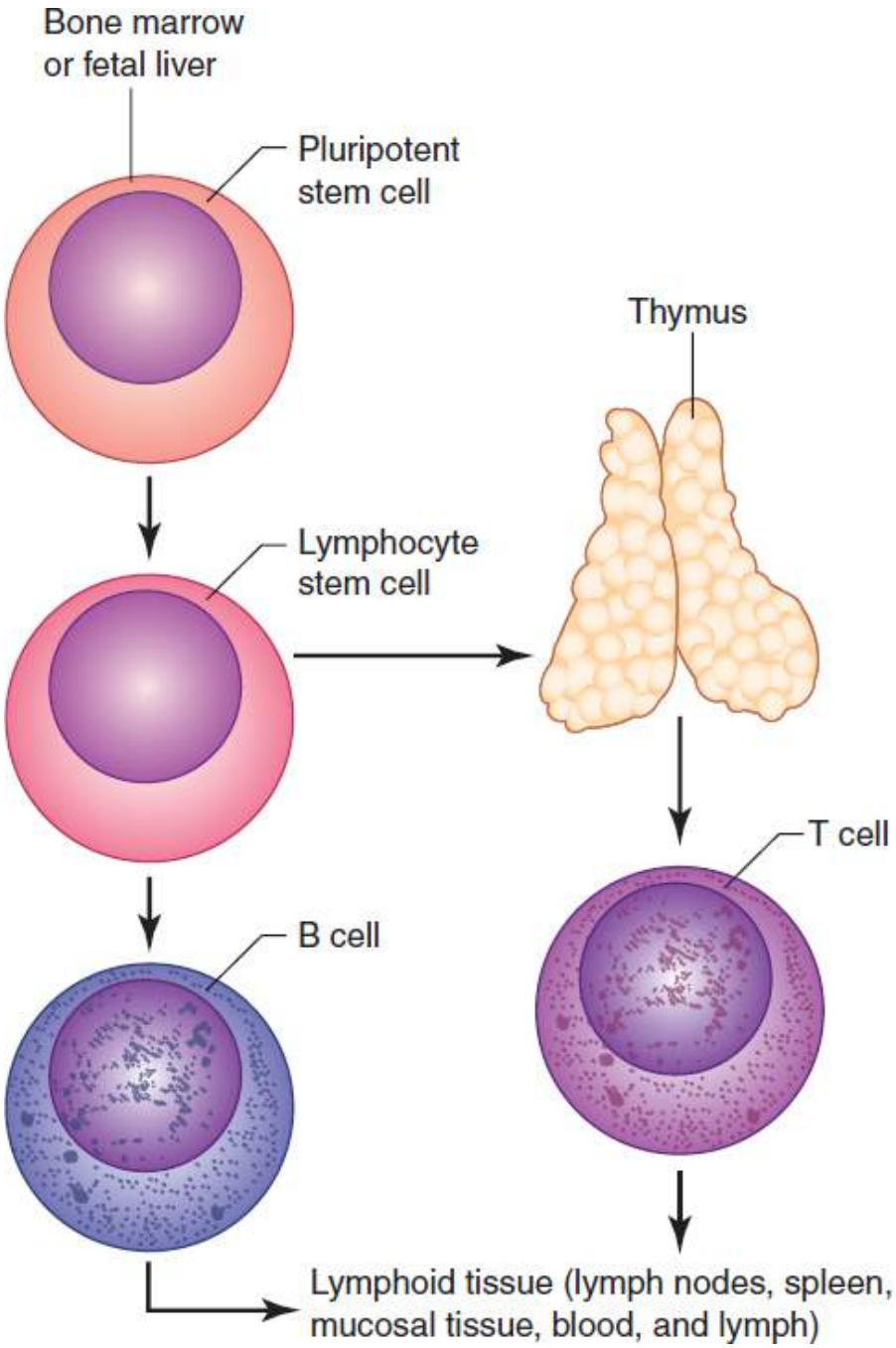

Figure 31-3 • Pathway for T- and B-cell differentiation. Reprinted with permission from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed., Fig. 11.5, p. 288). Philadelphia, PA: Wolters Kluwer.

Natural Immunity

Natural immunity, which is nonspecific, provides a broad spectrum of defense against and resistance to infection. It is considered the first line of host defense following antigen exposure, because it protects the host without remembering prior contact with an infectious agent (Norris, 2019). Responses to a foreign invader are very similar from one encounter to the next, regardless of the

number of times the invader is encountered. Natural (innate) immunity coordinates the initial response to pathogens through the production of cytokines and other effector molecules, which either activate cells for control of the pathogen (by elimination) or promote the development of the acquired **immune response**. The cells involved in this response are monocytes, macrophages, dendritic cells, **natural killer (NK) cells**, basophils, eosinophils, and granulocytes. The early events in this process are critical in determining the nature of the adaptive immune response. Natural immune mechanisms can be divided into two stages: immediate (generally occurring within minutes) and delayed (occurring within several days after exposure) (Norris, 2019).

White Blood Cell Action

The cellular response is the key to the effective initiation of the immune response. WBCs, or leukocytes, participate in both the natural and the acquired immune responses. Granular leukocytes, or granulocytes (so called because of granules in their cytoplasm), fight invasion by foreign bodies or toxins by releasing cell mediators, such as histamine, bradykinin, and prostaglandins, and by engulfing the foreign bodies or toxins. Granulocytes include neutrophils, eosinophils, and basophils.

Neutrophils (polymorphonuclear leukocytes) are the first cells to arrive at the site where inflammation occurs. Eosinophils and basophils, other types of granulocytes, increase in number during allergic reactions and stress responses. Nongranular leukocytes include monocytes or macrophages (referred to as histiocytes when they enter tissue spaces) and lymphocytes. Monocytes are the first to arrive on the scene and function as **phagocytic cells**, engulfing, ingesting, and destroying greater numbers and quantities of foreign bodies or toxins than granulocytes do. Lymphocytes, consisting of B cells and T cells, play major roles in humoral and cell-mediated immune responses. About 70% to 80% of lymphocytes in the blood are T cells, and about 10% to 15% are B cells (Haynes, Soderberg, & Fauci, 2018).

Inflammatory Response

The inflammatory response is a major function of the natural immune system that is elicited in response to tissue injury or invading organisms. Chemical mediators assist this response by minimizing blood loss, walling off the invading organism, activating phagocytes, and promoting formation of fibrous scar tissue and regeneration of injured tissue. The inflammatory response (discussed further in Chapter 5) is facilitated by physical and chemical barriers that are part of the human organism.

Physical and Chemical Barriers

Activation of the natural immunity response is enhanced by processes inherent in physical and chemical barriers. Physical surface barriers include intact skin,

mucous membranes, and cilia of the respiratory tract, which prevent pathogens from gaining access to the body. The cilia of the respiratory tract, along with coughing and sneezing responses, filter and clear pathogens from the upper respiratory tract before they can invade the body further. Chemical barriers, such as mucus, acidic gastric secretions, enzymes in tears and saliva, and substances in sebaceous and sweat secretions, act in a nonspecific way to destroy invading bacteria and fungi. Viruses are countered by other means, such as interferon (see discussion later in chapter).

Immune Regulation

Regulation of the immune response involves balance and counterbalance. Dysfunction of the natural immune system can occur when the immune components are inactivated or when they remain active long after their effects are beneficial. A successful immune response eliminates the responsible antigen. If an immune response fails to develop and clear an antigen sufficiently, the host is considered immunocompromised or immunodeficient. If the response is overly robust or misdirected, allergies, asthma, or autoimmune disease results. The immune system's recognition of one's own cells or tissues as "foreign" rather than as self is the basis of many autoimmune disorders (Norris, 2019). While the immune response is critical to the prevention of disease, it must be well controlled to curtail immunopathology. Most microbial infections induce an inflammatory response mediated by T cells and cytokines, which, in excess, can cause tissue damage (Haynes et al., 2018). Therefore, regulatory mechanisms must be in place to suppress or halt the immune response. This is mainly achieved by the production of cytokines and transformation of growth factor that inhibit macrophage activation. In some cases, T-cell activation is so acute that these mechanisms fail, and pathology develops. Ongoing research on **immunoregulation** holds the promise of preventing graft rejection and aiding the body in eliminating cancerous or infected cells (Chae & Bothwell, 2018; Romano, Fanelli, Albany, et al., 2019).

Although natural immunity can often effectively combat infections, many pathogenic microbes have evolved that resist natural immunity. Acquired immunity is necessary to defend against these resistant agents.

Acquired Immunity

Acquired (adaptive) immunity usually develops due to prior exposure to an antigen through immunization (vaccination) or by contracting a disease, both of which generate a protective immune response. Weeks or months after exposure to a disease or vaccine, the body produces an immune response that is sufficient to defend against the disease on re-exposure. In contrast to the rapid but nonspecific natural immune response, this form of immunity relies on the recognition of specific foreign antigens. The acquired immune response

is broadly divided into two mechanisms: (1) the cell-mediated response, involving T-cell activation, and (2) effector mechanisms, involving B-cell maturation and production of antibodies (Haynes et al., 2018).

The two types of acquired immunity are known as active and passive and are interrelated. Active acquired immunity refers to immunologic defenses developed by the person's own body. This immunity typically lasts many years or even a lifetime. Passive acquired immunity is temporary immunity transmitted from a source outside the body that has developed immunity through previous disease or immunization. Examples include immunity resulting from the transfer of antibodies from the mother to an infant in utero or through breast-feeding or receiving injections of immune globulin. Active and passive acquired immunity involve humoral and cellular (cell-mediated) immunologic responses (described later).

Response to Invasion

When the body is invaded or attacked by bacteria, viruses, or other pathogens, it has three means of defense:

- The phagocytic immune response
- The humoral or antibody immune response
- The cellular immune response

The first line of defense, the **phagocytic immune response**, primarily involves the WBCs (granulocytes and macrophages), which ingest foreign particles and destroy the invading agent; eosinophils are only weakly phagocytic. Phagocytes also remove the body's own dying or dead cells. Cells in necrotic tissue that are dying release substances that trigger an inflammatory response. **Apoptosis**, or programmed cell death, is the body's way of destroying worn-out cells such as blood or skin cells or cells that need to be renewed (Norris, 2019).

A second protective response, the **humoral immune response** (*synonym:* antibody response), begins with the B lymphocytes, which can transform themselves into plasma cells that manufacture antibodies. An **antibody** is a protein substance developed by the body, transported in the bloodstream, and attempts to disable invaders. The third mechanism of defense, the **cellular immune response**, involves the T lymphocytes, which can turn into special cytotoxic (or killer) T cells that can attack the pathogens.

The structural part of the invading or attacking organism that is responsible for stimulating antibody production is called an **antigen** (or an immunogen). For example, an antigen can be a small patch of proteins on the outer surface of a microorganism. Not all antigens are naturally immunogenic; some must be coupled to other molecules to stimulate the immune response. A single bacterium or large molecule, such as a diphtheria or tetanus toxin, may have several antigens, or markers, on its surface, thus inducing the body to produce many different antibodies. Once produced, an antibody is released into the

bloodstream and carried to the attacking organism. There, it combines with the antigen, binding with it like an interlocking piece of a jigsaw puzzle (Fig. 31-4). There are four well-defined stages in an immune response: recognition, proliferation, response, and effector (Fig. 31-5).

Recognition Stage

Recognition of antigens as foreign, or non-self, by the immune system is the initiating event in any immune response. Recognition involves the use of lymph nodes and lymphocytes for surveillance. Lymph nodes are widely distributed internally throughout the body and in the circulating blood, as well as externally near the body's surfaces. They continuously discharge small lymphocytes into the bloodstream. These lymphocytes patrol the tissues and vessels that drain the areas served by that node. Lymphocytes recirculate from the blood to lymph nodes and from the lymph nodes back into the bloodstream in a continuous circuit. Lymphocytes and other cells have "microbial sensors" that identify molecules on microbes and other microorganisms. The interaction of these sensors with the offending agent sets off a cascade aimed at destroying the microbe. Invading organisms have pathogen-associated molecular patterns (PAMPs) contained in their cell membranes that are recognized by the immune system cells. Once the receptors on the immune cells reach the PAMPs, the immune response is triggered. Macrophages play an important role in helping the circulating lymphocytes process the antigens. Both macrophages and neutrophils have receptors for antibodies and complement; as a result, they coat microorganisms with antibodies, complement, or both, thereby enhancing phagocytosis (Norris, 2019).

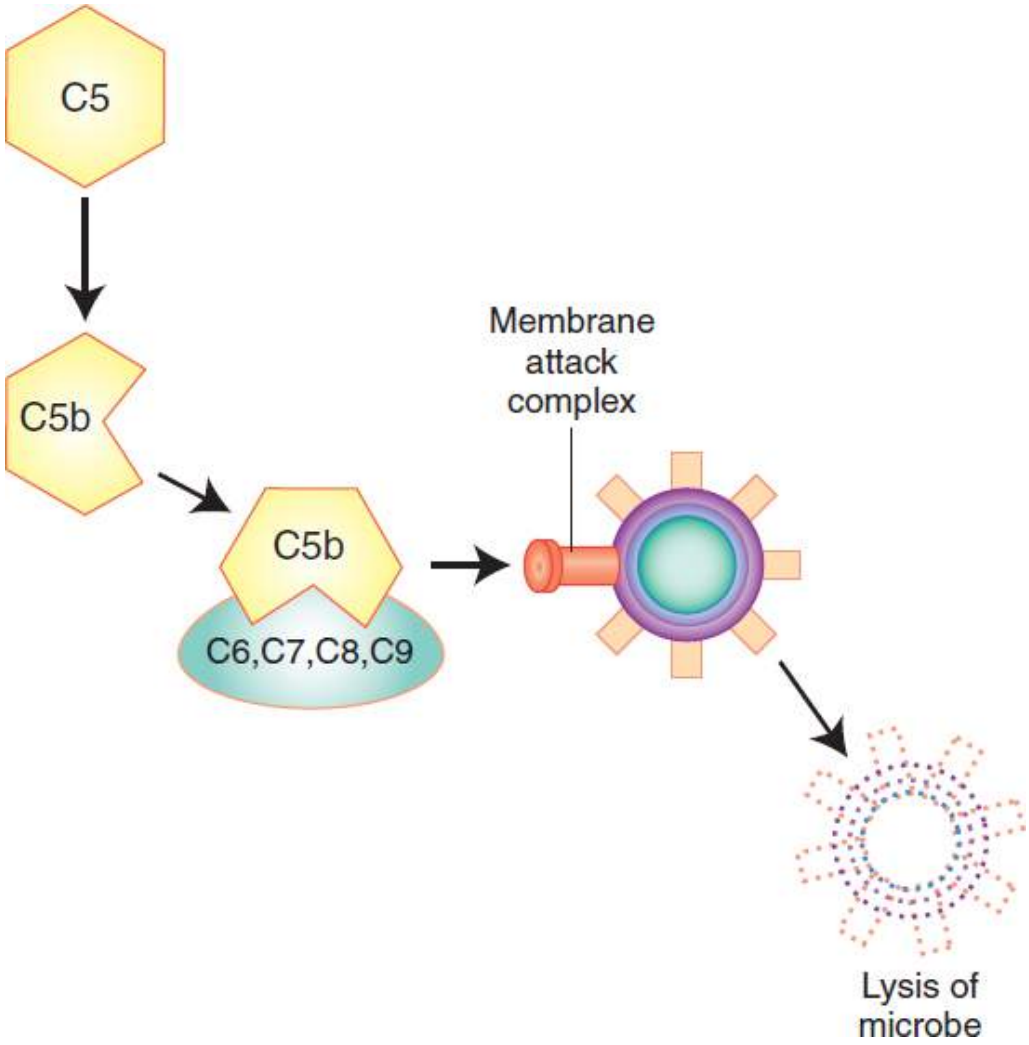

Figure 31-4 • Complement-mediated immune responses. Reprinted with permission from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed., second figure in Understanding box, p. 286). Philadelphia, PA: Wolters Kluwer.

In a streptococcal throat infection, for example, the streptococcal organism gains access to the mucous membranes of the throat. A circulating lymphocyte moving through the tissues of the throat comes in contact with the organism. The lymphocyte recognizes the antigens on the microbe as different (non-self) and the streptococcal organism as antigenic (foreign). This triggers the second stage of the immune response—proliferation.

Proliferation Stage

The circulating lymphocytes containing the antigenic message return to the nearest lymph node. Once in the node, these sensitized lymphocytes stimulate some of the resident T and B lymphocytes to enlarge, divide, and proliferate. T lymphocytes differentiate into cytotoxic (or killer) T cells, whereas B

lymphocytes produce and release antibodies. Enlargement of the lymph nodes in the neck in conjunction with a sore throat is one example of the immune response.

Response Stage

In the response stage, the differentiated lymphocytes function in either a humoral or a cellular capacity. This stage begins with the production of antibodies by the B lymphocytes in response to a specific antigen. The cellular response stimulates the resident lymphocytes to become cells that attack microbes directly rather than through the action of antibodies. These transformed lymphocytes are known as cytotoxic (killer) T cells.

Viral antigens induce a cellular response. This response is manifested by the increasing number of T lymphocytes (lymphocytosis) seen in the blood tests of people with viral illnesses such as infectious mononucleosis. (Cellular immunity is discussed later in this chapter.) Most immune responses to antigens involve both humoral and cellular responses, although one usually predominates. For example, during transplant rejection, the cellular response involving T cells predominates, whereas in the bacterial pneumonias and sepsis, the humoral response involving B cells plays the dominant protective role (Chart 31-1).

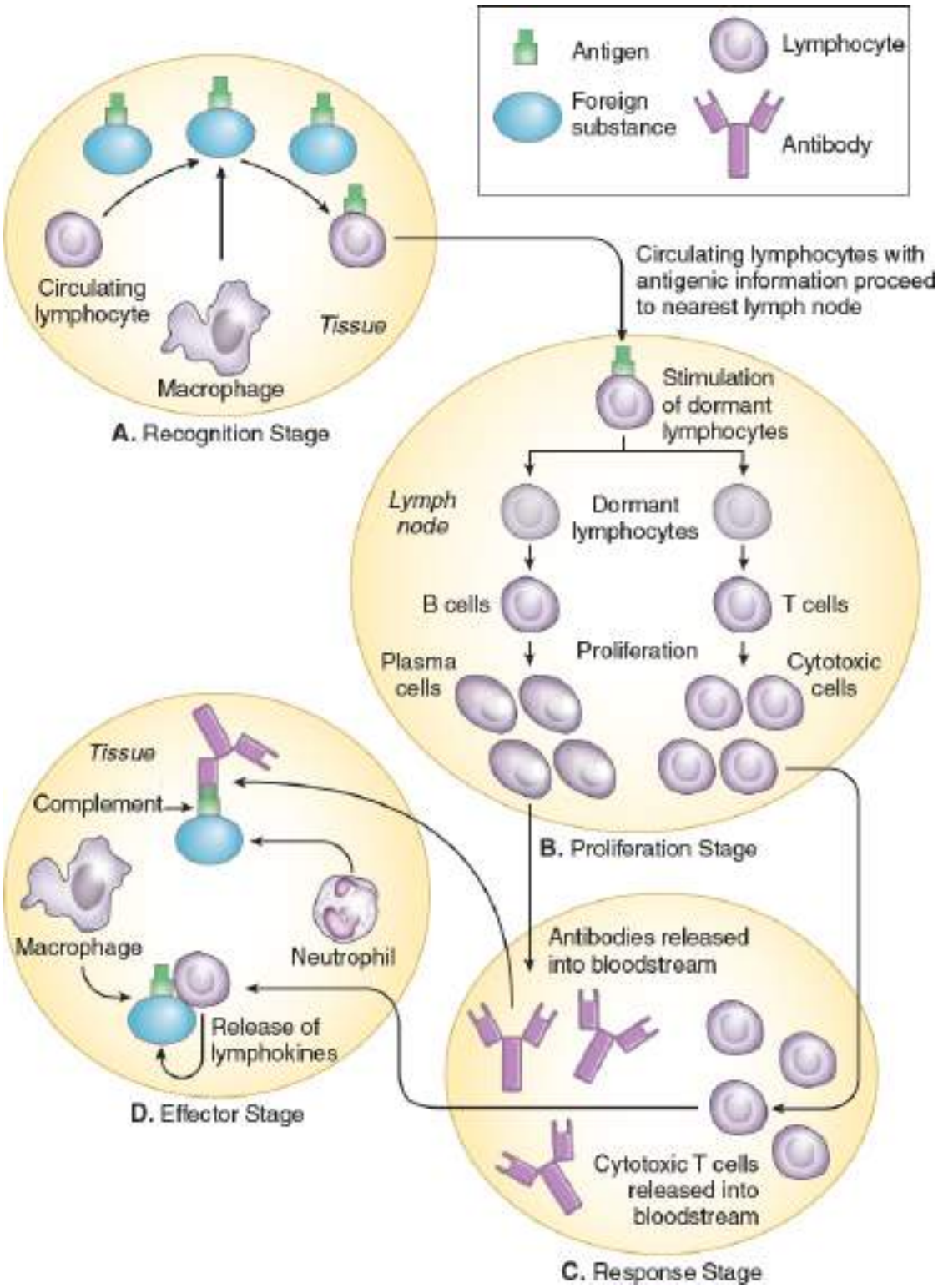

Figure 31-5 • Stages of the immune response. **A.** In the *recognition stage,* antigens are recognized by circulating lymphocytes and macrophages. **B.** In the *proliferation stage,* the dormant lymphocytes proliferate and differentiate into cytotoxic (killer) T cells or B cells responsible for formation and release of antibodies. **C.** In the *response stage,* the cytotoxic T cells and the B cells perform cellular and humoral functions, respectively. **D.** In the

effector stage, antigens are destroyed or neutralized through the action of antibodies, complement, macrophages, and cytotoxic T cells.

Chart 31-1

Comparison of Humoral and Cellular Immune Responses

Humoral Responses (B Cells)

- Bacterial phagocytosis and lysis
- Anaphylaxis
- Allergic hay fever and asthma
- Immune complex disease
- Bacterial and some viral infections

Cellular Responses (T Cells)

- Transplant rejection
- Delayed hypersensitivity (tuberculin reaction)
- Graft-versus-host disease
- Tumor surveillance or destruction
- Intracellular infections
- Viral, fungal, and parasitic infections

Effector Stage

In the effector stage, either the antibody of the humoral response or the cytotoxic (killer) T cell of the cellular response reaches and connects with the antigen on the surface of the foreign invader. This action initiates activities involving an interplay of antibodies (humoral immunity), complement, and action by the cytotoxic T cells (cellular immunity).

Humoral Immune Response

The humoral response is characterized by the production of antibodies by B lymphocytes in response to a specific antigen. Following antibody production, the macrophages of natural immunity and the special T lymphocytes of cellular immunity are involved in antigen recognition.

Antigen Recognition

Several theories explain the mechanisms by which B lymphocytes recognize the invading antigen and respond by producing antibodies. It is known that B lymphocytes recognize and respond to invading antigens in more than one way.

The B lymphocytes respond to some antigens by directly triggering antibody formation; however, in response to other antigens, they need the assistance of T cells to trigger antibody formation. With the help of macrophages, the T lymphocytes are believed to recognize the antigen of a foreign invader. The T lymphocyte picks up the antigenic message, or "blueprint," of the antigen and returns to the nearest lymph node with that message. B lymphocytes stored in the lymph nodes are subdivided into thousands of clones, which are stimulated to enlarge, divide, proliferate, and differentiate into plasma cells capable of producing specific antibodies to the antigen. Other B lymphocytes differentiate into B-lymphocyte clones with a memory for the antigen. These memory cells are responsible for the more exaggerated and rapid immune response in a person who is repeatedly exposed to the same antigen.

Role of Antibodies

Antibodies are large proteins, called *immunoglobulins,* that consist of two subunits, each containing a light and a heavy peptide chain held together by a chemical link composed of disulfide bonds. Each subunit has one portion that serves as a binding site for a specific antigen and another portion that allows the antibody molecule to take part in the complement system.

Antibodies defend against foreign invaders in several ways, and the type of defense used depends on the structure and composition of both the antigen and the immunoglobulin. The antibody molecule has at least two combining sites, or Fab fragments (Fig. 31-6). One antibody can act as a cross-link between two antigens, causing them to bind or clump together. This clumping effect, referred to as **agglutination**, helps clear the body of the invading organism by facilitating phagocytosis. Some antibodies assist in the removal of offending organisms through **opsonization**. In this process, the antigen–antibody molecule is coated with a sticky substance that also facilitates phagocytosis.

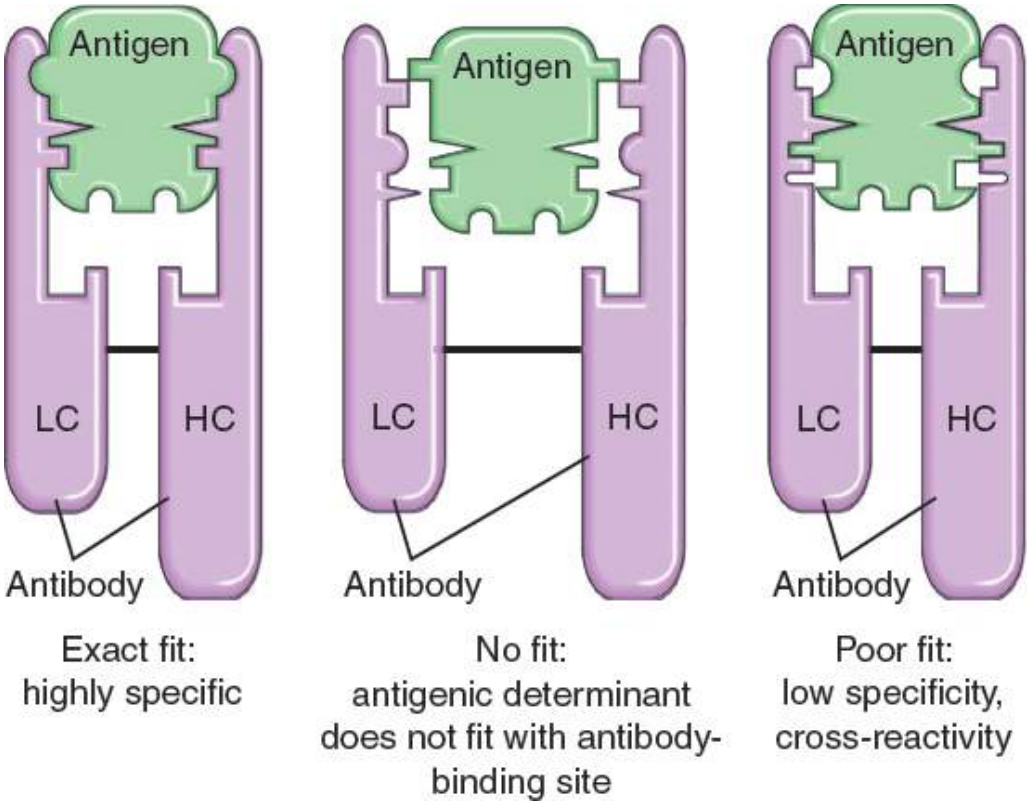

Figure 31-6 • Antigen–antibody binding. (**Left**) A highly specific antigen–antibody complex. (**Center**) No match and, therefore, no immune response. (**Right**) Poor fit or match with low specificity; antibody reacts to antigen with similar characteristics, producing cross-reactivity. HC, heavy chain; LC, light chain.

Chart 31-2

Major Characteristics of the Immunoglobulins

IgG (75% of Total Immunoglobulin)

- Appears in serum and tissues (interstitial fluid)
- Assumes a major role in bloodborne and tissue infections
- Activates the complement system
- Enhances phagocytosis
- Crosses the placenta

IgA (15% of Total Immunoglobulin)

- Appears in body fluids (blood, saliva, tears, and breast milk, as well as pulmonary, gastrointestinal, prostatic, and vaginal secretions)
- Protects against respiratory, gastrointestinal, and genitourinary infections
- Prevents absorption of antigens from food
- Passes to neonate in breast milk for protection

IgM (10% of Total Immunoglobulin)

- Appears mostly in intravascular serum
- Appears as the first immunoglobulin produced in response to bacterial and viral infections
- Activates the complement system

IgD (0.2% of Total Immunoglobulin)

- Appears in small amounts in serum
- Possibly influences B-lymphocyte differentiation, but role is unclear

IgE (0.004% of Total Immunoglobulin)

- Appears in serum
- Takes part in allergic and some hypersensitivity reactions
- Combats parasitic infections

Ig, immunoglobulin.

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Antibodies also promote the release of vasoactive substances, such as histamine and slow-reacting substances, two of the chemical mediators of the inflammatory response. Antibodies do not function in isolation; rather, they mobilize other components of the immune system to defend against the invader.

The body can produce five different types of immunoglobulin (Ig). Each of the five types, or classes, is identified by a specific letter of the alphabet, IgA,

IgD, IgE, IgG, and IgM. Classification is based on the chemical structure and biologic role of the individual immunoglobulin. Major characteristics of the immunoglobulins are summarized in Chart 31-2. The normal laboratory values for the three major Igs (IgA, IgG, and IgM) can be found in Appendix A on thePoint at thepoint.lww.com.

Antigen–Antibody Binding

The portion of the antigen involved in binding with the antibody is referred to as the **antigenic determinant**. The most efficient immunologic responses occur when the antibody and antigen fit like a lock and key. Poor fit can occur with an antibody that was produced in response to a different antigen. This phenomenon is known as cross-reactivity. For example, in acute rheumatic fever, the antibody produced against *Streptococcus pyogenes* in the upper respiratory tract may cross-react with the patient's heart tissue, leading to heart valve damage.

Cellular Immune Response

The T lymphocytes are primarily responsible for cellular immunity. Stem cells continuously migrate from the bone marrow to the thymus gland, where they develop into T cells. Despite the partial degeneration of the gland at puberty, T cells continue to develop in the thymus gland. Several types of T cells exist, each with designated roles in the defense against bacteria, viruses, fungi, parasites, and malignant cells. T cells attack foreign invaders directly rather than by producing antibodies.

Cellular reactions are initiated, with or without the assistance of macrophages, by the binding of an antigen to an antigen receptor located on the surface of a T cell. The T cells then carry the antigenic message, or blueprint, to the lymph nodes, where the production of other T cells is stimulated. Some T cells remain in the lymph nodes and retain a memory for the antigen. Other T cells migrate from the lymph nodes into the general circulatory system and ultimately to the tissues, where they remain until they bind with their respective antigens or die (Norris, 2019).

Types of T Lymphocytes

T cells include effector T cells, suppressor T cells, and memory T cells. The two major categories of effector T cells—helper T cells (also referred to as $CD4^+$ cells) and cytotoxic T cells (also referred to as $CD8^+$ cells)—participate in the destruction of foreign organisms. T cells interact closely with B cells, indicating that humoral and cellular immune responses are not separate, unrelated processes but rather are branches of the immune response that interact.

Helper T cells are activated on recognition of antigens and stimulate the rest of the immune system. When activated, helper T cells secrete **cytokines**, which attract and activate B cells, cytotoxic T cells, NK cells, macrophages, and other cells of the immune system. Cytokines are proteins produced by the cells of the immune system that determine the actions of the immune system cells. Separate subpopulations of helper T cells produce different types of cytokines and determine whether the immune response will be the production of antibodies or a cell-mediated immune response. Helper T cells also produce **lymphokines**, one category of cytokines (Table 31-2).

Cytotoxic T cells (killer T cells) attack the antigen directly by altering the cell membrane, causing cell lysis (disintegration), and releasing cytolytic enzymes and cytokines. Lymphokines can recruit, activate, and regulate other lymphocytes and WBCs. These cells then assist in destroying the invading organism. Delayed-type hypersensitivity is an example of an immune reaction that protects the body from antigens through the production and release of lymphokines (see later discussion).

Suppressor T cells have the ability to decrease B-cell production, thereby keeping the immune response at a level that is compatible with health (e.g., sufficient to fight infection adequately without attacking the body's healthy tissues). **Memory cells** are responsible for recognizing antigens from previous exposure and mounting an immune response (Table 31-3).

Null Lymphocytes and Natural Killer Cells

Null lymphocytes and NK cells are other lymphocytes that assist in combating organisms. These cells are distinct from B cells and T cells and lack the usual characteristics of those cells. **Null lymphocytes**, a subpopulation of lymphocytes, destroy antigens already coated with antibody. These cells have special receptor sites on their surface that allow them to connect with the end of antibodies; this is known as antibody-dependent, cell-mediated cytotoxicity.

NK cells are a class of lymphocytes that recognize infected and stressed cells and respond by killing these cells and by secreting macrophage-activating cytokine. The helper T cells contribute to the differentiation of null and NK cells.

Complement System

Circulating plasma proteins, known as **complement**, are made in the liver and activated when an antibody connects with its antigen. Complement plays an important role in the defense against microbes. Destruction of an invading or attacking organism or toxin is not achieved merely by the binding of the antibody and antigens; it also requires activation of complement, the arrival of killer T cells, or the attraction of macrophages. Complement has three major physiologic functions: defending the body against bacterial infection, bridging

natural and acquired immunity, and disposing of immune complexes and the by-products associated with inflammation (Klimov, 2019).

The proteins that comprise complement interact sequentially with one another in a cascading effect. The complement cascade is important to modifying the effector arm of the immune system. Activation of complement allows important events, such as removal of infectious agents and initiation of the inflammatory response, to take place. These events involve active parts of the pathway that enhance chemotaxis of macrophages and granulocytes, alter blood vessel permeability, change blood vessel diameters, cause cells to lyse, alter blood clotting, and cause other points of modification. These macrophages and granulocytes continue the body's defense by devouring the antibody-coated microbes and by releasing bacterial products.

The complement cascade may be activated by any of three pathways: classic, lectin, and alternative. The classic pathway is triggered after antibodies bind to microbes or other antigens and is part of the humoral type of adaptive immunity. The lectin pathway is activated when a plasma protein (mannose-binding lectin) binds to terminal mannose residue on the surface glycoproteins of microbes. The alternative pathway is triggered when complement proteins are activated on microbial surfaces. This pathway is part of natural immunity.

Complement components, prostaglandins, leukotrienes, and other inflammatory mediators all contribute to the recruitment of inflammatory cells, as do chemokines, a group of cytokines. The activated neutrophils pass through the vessel walls to accumulate at the site of infection, where they phagocytize complement-coated microbes. This response is usually therapeutic and can be lifesaving if the cell attacked by the complement system is a true foreign invader. However, if that cell is part of the human organism, the result can be devastating disease and even death. Many autoimmune diseases and disorders characterized by chronic infection are thought to be caused in part by continued or chronic activation of complement, which in turn results in chronic inflammation. The RBCs and platelets have complement receptors and, as a result, play an important role in the clearance of immune complexes that consist of antigen, antibody, and components of the complement system (Norris, 2019).

TABLE 31-2 Cytokines of Innate and Adaptive Immunity

Cytokines	Source	Biologic Activity
Interleukin-1 (IL-1)	Macrophages, endothelial cells, some epithelial cells	Wide variety of biologic effects; activates endothelium in inflammation; induces fever and acute-phase response; stimulates neutrophil production
Interleukin-2 (IL-2)	$CD4^+$, $CD8^+$ T cells	Growth factor for activated T cells; induces synthesis of other cytokines; activates cytotoxic T lymphocytes and NK cells
Interleukin-3 (IL-3)	$CD4^+$ T cells	Growth factor for progenitor hematopoietic cells
Interleukin-4 (IL-4)	$CD4^+$ T_H2 cells, mast cells	Promotes growth and survival of T, B, and mast cells; causes T_H2 cell differentiation; activates B cells and eosinophils and induces IgE-type responses
Interleukin-5 (IL-5)	$CD4^+$ T_H2 cells	Induces eosinophil growth and development
Interleukin-6 (IL-6)	Macrophages, endothelial cells, T lymphocytes	Stimulates the liver to produce mediators of acute-phase inflammatory response; also induces proliferation of antibody-producing cells by the adaptive immune system
Interleukin-7 (IL-7)	Bone marrow stromal cells	Primary function in adaptive immunity; stimulates pre-B cells and thymocyte development and proliferation
Interleukin-8 (IL-8)	Macrophages, endothelial cells	Primary function in adaptive immunity; chemoattracts neutrophils and T lymphocytes; regulates lymphocyte homing and neutrophil infiltration
Interleukin-10 (IL-10)	Macrophages, some T-helper cells	Inhibitor of activated macrophages and dendritic cells; decreases inflammation by inhibiting T_H1 cells and release of interleukin-12 from macrophages
Interleukin-12 (IL-12)	Macrophages, dendritic cells	Enhances NK cell cytotoxicity in innate immunity; induces T_H1 cell differentiation in adaptive immunity
Type I interferons (IFN-α, IFN-β)	Macrophages, fibroblasts	Inhibit viral replication, activate NK cells, and increase expression of MHC-I molecules on virus-infected cells
Interferon-γ (IFN-γ)	NK cells, $CD4^+$ and $CD8^+$ T lymphocytes	Activates macrophages in both innate immune responses and adaptive cell–mediated immune responses; increases expression of MHC I and II and antigen processing and presentation
Tumor necrosis factor α (TNF-α)	Macrophages, T cells	Induces inflammation, fever, and acute-phase response; activates neutrophils and endothelial cells; kills cells through apoptosis
Chemokines	Macrophages,	Large family of structurally similar cytokines that

	endothelial cells, T lymphocytes	stimulate leukocyte movement and regulate the migration of leukocytes from the blood to the tissues
Granulocyte–monocyte CSF (GM-CSF)	T cells, macrophages, endothelial cells, fibroblasts	Promotes neutrophil, eosinophil, and monocyte maturation and growth; activates mature granulocytes
Granulocyte CSF (G-CSF)	Macrophages, fibroblasts, endothelial cells	Promotes growth and maturation of neutrophils consumed in inflammatory reactions
Monocyte CSF (M-CSF)	Macrophages, activated T cells, endothelial cells	Promotes growth and maturation of mononuclear phagocytes

CSF, colony-stimulating factor; IgE, immunoglobulin E; MHC, major histocompatibility complex; NK, natural killer; T_H1, T-helper type 1; T_H2, T-helper type 2.

Adapted from Norris, T. L. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Immunomodulators

Antimicrobial agents and vaccines have yielded considerable therapeutic success and the immune system usually works effectively; however, many infectious diseases remain difficult clinical challenges. Treatment success may be compromised by defects of the immune system; in this case, enhancement of the host immune response may be therapeutically beneficial. An immunomodulator (also known as a biologic response modifier) affects the host via direct or indirect effects on one or more components of the immunoregulatory network. Interferons, colony-stimulating factors, and monoclonal antibodies (MoAbs) are examples of agents used to help enhance the immune system (Davis & Ballas, 2017).

TABLE 31-3 Lymphocytes Involved in Immune Responses

Type of Immune Response	Cell Type	Function
Humoral	B lymphocyte	Produces antibodies or immunoglobulins (IgA, IgD, IgE, IgG, IgM)
Cellular	T lymphocyte	
	Helper T	Attacks foreign invaders (antigens) directly
		Initiates and augments inflammatory response
	Helper T_1	Increases activated cytotoxic T cells
	Helper T_2	Increases B-cell (BG8) antibody production
	Suppressor T	Suppresses the immune response
	Memory T	Remembers contact with an antigen and on subsequent exposures mounts an immune response
	Cytotoxic T (killer T)	Lyses cells infected with virus; plays a role in graft rejection
Nonspecific	Non-T or non–B-lymphocyte null cell	Destroys antigens already coated with antibody
	Natural killer cell (granular lymphocyte)	Defends against microorganisms and some types of malignant cells; produces cytokines

Interferons

Interferon, one type of biologic response modifier, is a nonspecific viricidal protein that is naturally produced by the body and capable of activating other components of the immune system. Interferons continue to be investigated to determine their roles in the immune system and their potential therapeutic effects in disorders characterized by disturbed immune responses. These substances have antiviral and antitumor properties. In addition to responding to viral infection, interferons are produced by T lymphocytes, B lymphocytes, and macrophages in response to antigens. They are thought to modify the immune response by suppressing antibody production and cellular immunity. They also facilitate the cytolytic role of macrophages and NK cells. Interferons are used to treat immune-related disorders (e.g., multiple sclerosis) and chronic inflammatory conditions (e.g., chronic hepatitis). Research continues to evaluate the effectiveness of interferons in treating cancers (Makowska, Braunschweig, Denecke, et al., 2019) and acquired immunodeficiency syndrome.

Colony-Stimulating Factors

Colony-stimulating factors are a group of naturally occurring glycoprotein cytokines that regulate production, differentiation, survival, and activation of hematopoietic cells. Erythropoietin stimulates RBC production. Thrombopoietin plays a key regulatory role in the growth and differentiation of bone marrow cells. Interleukin-5 (IL-5) stimulates the growth and survival of eosinophils and basophils. Stem cell factor and IL-3 serve as stimuli for multiple hematopoietic cell lines. Granulocyte colony-stimulating factor, granulocyte–macrophage colony-stimulating factor, and macrophage colony-stimulating factor all serve as growth factors for specific cell lines. These cytokines have attracted considerable interest for their potential role in immunomodulation (Leleu, Gay, Flament, et al., 2017).

Monoclonal Antibodies

MoAbs have become available through technologic advances, enabling investigators to grow and produce targeted antibodies for specific pathologic organisms. This type of specificity allows MoAbs to destroy pathologic organisms and spare normal cells. The specificity of MoAbs depends on identifying key antigen proteins that are present on the surface of tumors, but not on normal tissues. When the MoAb attaches to the cell surface antigen, it blocks an important signal transduction pathway for communication between the malignant cells and the extracellular environment. The results may include an inability to initiate apoptosis, reproduce, or invade surrounding tissues (Pento, 2017; Singh, Tank, Dwiwedi, et al., 2018).

Advances in Immunology

Important developments in immunology revolve around advances in genetic engineering, use of stem cells, and immunotherapy treatments.

Genetic Engineering

One of the more remarkable evolving technologies is **genetic engineering**, which uses recombinant deoxyribonucleic acid (DNA) technology. Two facets of this technology exist. The first permits scientists to combine genes from one type of organism with genes of a second organism. This type of technology allows cells and microorganisms to manufacture proteins, monokines, and lymphokines, which can alter and enhance immune system function. The second facet of recombinant DNA technology involves gene therapy. If a specific gene is abnormal or missing, experimental recombinant DNA technology may be capable of restoring normal gene function. For example, a recombinant gene is inserted into a virus particle. When the virus particle splices its genes, the virus automatically inserts the missing gene and

theoretically corrects the genetic anomaly. Extensive research into recombinant DNA technology and gene therapy is ongoing (Gonçalves & Paiva, 2017).

Stem Cells

Stem cells are capable of self-renewal and differentiation; they continually replenish the body's entire supply of both RBCs and WBCs. Some stem cells, described as totipotent cells, have tremendous capacity to self-renew and differentiate. Embryonic stem cells, described as pluripotent, give rise to numerous cell types that are able to form tissues. Research has shown that stem cells can restore an immune system that has been destroyed (Haynes et al., 2018). Stem cell transplantation has been carried out in humans with certain types of immune dysfunction, such as severe combined immunodeficiency; clinical trials using stem cells are under way in patients with a variety of disorders having an autoimmune component, including systemic lupus erythematosus, rheumatoid arthritis, scleroderma, and multiple sclerosis. Research with embryonic stem cells has enabled investigators to make substantial gains in developmental biology, gene therapy, therapeutic tissue engineering, and the treatment of a variety of diseases (Haynes et al., 2018).

Cancer and Immunotherapy

It has long been understood that the immune system plays a role in fighting off malignancies. Recent advances in cancer treatment have sought to augment the body's natural antitumor activity and to shut down the pathways that allow malignancies to elude the immune system, which has led to the development of such treatments as MoAbs, cancer vaccines, immune adjuvants, immune checkpoint inhibitors, chimeric antigen receptor (CAR) T-cell therapy and cytokines. These immunotherapeutic treatments are designed to stimulate the patient's immune system to mount its own defense against the cancer and have revolutionized the treatment of many different cancer types. See Chapter 12 for a discussion on the use of immunotherapy in cancer (Gonçalves & Paiva, 2017; Ribas & Wolchok, 2018).

Assessment of the Immune System

An assessment of immune function begins during the health history and physical examination. Areas to be assessed include nutritional status; infections and immunizations; allergies; disorders and disease states, such as autoimmune disorders, cancer, and chronic illnesses; surgeries; medications; and blood transfusions. In addition to inspection of general characteristics,

palpation of the lymph nodes and examinations of the skin, mucous membranes, and respiratory, gastrointestinal, musculoskeletal, genitourinary, cardiovascular, and neurosensory systems are performed (Chart 31-3).

Health History

The history should note the patient's age along with information about past and present conditions and events that may provide clues to the status of the patient's immune system.

Gender

There are differences in the immune system functions of men and women. For example, many autoimmune diseases have a higher incidence in females than in males, a phenomenon believed to be correlated with sex hormones. In the past two decades, research has revealed that sex hormones are integral signaling modulators of the immune system. Sex hormones play definitive roles in lymphocyte maturation, activation, and synthesis of antibodies and cytokines. In autoimmune disease, expression of sex hormones is altered, and this change contributes to immune dysregulation (Rainville, Tsyglakova, & Hodes, 2018).

Gerontologic Considerations

Immunosenescence is the term for age-related changes in the immune system. These changes have been linked to the increased rates of illness and mortality in older adults (Tariq, Hazeldine, & Lord, 2017). Some of the changes that occur in immunosenescence include, but are not limited to, bone marrow defects, dysfunction of the thymus gland, and impaired lymphocytes. Cellular changes occur as the result of aging and include impaired neutrophil function, decreased circulating macrophages, impaired dendritic cell function, and reduced T-cell activation. As the immune system undergoes age-associated alterations, its response to infections progressively deteriorates. The capacity for self-renewal of hematopoietic stem cells diminishes. There is a notable decline in the total number of phagocytes, coupled with an intrinsic reduction in their activity. The cytotoxicity of NK cells decreases, contributing to a decline in humoral immunity (Tariq et al., 2017). Inflammatory cytokines also tend to increase with age. Acquired immunity may be negatively affected as the efficacy of vaccines is frequently decreased in older adults (Smetana, Chlibek, Shaw, et al., 2018).

Chart 31-3 ASSESSMENT

Assessing for Immune Dysfunction

Be alert for the following signs and symptoms:

Respiratory System

- Changes in respiratory rate
- Cough (dry or productive)
- Abnormal lung sounds (wheezing, crackles, rhonchi)
- Rhinitis
- Hyperventilation
- Bronchospasm

Cardiovascular System

- Hypotension
- Tachycardia
- Arrhythmia
- Vasculitis
- Anemia

Gastrointestinal System

- Hepatosplenomegaly
- Colitis
- Vomiting
- Diarrhea

Genitourinary System

- Frequency and burning on urination
- Hematuria
- Discharge

Musculoskeletal System

- Joint mobility, edema, and pain

Skin

- Rashes
- Lesions
- Dermatitis
- Hematomas or purpura
- Edema or urticaria
- Inflammation
- Discharge

Neurosensory System

- Cognitive dysfunction
- Hearing loss
- Visual changes
- Headaches and migraines
- Ataxia
- Tetany

Older adults have an increased incidence of infections, autoimmune diseases, metabolic diseases, osteoporosis, and neurologic disorders (Eliopoulos, 2018; Tariq et al., 2017). The increased incidence of autoimmune diseases may be from a decreased ability of antibodies to differentiate between self and non-self. Failure of the surveillance system to recognize mutant or abnormal cells may also be responsible, in part, for the high incidence of cancer associated with increasing age.

Age-related changes in many body systems also contribute to impaired immunity (Table 31-4). For example, postmenopausal females are at a greater risk for urinary tract infections due to residual urine, urinary incontinence, and estrogen deficiency (Jung & Brubaker, 2019). Secondary changes, including malnutrition and poor circulation, as well as the breakdown of natural mechanical barriers such as the skin, place the aging immune system at even greater disadvantage against infection (Tariq et al., 2017).

The effects of the aging process and psychological stress interact, with the potential to negatively influence immune integrity (Gidron, 2019). Consequently, continual assessment of the physical and emotional status of older adults is imperative, because early recognition and management of factors influencing immune response may prevent or mitigate the high morbidity and mortality seen with illness in the older adult population.

Nutrition

Nutritional status is a key determinant of health. Traditionally, the relationship between infection and nutrition focused on the effect of nutrients on host defenses and the effect of infection on nutritional needs (Yaqoob, 2017). This has expanded in scope to encompass the role of specific nutrients in acquired immune function—the modulation of inflammatory processes and the virulence of the infectious agent itself (Lang & Aspinall, 2017). Iron and the immune system are linked in homeostasis and pathology, thus making it essential for maximum function (Martins, Almeida, Lima, et al., 2017). The list of nutrients affecting infection, immunity, inflammation, and cell injury has expanded from traditional proteins to several vitamins, multiple minerals, and, more recently, specific lipid components of the diet. The role of micronutrients and fatty acids on the response of cells and tissues to hypoxic and toxic

damage has been recognized, suggesting that there is another dimension to the relationship. Deficiencies in micronutrients have been connected to impairment in various body functions, including immunity (Carr & Maggini, 2017; Mikkelsen & Apostolopoulos, 2018). Zinc deficiency in particular has been linked to the development of a number of diseases. Zinc plays an important role in homeostasis, immune function, and apoptosis, among other functions (Wessels, Maywald, & Rink, 2017).

TABLE 31-4 Age-Related Changes in Immunologic Function

Body System	Changes	Consequences
Immune	Impaired function of B and T lymphocytes Failure of lymphocytes to recognize mutant or abnormal cells Decreased antibody production Failure of immune system to differentiate "self" from "non-self" Suppressed phagocytic immune response	Suppressed responses to pathogenic organisms with increased risk for infection Increased incidence of cancers Anergy (lack of response to antigens applied to the skin [allergens]) Increased incidence of autoimmune diseases Absence of typical signs and symptoms of infection and inflammation Dissemination of organisms usually destroyed or suppressed by phagocytes (e.g., reactivation or spread of tuberculosis)
Gastrointestinal	Decreased gastric secretions and motility Decreased phagocytosis by the liver's Kupffer cells Altered nutritional intake with inadequate protein intake	Proliferation of intestinal organisms resulting in gastroenteritis and diarrhea Increased incidence and severity of hepatitis B; increased incidence of liver abscesses Suppressed immune response
Urinary	Decreased kidney function and changes in lower urinary tract function (enlargement of prostate gland, neurogenic bladder); altered genitourinary tract flora	Urinary stasis and increased incidence of urinary tract infections
Pulmonary	Impaired ciliary action due to exposure to smoke and environmental toxins	Impaired clearance of pulmonary secretions; increased incidence of respiratory infections
Integumentary	Thinning of skin with less elasticity; loss of adipose tissue	Increased risk of skin injury, breakdown, and infection
Circulatory	Impaired microcirculation	Stasis and pressure injuries
Neurologic function	Decreased sensation and slowing of reflexes	Increased risk of injury, skin ulcers, abrasions, and burns

Adapted from Eliopoulos, C. (2018). *Gerontological nursing* (9th ed.). Philadelphia, PA: Wolters Kluwer.

The effects exerted by polyunsaturated fatty acids on immune system functions are under investigation. Studies suggest that these elements play a role in diminishing the incidence and severity of inflammatory disorders. Research suggests that diets high in olive oil are not as immunosuppressive as diets rich in fish oil. The contribution of immune modulation by lipids to the high risk of infectious complications associated with the use of parenteral nutrition is unclear (Raman, Almutairdi, Mulesa, et al., 2017).

Depletion of protein reserves results in atrophy of lymphoid tissues, depression of antibody response, reduction in the number of circulating T cells, and impaired phagocytic function. As a result, susceptibility to infection is greatly increased. During periods of infection or serious illness, nutritional requirements may be further altered, potentially contributing to depletion of protein, fatty acid, vitamin, and trace elements and causing even greater risk of impaired immune response and sepsis (Wischmeyer, 2018). Nutritional intake that supports a competent immune response plays an important role in reducing the incidence of infections (Shlisky, Bloom, Beaudreault, et al., 2017); patients whose nutritional status is compromised have a delayed postoperative recovery and often experience more severe infections and delayed wound healing. There is evidence that nutrition plays a role in the development of cancer and that diet and lifestyle can alter the risk of cancer development as well as other chronic diseases (Theodoratou, Timofeeva, Li, et al., 2017). The nurse must assume a proactive role in ensuring the best possible nutritional intake for all patients as a vital step in preventing disease and poor outcomes. The nurse must assess the patient's nutritional status, caloric intake, and quality of foods ingested (see Chapter 4 for further discussion of nutritional assessment).

Immunization

The patient is asked about childhood and adult immunizations, including vaccinations to provide protection against influenza, pneumococcal diseases, herpes zoster, pertussis, and the usual childhood diseases (e.g., measles, mumps). Education about the importance of adhering to the recommended schedule for adult vaccines should be initiated. See Chapter 3, Table 3-3: Select Health Promotion Screening for Adults for more information about adult immunizations.

Infection

A history of past and present infections and the dates and types of treatments, along with a history of any multiple persistent infections, fevers of unknown origin, lesions or sores, or any type of drainage, as well as the response to treatment, are obtained.

Known past or present exposure to tuberculosis is assessed, and the dates and results of any tuberculin tests (purified protein derivative [PPD] test) and chest x-rays are documented. Recent exposure to any infections, recent travel, and dates are elicited. The nurse must assess whether the patient has been exposed to any sexually transmitted infections (STIs) or bloodborne pathogens such as hepatitis B, C, and D viruses and human immune deficiency virus (HIV). A history of STIs such as gonorrhea, syphilis, human papillomavirus infection, and chlamydia can alert the nurse that the patient may have been exposed to HIV or hepatitis. Herpes simplex virus infections have a significant impact on health, causing a wide range of diseases (e.g., oral and genital herpes).

Allergy

The patient is asked about any allergies, including types of allergens (e.g., pollens, dust, plants, cosmetics, food, medications, vaccines, latex), the symptoms experienced, and seasonal variations in occurrence or severity in the symptoms. A history of testing and treatments, including prescribed and over-the-counter medications that the patient has taken or is currently taking for these allergies and the effectiveness of the treatments, is obtained. All medication and food allergies are listed on paper records with an allergy alert sticker or within the patient's electronic health record (EHR) to make others aware of these allergies. Continued assessment for potential allergic reactions in the patient is vital. See Chapter 33 for more information on allergies.

Disorders and Diseases

Part of the focused immunologic assessment includes determining whether the patient has a history of autoimmune disorders, neoplasms, chronic illnesses, surgeries, or any recent major stressors that may place the patient at increased risk.

Autoimmune Disorders

Autoimmune disorders affect people of both genders of all ages, ethnicities, and social classes. Autoimmune disorders are a group of disorders that can affect almost any cell or tissue in the body (Norris, 2019). As mentioned previously, they tend to be more common in women because estrogen tends to enhance immunity. Androgen, on the other hand, tends to be immunosuppressive. Autoimmune diseases are a leading cause of death by disease in females of reproductive age.

The patient is asked about any autoimmune disorders, such as lupus erythematosus, rheumatoid arthritis, multiple sclerosis, or psoriasis. The onset, severity, remissions and exacerbations, functional limitations, treatments that the patient has received or is currently receiving, and effectiveness of the

treatments are described. Certain autoimmune diseases appear to be genetically linked, so a family history of these is important (Generali, Ceribelli, Stazi, et al., 2017) (Chart 31-4).

Neoplastic Disease

If there is a history of cancer in the family, more information is obtained, including the type of cancer, age at onset, and relationship (maternal or paternal) of the patient to the affected family members. Dates and results of any cancer screening tests for the patient are documented.

A history of cancer in the patient is also obtained, along with the type of cancer, date of diagnosis, and treatment modalities used. Immunosuppression contributes to the development of cancers; however, cancer itself is immunosuppressive, as are many treatments for cancer. Large tumors can release antigens into the blood, and these antigens combine with circulating antibodies and prevent them from attacking the tumor cells. Furthermore, tumor cells may possess special blocking factors that coat tumor cells and prevent their destruction by killer T lymphocytes. During the early development of tumors, the body may fail to recognize the tumor antigens as foreign and subsequently fail to initiate destruction of the malignant cells. Hematologic cancers, such as leukemia and lymphoma, are associated with altered production and function of WBCs and lymphocytes.

Chart 31-4 **GENETICS IN NURSING PRACTICE**

Immunologic Disorders

An immunologic disorder is a disorder of a person's immune system, which is a network of cells, tissues, and organs that work together to defend the body against attacks by foreign invaders such as bacteria, parasites, and fungi that can cause infection. A number of immunologic disorders have a known inheritance pattern, while others are noted to have a genetic abnormality that is influenced by environmental exposures. Therefore, the pattern of inheritance is unclear in some immunologic disorders. Examples of immunologic disorders caused by a genetic abnormality include:

- Adenosine deaminase deficiency (autosomal recessive)
- Alopecia areata
- Alopecia totalis
- Asthma
- Ataxia telangiectasia (autosomal recessive)
- Autoimmune polyglandular syndrome
- Bruton agammaglobulinemia (X-linked)
- Burkitt lymphoma
- Crohn's disease
- Diabetes, type 1
- DiGeorge syndrome (Autosomal dominant)
- Familial Mediterranean fever
- Job syndrome (autosomal dominant and recessive)
- Purine nucleoside phosphorylase deficiency (autosomal dominant)
- Severe combined immunodeficiency (primarily X-linked)
- Wiskott–Aldrich syndrome (X-linked)

Nursing Assessments

Refer to Chapter 4, Chart 4-2: Genetics in Nursing Practice: Genetic Aspects of Health Assessment

Family History Assessment Specific to Immunologic Disorders

- Collect a family history for both maternal and paternal relatives for three generations.
- Assess family history for other family members with histories of immunologic disorders.
- Obtain information about family members with a history of recurrent infections or illness.
- Recognize ethnic risk (non-Ashkenazi Jewish, Armenian, Arab, and Turkish are at greater risk for familial Mediterranean fever; Caucasians have a higher incidence of Crohn's disease)

Patient Assessment

- Assess for symptoms such as changes in respiratory status associated with asthma (e.g., wheezing, or airway hyperresponsiveness; mucosal edema; and mucus production).
- Gather information regarding immunizations and whether an altered response to any immunization has occurred.
- Assess for symptoms of immunodeficiency disorders, such as unexplained weight gain or loss, skin rashes, changes in hair texture or distribution, joint or muscle pain, intolerance to cold, irregular menstrual periods, abdominal discomfort, or the presence of diarrhea.
- Identify pattern of sickness with regard to frequency of colds, respiratory infections, or history of illness that tends to linger.
- Obtain history of childhood illnesses and details of the illness experience.
- Assess for medical history of frequent or recurrent infections.
- Learn about susceptibility to infections, assess for patterns (frequency, length of illness, severity of symptoms), and recognize infections that would be atypical for age.
- Inquire about environmental exposures (e.g., smoke, chloroform, metal or dust particles, paint).
- Ask about exposure to other viruses such as Epstein–Barr or Influenza.

Resources

American Autoimmune Related Diseases Association, www.aarda.org
Genetic and Rare Diseases Information Center, www.rarediseases.info.nih.gov
See Chapter 6, Chart 6-7 for components of genetic counseling.

All treatments that the patient has received or is currently receiving, such as radiation, chemotherapy, and immunotherapy, are recorded in the health history. In addition, the nurse should elicit information related to complementary or alternative modalities that have been used and the response to these efforts. Radiation destroys lymphocytes and decreases the ability to mount an effective immune response. The size and extent of the irradiated area determine the extent of immunosuppression. Whole-body irradiation may leave the patient completely immunosuppressed. Chemotherapy and other cancer treatments also affect bone marrow function, destroying cells that contribute to an effective immune response and resulting in immunosuppression. Immunotherapy can cause inflammatory overreactions of the immune system that mimic autoimmune disorders (Kroschinsky, Stolzel, von Bonin, et al., 2017; Munro, 2019).

Chronic Illness and Surgery

The health assessment includes a history of chronic illness, particularly diabetes, renal disease, or chronic obstructive pulmonary disease (COPD). The

onset and severity of illnesses, as well as treatment that the patient is receiving for the illness, are obtained. Chronic illness may contribute to immune system impairments in various ways. Kidney injury is associated with a deficiency in circulating lymphocytes. In addition, immune defenses may be altered by acidosis and uremic toxins. In diabetes, an increased incidence of infection has been associated with vascular insufficiency, neuropathy, and poor control of serum glucose levels. Recurrent respiratory tract infections are associated with COPD due to altered inspiratory and expiratory function and ineffective airway clearance. In addition, a history of organ transplantation or surgical removal of the spleen, lymph nodes, or thymus should be noted, because these conditions may place the patient at risk for impaired immune function (Bagatini, Cardoso, dos Santos, et al., 2017; Dionne, Dehority, Brett, et al., 2017).

Special Problems

Conditions such as burns and other forms of injury and infection may contribute to altered immune system function. Major burns cause impaired skin integrity and compromise the body's first line of defense. Loss of large amounts of serum occurs with burn injuries and depletes the body of essential proteins, including immunoglobulins.

The physiologic and psychological stressors associated with surgery or injury stimulate cortisol release from the adrenal cortex; increased serum cortisol also contributes to suppression of normal immune responses. The immune system's inflammatory response to surgery is followed by an anti-inflammatory compensatory response, and it is thought that these responses may contribute to postoperative complications (Cerra, 2018).

Patients who have had an ischemic stroke or transient ischemic attack (TIA) are at risk for infection following the event. Evidence suggests that an acute stroke leads to immunosuppression and a subsequently high infection risk; infection is the leading cause of death following a stroke (Hoffmann, Harms, Ulm, et al., 2017). Stroke-induced immunosuppression is linked to the development of stroke-associated pneumonia, which is the most common infection seen in patients who have had a stroke (Liu, Chu, Chen, et al., 2018).

Medications and Blood Transfusions

A list of past and present medications is obtained. In large doses, antibiotics, corticosteroids, cytotoxic agents, salicylates, nonsteroidal anti-inflammatory drugs, and anesthetic agents can cause immune suppression (Table 31-5).

A history of blood transfusions is obtained; previous exposure to foreign antigens through transfusion may be associated with abnormal immune function. In addition, although the risk of HIV transmission through blood transfusion is extremely low in patients who received a transfusion after 1985

(when testing of blood for HIV was initiated in the United States), a small risk remains.

The patient is also asked about the use of herbal agents and over-the-counter medications. Because many herbal agents have not been subjected to rigorous testing, their effects have not been fully identified. It is important, therefore, to ask patients about their use of these substances, to document their use, and to educate patients about untoward effects that may alter immune responsiveness.

Lifestyle Factors

Personal lifestyle choices have an impact on the immune system. Poor nutritional intake, smoking (Qiu, Liang, Liu, et al., 2017), excessive consumption of alcohol (Rehm, Gmel, Gmel, et al., 2017), illicit drug use, and occupational or residential exposure to environmental radiation and pollutants have been associated with impaired immune function and are assessed in a detailed patient history. Although factors that are not consistent with a healthy lifestyle are predominately responsible for ineffective immune function, positive lifestyle factors can also negatively affect immune function and require assessment. For example, rigorous exercise or competitive exercise—usually considered a positive lifestyle factor—can be a physiologic stressor and cause negative effects on immune response (Aoi & Naito, 2019; Shaw, Merien, Braakhuis, et al., 2018).

TABLE 31-5 Select Medications and Effects on the Immune System

Drug Classification (and Examples)	Effects on the Immune System
Antibiotics (in Large Doses)	**Bone Marrow Suppression**
ceftriaxone	Eosinophilia, hemolytic anemia, hypoprothrombinemia, neutropenia, thrombocytopenia
cefuroxime sodium	Eosinophilia, hemolytic anemia, hypoprothrombinemia, neutropenia, thrombocytopenia
chloramphenicol	Leukopenia, aplastic anemia
dactinomycin	Agranulocytosis, neutropenia
fluoroquinolones (ciprofloxacin, levofloxacin)	Hemolytic anemia, methemoglobinemia, eosinophilia, leukopenia, pancytopenia
gentamicin sulfate	Agranulocytosis, granulocytosis
macrolides (erythromycin, azithromycin, clarithromycin)	Neutropenia, leukopenia
penicillins	Agranulocytosis
streptomycin	Leukopenia, neutropenia, pancytopenia
vancomycin	Transient leucopenia
Antithyroid Drugs	
propylthiouracil	Agranulocytosis, leukopenia
Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) (in Large Doses)	**Inhibit Prostaglandin Synthesis or Release**
aspirin	Agranulocytosis
COX-2 inhibitors (celecoxib)	Anemia, allergy, no other major adverse effects
ibuprofen	Leukopenia, neutropenia
indomethacin	Agranulocytosis, leukopenia
phenylbutazone	Pancytopenia, agranulocytosis, aplastic anemia
Adrenal Corticosteroids	**Immunosuppression**
prednisone	
Antineoplastic Agents (cytotoxic agents)	**Immunosuppression**
cyclophosphamide	Leukopenia, neutropenia
cisplatin	Leukopenia
cyclosporine	Leukopenia, inhibits T-lymphocyte function
Antimetabolites	**Immunosuppression**
pyrimidine antagonist	Leukopenia, eosinophilia
folic acid antagonist	Leukopenia, aplastic bone marrow
purine antagonist	Leukopenia, pancytopenia

COX, cyclo-oxygenase.

Adapted from Comerford, K. C., & Durkin, M. T. (Eds.). (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer.

Psychoneuroimmunologic Factors

The bidirectional pathway between the brain and immune system (the mind–body system) is referred to as psychoneuroimmunology. Patient assessment must also address psychoneuroimmunologic factors, such as stress and psychological illness, that may be influencing the patient's health. The immune response is regulated and modulated in part by neuroendocrine influences. Lymphocytes and macrophages have receptors that can respond to neurotransmitters and endocrine hormones. Lymphocytes can produce and secrete adrenocorticotropic hormone and endorphinlike compounds. Cells in the brain, especially in the hypothalamus, can recognize prostaglandins, interferons, and interleukins, as well as histamine and serotonin, all of which are released during the inflammatory process. Like all other biologic systems functioning to maintain homeostasis, the immune system is integrated with other psychophysiologic processes and is regulated and modulated by the brain. These relationships may have immunologic consequences (Lasselin, Schedlowski, Lekander, et al., 2019).

Growing evidence indicates that a measurable immune system response can be positively influenced by biobehavioral strategies such as relaxation, imagery techniques, biofeedback, humor, hypnosis, mindfulness-based strategies, and yoga (Park & Han, 2017; Pascoe, Thompson, & Ski, 2017; Reich, Lengacher, Klein, et al., 2017). Therefore, the assessment should address the patient's general psychological status and the patient's use of and response to these strategies. See the Nursing Research Profile in Chart 31-5.

Physical Assessment

During the physical examination (see Chart 31-3), the skin and mucous membranes are assessed for lesions, dermatitis, purpura (subcutaneous bleeding), urticaria, inflammation, or any discharge. Any signs of infection are noted. The patient's temperature is recorded, and the patient is observed for chills and sweating. The anterior and posterior cervical, supraclavicular, axillary, and inguinal lymph nodes are palpated for enlargement; if palpable nodes are detected, their location, size, consistency, and reports of tenderness on palpation are noted. Joints are assessed for tenderness, swelling, increased warmth, and limited range of motion. The patient's respiratory, cardiovascular, genitourinary, gastrointestinal, and neurosensory systems are evaluated for signs and symptoms indicative of immune dysfunction. Any functional limitations or disabilities the patient may have are also assessed.

Diagnostic Evaluation

A series of blood tests and skin tests, as well as bone marrow biopsy, may be performed to evaluate the patient's immune competence. Specific laboratory and diagnostic tests are discussed in greater detail along with individual disease processes in subsequent chapters in this unit. Select laboratory and diagnostic tests used to evaluate immune competence are summarized in Chart 31-6.

Nursing Management

The nurse needs to be aware that patients undergoing evaluation for possible immune system disorders experience not only physical pain and discomfort with certain types of diagnostic procedures but also many psychological reactions. It is the nurse's role to counsel, educate, and support patients throughout the diagnostic process. Many patients may be extremely anxious about the results of diagnostic tests and the possible implications of those results for their future health, employment, and personal relationships. This is an ideal time for the nurse to provide counseling and education, should these interventions be warranted.

Chart 31-5 NURSING RESEARCH PROFILE

Stress Reduction and Effect on Inflammatory Cytokines

Reich, R. R., Lengacher, C. A., Klein, T. W., et al. (2017). A randomized controlled trial of the effects of mindfulness-based stress reduction (MBSR[BC]) on levels of inflammatory biomarkers among recovering breast cancer survivors. *Biological Research for Nursing*, *19*(4), 456–464.

Purpose

The purpose of this study was to evaluate the efficacy of the Mindfulness-Based Stress Reduction (Breast Cancer) (MBSR[BC]) program versus usual care in normalizing blood levels of proinflammatory cytokines among breast cancer survivors.

Design

This was a substudy of a large randomized controlled trial. A total of 322 participants were randomized to a 6-wk MBSR(BC) program or usual care. Blood samples, demographic data (age, race, and ethnicity), and clinical data (disease stage and treatments) were collected at baseline, 6 wks, and 12 wks. Plasma cytokines (IL-1β, IL-6, IL-10), tumor necrosis factor α (TNF-α), transforming growth factor β1, and soluble tumor necrosis factor receptor 1 (sTNFR1) were assayed. Linear mixed models were used to assess the cytokine levels across the three time points by group.

Findings

Three of the cytokines were not detectable and thus not analyzed further. For the remaining cytokines (TNF-α, IL-6, sTNFR1), TNFα and IL-6 increased during the follow-up period between 6 and 12 wks, but not during the MBSR(BC) training period (baseline to 6 wks). The sTNFR1 levels did not change across the 12-wk study period significantly. The s cytokines TNF-α and IL-6 may be markers for recovery.

Nursing Implications

Patients recovering from cancer treatment are at increased risk for infections and increased levels of psychological distress. Stress reducing activities and programs such as the 2 h per wk mindfulness program can be implemented in clinical practice as part of an interdisciplinary approach to cancer care. Nurses should advise patients that the programs may not take effect immediately; in fact, some of the increases in cytokine levels were not seen until 6 wks after the program ended.

Chart 31-6

Select Tests for Evaluating Immunologic Status

Various laboratory tests may be performed to assess immune system activity or dysfunction. The studies assess leukocytes and lymphocytes, humoral immunity, cellular immunity, phagocytic cell function, complement activity, hypersensitivity reactions, specific antigen–antibodies, or human immune deficiency virus infection.

Humoral (Antibody-Mediated) Immunity Tests

- B-cell quantification with monoclonal antibody
- In vivo immunoglobulin synthesis with T-cell subsets
- Specific antibody response
- Total serum globulins and individual immunoglobulins (electrophoresis, immunoelectrophoresis, single radial immunodiffusion, nephelometry, and isohemagglutinin techniques)

Cellular (Cell-Mediated) Immunity Tests

- Total lymphocyte count
- T-cell and T-cell subset quantification with monoclonal antibody
- Delayed hypersensitivity skin test
- Cytokine production
- Lymphocyte response to mitogens, antigens, and allogeneic cells
- Helper and suppressor T-cell functions

Adapted from Fischbach, F. T., & Fischbach, M. A. (2018). *A manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Wolters Kluwer.

CRITICAL THINKING EXERCISES

1 pq You are caring for an 80-year-old woman who is admitted to a long-term care facility after having a stroke. What potential immunity-related complications do you need to be aware of for this patient? What are your priority nursing observations and assessments? Identify priorities for this patient's care given her recent stroke.

2 ebp A 40-year-old woman with melanoma is being treated with immunotherapy and is admitted to your hospital for treatment-related pneumonitis. She is prescribed high-dose corticosteroids for treatment of the pneumonitis. The patient has asked you to explain what is happening to her and why this has occurred. How will you educate her and her family about her current condition? Develop an evidence-based education plan for the patient and her family. Discuss the criteria used to assess the strength of the evidence for your education plan.

3 ipc A 35-year-old pregnant woman with systemic lupus erythematosus (SLE) presents with an acute flare-up of her symptoms. How might psychosocial and emotional factors impact her health? What interdisciplinary referrals would you anticipate for this patient's care?

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*Asterisk indicates nursing research.

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Resources

American Academy of Allergy, Asthma & Immunology, www.aaaai.org
American Cancer Society, www.cancer.org
Centers for Disease Control and Prevention, www.cdc.gov
National Institute of Allergy and Infectious Diseases, www.niaid.nih.gov
National Institutes of Health, Health Information, www.nih.gov/health/infoline.htm
National Institutes of Health, National Cancer Institute, www.cancer.gov
U.S. Department of Health & Human Services, www.hhs.gov

32 Management of Patients with Immune Deficiency Disorders

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Identify the pathophysiology, clinical manifestations, and nursing management of patients with primary immune deficiency disorders.
2. Describe the modes of transmission of human immune deficiency virus infection and prevention strategies.
3. Explain the pathophysiology associated with the clinical manifestations of human immune deficiency virus and acquired immune deficiency syndrome and the purpose of antiretroviral therapy.
4. Use the nursing process as a framework for care of the patient with human immune deficiency virus/acquired immune deficiency syndrome.
5. Identify available resources for patients and support systems to promote self-management of immune deficiency disorders.

NURSING CONCEPTS

Family
Immunity
Infection
Nutrition

GLOSSARY

candidiasis: fungal infection, usually of skin or mucous membranes, caused by Candida species

enzyme immunoassay (EIA): a blood test that can determine the presence of antibodies to HIV in the blood or saliva; a variant of this test is called enzyme-linked immunosorbent assay (ELISA)

HIV-1: retrovirus isolated and recognized as the etiologic agent of HIV disease

HIV encephalopathy: clinical syndrome characterized by a progressive decline in cognitive, behavioral, and motor functions

immune reconstitution inflammatory syndrome (IRIS): a syndrome that results from rapid restoration of pathogen-specific immune responses to opportunistic infections

Kaposi sarcoma: malignancy that involves the epithelial layer of blood and lymphatic vessels

latent reservoir: the integrated HIV provirus within the $CD4^+$ T cell during the resting memory state; does not express viral proteins and is invisible to the immune system and antiviral medications

***Mycobacterium avium* complex (MAC):** opportunistic infection caused by mycobacterial organisms that commonly causes a respiratory illness but can also infect other body systems

opportunistic infection: illness caused by various organisms, some of which typically do not cause disease in people with normal immune systems

peripheral neuropathy: disorder characterized by sensory loss, pain, muscle weakness, and wasting of muscles in the hands or legs and feet

***Pneumocystis* pneumonia (PCP):** common opportunistic lung infection; pathogen implicated is *Pneumocystis jirovecii*

polymerase chain reaction (PCR): a sensitive laboratory technique that can detect and quantify HIV in a person's blood or lymph nodes

post-exposure prophylaxis (PEP): taking antiretroviral medicines as soon as possible, but no more than 72 hours (3 days) after possible HIV exposure; two to three drugs are usually prescribed which must be taken for 28 days

pre-exposure prophylaxis (PrEP): prevention method for HIV-negative people who are at high risk of HIV infection; involves taking a specific combination of HIV medicines daily; use with condoms and other prevention tools

primary immune deficiency diseases (PIDDs): rare, genetic disorders that impair the immune system

progressive multifocal leukoencephalopathy: opportunistic infection that infects brain tissue and causes damage to the brain and spinal

cord

retrovirus: a virus that carries genetic material in ribonucleic acid (RNA) instead of DNA and contains reverse transcriptase

viral load test: measures the quantity of HIV RNA or DNA in the blood

viral set point: amount of virus present in the blood after the initial burst of viremia and the immune response that follows

wasting syndrome: involuntary weight loss consisting of both lean and fat body mass

The human immune system is complex and multidimensional. It works to protect against invasion by foreign substances, protect against the proliferation of neoplastic cells, and plays a key role in inflammation and healing. Patients with primary or secondary immune system disorders (Norris, 2019) require care from nurses who are knowledgeable about the pathophysiology, diagnostic procedures, and interventions that are used in the management of these disorders.

PRIMARY IMMUNE DEFICIENCIES DISEASES

The majority of **primary immune deficiency diseases** (**PIDDs**), rare inherited disorders that impair the immune system, are commonly diagnosed in infancy, with a male-to-female ratio of 5 to 1. However, some PIDDs are not diagnosed until adolescence or early adulthood, when the gender distribution equalizes. Diagnosis at this stage frequently is confounded by frequent use of antibiotics that mask symptoms. Adults may present with clinical episodes of infectious diseases beyond the scope of normal immunocompetence, such as infections that are unusually persistent, recurrent, or resistant to treatment and that involve unexpected dissemination of disease or atypical pathogens. These rare inherited disorders not only lead to frequent infections, but also to increased risk of autoimmune disorders and malignancy (Hajjar, Guffey, Minard, et al., 2017).

Pathophysiology

There are more than 200 forms of PIDDs affecting about 500,000 people in the United States, and more than 270 different genes are associated with PIDDs. These rare genetic diseases prevent the body from developing normal immune responses resulting in a complex group of disorders with a wide array of clinical presentations. Many present during the first year of life and may be chronic, debilitating, and costly (National Institute of Allergy and Infectious Diseases [NIAID], 2019a).

Clinical Manifestations

Major signs and symptoms include multiple infections despite aggressive treatment, infections with unusual or opportunistic organisms, failure to thrive or poor growth, and a significant family history. Fatigue was reported in 18% of patients with PIDDs (Hajjar et al., 2017). See Table 32-1 for select PIDDs along with some of their clinical manifestations.

Assessment and Diagnostic Findings

There is often a considerable delay between the onset of symptoms and time of diagnosis of PIDDs. Because of the genetic origins of PIDDs, family history should be carefully assessed but epidemiologic data about specific infectious agents should be considered as well.

Laboratory tests are used to identify antibody deficiencies, cellular (T-cell) defects, neutrophil disorders, and complement deficiencies. A complete blood cell count with manual differential should always be analyzed first. Lymphopenia may indicate an immunologic abnormality; serum Ig levels (IgG, IgM, and IgA) and antibody responses to vaccines should be assessed to detect a humoral immune defect. Age-matched normal ranges need to be used since antibody levels change as the person ages (Fischbach & Fischbach, 2018).

Prevention

Live vaccines are contraindicated in patients with antibody deficiency disorders. The patient is incapable of generating antibodies and the live substance in the vaccine can cause disease. Family planning should be addressed in terms of future pregnancies; in some situations, prenatal in utero testing of a fetus can determine whether the infant will be affected.

Medical Management

A pattern of unusually frequent, opportunistic, or severe infections generates the possibility of a PIDD and initial testing or referral to an immunologist. Patients with neutropenia are at increased risk for developing severe infections despite substantial advances in supportive care. Epidemiologic shifts occur periodically and must be detected early because they influence prophylactic, empiric, and specific strategies for medical management. Attention to infection control practices is important, especially with the emergence of multidrug-resistant organisms.

Hematopoietic stem cell transplantation (HSCT) is a curative modality. The stem cells may be from embryos or adults. Toxicity and reduced efficacy are

frequent limitations of HSCT. See Chapter 12 for further discussion of HSCT.

Another therapy involves the use of cells as vehicles for the delivery of genes or gene products. Gene therapy has had many adverse effects; the first studies in human participants revealed numerous toxicities with this therapy. Rapidly emerging new technologies allowing precise DNA targeting may prove to be a useful approach (McDermott & Murphy, 2019).

Pharmacologic Therapy

Pharmacologic treatment depends upon the type and severity of presenting infection and the particular PIDD diagnosis. Prophylactic drug treatment prevents some bacterial and fungal infections but it must be used with caution because it has been implicated in the emergence of resistant organisms. The choices for empiric therapy include combination regimens and monotherapy. Specific choices depend on local factors (epidemiology, susceptibility/resistance patterns, availability, cost). Patients with antibody deficiencies receive regular Ig replacement therapy including both IV immunoglobulin (IVIG) and subcutaneous immunoglobulin (SCIG) to provide functional antibodies (Stonebraker, Hajjar, & Orange, 2018; Vitiello, Emmi, Silvestri, et al., 2019).

TABLE 32-1 Select Primary Immune Deficiency Disorders (PIDDs)

Disorder	Characteristics
Autoimmune lymphoproliferative syndrome (ALPS)	Unusually high numbers of lymphocytes accumulate in the lymph nodes, liver, and spleen leading to enlargement of those organs. Causes numerous autoimmune problems including low levels of red blood cells, platelets, and neutrophils that can increase the risk of infection and hemorrhage.
Autoimmune polyglandular syndrome type 1 (APS-1) (also called autoimmune polyendocrinopathy-candidiasis-ectodermal dystrophy [APECED])	Causes a diverse range of symptoms, including autoimmunity against different types of organs and increased susceptibility to candidiasis, a fungal infection caused by *Candida* yeast.
CARD9 Deficiency and other syndromes of susceptibility to candidiasis	Results in susceptibility to fungal infections such as candidiasis; particularly susceptible to Candida infections of the central nervous system.
Chronic granulomatous disease (CGD)	May be caused by mutations in one of five different genes. Phagocytes are unable to kill certain bacteria and fungi resulting in increased susceptibility to infections.
Common variable immunodeficiency (CVID)	Caused by a variety of genetic abnormalities resulting in defective ability of immune cells to produce normal amounts of antibodies, resulting in frequent bacterial or viral infections of the upper airway, sinuses, and lungs.
Congenital neutropenia syndromes	Characterized by low levels of neutrophils from birth.
CTLA4 Deficiency	Autoimmunity, low levels of antibodies, and excessive numbers of lymphocytes which infiltrate the gut, lungs, bone marrow, central nervous system, kidneys resulting in recurrent infections.
DOCK8 Deficiency	Lower-than-normal numbers of immune cells, which have a diminished capacity to move through dense tissues like the skin leading to recurrent viral infections of the skin and respiratory system.
GATA2 Deficiency	Characterized by immune deficiency, lung disease, problems of the vascular and lymphatic systems, and myelodysplastic syndrome (a condition characterized by ineffective blood cell production).
Glycosylation disorders with immune deficiency	Defects in glycosylation, which refers to the attachment of sugars to proteins; can disrupt the immune system resulting in immune deficiency.
Hyper-immunoglobulin E syndrome (HIES)	A rare primary immune deficiency disease characterized by eczema, recurrent staphylococcal skin abscesses, recurrent lung infections, eosinophilia (a high number of eosinophils in the blood) and high serum levels of IgE.

Hyper-immunoglobulin M (hyper-IgM) syndromes	Immune system fails to produce normal IgA, IgG, and IgE antibodies but can produce normal or elevated IgM.
Interferon gamma, interleukin 12, interleukin 23 deficiencies	Interferon gamma, interleukin 12, and interleukin 23 are key signals that raise alert against bacteria and other infectious microbes; deficiencies result in susceptibility to infections caused by bacteria and viruses.
Leukocyte adhesion deficiency (LAD)	Phagocytes are unable to move to the site of an infection resulting in an inability to fight pathogens resulting in recurrent, life-threatening infections and poor wound healing.
PI3 Kinase disease	Genetic mutations overactivate an important immune signaling pathway causing a change reaction that disrupts the infection-fighting B and T cells resulting in a weakened immune system and frequent bacterial and viral infections.
PLCG2-associated antibody deficiency and immune dysregulation (PLAID)	Rare disorder with allergic response to cold (cold urticaria) as the most distinct symptom.
Severe combined immune deficiency (SCID)	Group of rare, life-threatening disorders caused by mutations in different genes involved in development and function of T and B cells; infants appear healthy at birth but are highly susceptible to severe infections.
Warts, hypogammaglobulinemia, infections, and myelokathexis syndrome (WHIMS)	Low levels of white blood cells, especially neutrophils, which predispose to frequent infections and persistent warts.
Wiskott–Aldrich syndrome (WAS)	Problems with B and T cells and platelets resulting in prolonged episodes of bleeding, recurrent bacterial and fungal infections and increased risk of cancers and autoimmune diseases.

Adapted from National Institute of Allergy and Infectious Diseases (NIAID). (2019a). Types of primary immune deficiency disorders. Retrieved on 10/13/1019 at: www.niaid.nih.gov/diseases-conditions/types-pidds

For the procedural guidelines for managing immunoglobulin therapy, go to thepoint.lww.com/Brunner15e.

Nursing Management

Many patients with PIDDs have comorbid autoimmune disorders, such as thyroid disease, rheumatoid arthritis, cytopenias, and inflammatory bowel disease. Many patients require immunosuppression to ensure engraftment of depleted bone marrow during transplantation procedures. For this reason, nursing care must be meticulous. Appropriate hand hygiene and infection prevention precautions are essential. See Chapter 66, Chart 66-1 for hand hygiene methods and Chart 66-2 for a summary of infection prevention precautions. Institutional policies and procedures related to infection prevention care must be followed scrupulously until definitive evidence demonstrates that precautions are unnecessary. Continual monitoring of the patient's condition is critical, so early signs of impending infection may be detected and treated before they seriously compromise the patient's status.

Patients and caregivers in the home are taught how to administer medications, including regular Ig replacement therapy, if prescribed. Instruction is provided to the patient and family about how to administer the therapy at home (see Chart 32-1). Nurses provide ongoing education and support for the patient and family.

ACQUIRED IMMUNE DEFICIENCY

Immune deficiency can be acquired due to medical treatment such as chemotherapy (see Chapter 12) or infection from pathogens such as human immune deficiency virus (HIV). Advances have been made in treating HIV infection and acquired immune deficiency syndrome (AIDS); however, AIDS remains a critical public health issue in communities across the United States and around the world. Prevention, early detection, and ongoing treatment remain important aspects of care for people living with HIV infection or AIDS, who are sometimes referred to as persons living with HIV/AIDS (PLWHA). The American Nurses Association (ANA) has issued a position statement in support of efforts to end HIV (ANA, 2019).

HIV Infection and AIDS

Since the disease now known as AIDS was first identified in 1981, remarkable progress has been made in improving the length and quality of life for PLWHA. During the first decade, progress was associated with the recognition and treatment, including prophylactic medications, of **opportunistic infections** (illnesses caused by various organisms, some of which usually do not cause disease in people with normal immune systems). The second decade witnessed progress in the development of highly active antiretroviral drug therapies (HAART) as well as continuing progress in the treatment of opportunistic infections. The third decade has focused on issues of preventing

new infections, adherence to antiretroviral therapy (ART), development of second-generation combination medications that affect different stages of the viral life cycle, and continued need for an effective vaccine. The HIV antibody test, an **enzyme immunoassay** (**EIA**; or a variant of this test called *enzyme-linked immunosorbent assay* [ELISA]), became available in 1984, allowing early diagnosis of the infection before the onset of symptoms. Since then, HIV infection has been best managed as a chronic disease, most appropriately in an outpatient care setting, whereas AIDS may involve acute conditions that require hospitalization.

Chart 32-1 HOME CARE CHECKLIST

Home Administration of Ig Replacement Therapy

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of immune deficiency on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- State what types of changes are needed (if any) to maintain a clean home environment and prevent infection.
- State how to contact the primary provider, the team of home care professionals overseeing care, and intravenous supply vendor.
- State how to obtain medical supplies and carry out dressing changes, IV access site care, and other prescribed regimens.
- Identify the benefits and expected outcome of regular Ig replacement therapy.
- State rationale for prophylactic use of acetaminophen and diphenhydramine before treatment begins.
- State the rationale for prehydration on the day before infusion.
- Demonstrate how to prepare regular Ig replacement therapy.
- Demonstrate how to administer regular Ig replacement therapy.
- Demonstrate how to clean and maintain IV equipment, as applicable.
- Identify side effects and adverse effects of regular Ig replacement therapy.
- Demonstrate how to monitor for adverse effects of regular Ig replacement therapy.
- Describe to whom, how, and when to report adverse effects of regular Ig replacement therapy.
- Describe appropriate actions to take for adverse effects.
- Verbalize understanding of emergency measures for anaphylactic shock.
- Describe time periods associated with possible development of adverse reactions

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Epidemiology

Since the first cases of AIDS were reported in the United States in 1981, surveillance case definitions for HIV infection and AIDS have undergone several revisions (in 1985, 1987, 1993, 2008, and 2014) in response to diagnostic advances. Criteria for a confirmed case of HIV infection can be met by either laboratory evidence or clinical evidence but laboratory evidence, usually obtained through blood tests, is preferred over clinical evidence (e.g.,

patient signs and symptoms). A case of HIV infection can be classified in one of five HIV infection stages (0, 1, 2, 3, or unknown). Stage 0 indicates early HIV infection, inferred from laboratory testing; stages 1, 2, and 3 are based on the $CD4^+$ T-lymphocyte count; while cases with no information on $CD4^+$ T-lymphocyte count or percentage are classified as stage unknown (Centers for Disease Control and Prevention [CDC], 2014). See Table 32-2 for further explanation of stages.

In July 2015, the Obama White House released the *National HIV/AIDS Strategy for the United States: Updated to 2020*. This document has four Strategic Goals, which include reducing new infections; increasing access to care and improving health outcomes for people living with HIV; reducing HIV-related health disparities and health inequities; and achieving a more coordinated national response to the HIV epidemic. The strategy is being updated by the Office of HIV/AIDS and Infectious Disease Policy (OHAIDP, 2019).

According to the CDC, 1,006,691 persons aged 13 years and older are living with HIV infection, and an additional 534,515 are living with AIDS in the United States (CDC, 2019a). From 2012 through 2016, the rate of diagnoses of HIV infection decreased, although the annual number of diagnoses remained stable as survival rates have increased. The incidence was 11.8 per 100,000 persons for 2017, with men accounting for 81% of all HIV infection diagnoses (CDC, 2019a). The incidence per 100,000 persons was 41.1 for Blacks/African Americans, followed by 16.1 for Hispanics/Latinos, and 12.6 for persons of multiple races. The highest rate (32.9%) was for persons aged 25 to 29 years, followed by 28.7% for persons aged 20 to 24 years. Male-to-male sexual contact (MSM) (70%, including 3% male-to-male sexual contact and injection drug use) and those attributed to heterosexual contact (24%) accounted for approximately 94% of diagnosed HIV infections. Rates within the United States were 16.1% in the South, 10.6% in the Northeast, 9.4% in the West, and 7.4% in the Midwest (CDC, 2019a). Data about infections in transgender persons were not collected.

TABLE 32-2 HIV Infection Stages 1, 2, and 3 Based on Age-Specific Laboratory Data

	Age on Date of CD4+ T-Lymphocyte Test					
	<1 yr		1–6 yrs		≥6 yrs	
Stage	Cells/μL	%	Cells/μL	%	Cells/μL	%
1	≥1500	≥34	≥1000	≥30	≥500	≥26
2	750–1499	26–33	500–999	22–29	200–499	14–25
3	<750	<26	<500	<22	<200	<14

If a stage-3-defining opportunistic illness has been diagnosed, then the stage is 3 regardless of CD4+ T-lymphocyte test.

Stage-3-Defining Opportunistic Illnesses in HIV Infection
Bacterial infections, multiple or recurrent (only among children aged less than 6 yrs)
Candidiasis of bronchi, trachea, or lungs
Candidiasis of esophagus
Cervical cancer, invasive (only in persons aged 6 yrs or older)
Coccidioidomycosis, disseminated or extrapulmonary
Cryptococcosis, extrapulmonary
Cryptosporidiosis, chronic intestinal (>1 mo duration)
Cytomegalovirus disease (other than liver, spleen, or nodes), onset at age >1 mo
Cytomegalovirus retinitis (with loss of vision)
Encephalopathy attributed to HIV
Herpes simplex: chronic ulcers (>1 mo duration) or bronchitis, pneumonitis, or esophagitis (onset at age >1 mo)
Histoplasmosis, disseminated or extrapulmonary Isosporiasis, chronic intestinal (>1 mo duration)
Kaposi sarcoma
Lymphoma, Burkitt (or equivalent term)
Lymphoma, immunoblastic (or equivalent term)
Lymphoma, primary, of brain
Mycobacterium avium complex or Mycobacterium kansasii, disseminated or extrapulmonary
Mycobacterium tuberculosis of any site, pulmonary (only in persons aged 6 yrs or older) disseminated, or extrapulmonary
Mycobacterium, other species or unidentified species, disseminated or extrapulmonary
Pneumocystis jirovecii (previously known as "Pneumocystis carinii") pneumonia (PCP)
Pneumonia, recurrent (only in persons aged 6 yrs or older)
Progressive multifocal leukoencephalopathy
Salmonella septicemia (recurrent)
Toxoplasmosis of brain, onset at age >1 mo
Wasting syndrome attributed to HIV

Adapted from Centers for Disease Control and Prevention (CDC). (2014). Revised surveillance case definition for HIV infection—United States, 2014. *MMWR. Recommendations and Reports: Morbidity and Mortality Weekly Report. Recommendations and Reports, 63*(RR-03), 1–10.

According to the World Health Organization ([WHO], 2019), HIV through its morbid consequence of AIDS has claimed more than 32 million lives globally; in 2018, 770,000 people died from HIV-related causes. Globally, there were approximately 37.9 million people living with HIV at the end of 2018, with 1.7 million people becoming newly infected in 2018. The WHO African Region is the most affected region, with 25.7 million people living with HIV in 2018. The African region also accounts for almost two thirds of the global total of new HIV infections. Between 2000 and 2018, new HIV infections fell by 37%, and HIV-related deaths fell by 45% with 13.6 million lives saved due to patients receiving effective medication during that same period. The decrease in infection rates and deaths was the result of many efforts by national HIV programs supported by a range of funding partners (WHO, 2019).

HIV Transmission

Inflammation and breaks in the skin or mucosa result in the increased probability that an HIV exposure will lead to infection. Human immune deficiency virus type 1 (**HIV-1**) is transmitted in body fluids (blood, seminal fluid, vaginal secretions, amniotic fluid, and breast milk) that contain infected

cells. Higher amounts of HIV and infected cells in the body fluid are associated with the probability that the exposure will result in infection. Mother-to-child transmission of HIV-1 may occur in utero, at the time of delivery, or through breast-feeding, but most perinatal infections are thought to occur during labor and delivery. HIV is not transmitted through casual contact (see Chart 32-2).

Blood and blood products can transmit HIV to recipients. However, the risk associated with transfusions has been virtually eliminated as a result of voluntary self-deferral, completion of a detailed health history, extensive testing, heat treatment of clotting factor concentrates, and more effective virus inactivation methods. Donated blood is tested for antibodies to HIV-1, human immune deficiency virus-2 (retrovirus identified in 1986 in patients with AIDS in Western Africa), and the p24 antigen; since 1999, additional testing has been performed.

Chart 32-2 RISK FACTORS

Risks Associated with HIV Infection

- Sharing infected injection drug use equipment
- Having sexual relations with infected persons (both genders)
- Infants born to mothers with HIV infection or who are breast-fed by HIV-infected mothers
- People who received organ transplants, HIV-infected blood, or blood products (especially between 1978 and 1985)

Adapted from Centers for Disease Control and Prevention (CDC). (2019a). HIV Surveillance Report, 2017. Retrieved on 10/21/2019 at: www.cdc.gov/hiv/library/reports/hiv-surveillance.html

Gerontologic Considerations

According to the CDC, 91,127 persons between the ages of 60 and 64 years are living with HIV infection, and an additional 58,526 persons are living with AIDS. For persons aged 65 years and older, 82,046 persons are living with HIV infection and an additional 52,995 persons are living with AIDS (CDC, 2019a). Many were diagnosed with HIV in their younger years and are benefitting from effective treatment. However, thousands of older adults unknowingly become infected with HIV every year. Older adults are less likely than younger people to get tested. Thirty-five percent of persons aged 50 and older were diagnosed with late-stage infection or AIDS, indicating a failure to screen for HIV in this population. Although this rate is an improvement from 2011, when it was 42%, it is still high. Late diagnosis has an adverse impact on

treatment effectiveness (CDC, 2019b). Medicare will pay for annual screenings up until age 65 but there needs to be a special indication (such as unprotected sex with an infected partner) for a person to be screened after that age in order for Medicare to cover the cost of testing (CDC, 2019a).

Persons are often embarrassed to share that they have engaged in activities associated with HIV infection and so might not disclose this to the health care provider. The provider needs to use other cues, such as the presence of other sexually transmitted diseases, and recommend HIV testing. Providers may bring societal age and gender biases to their perceptions of patient sexuality, which influence their communication about sexual health with older adult patients. For some providers, assumptions that discussions about sexual health will offend their patients, as well as their own discomfort with talking to older adults about sex, inhibit them from assessing risk factors that may indicate a need for HIV and STI testing.

Comorbidities in older persons with HIV/AIDS include type 2 diabetes; non-AIDS cancerous diseases; cardiovascular disease; osteoporosis; and depression (Guaraldi, Malagoli, Calcagno, et al., 2018). Due to the high number of chronic illnesses, polypharmacy along with drug interactions becomes a major clinical challenge. Loneliness has been defined as the distress that exists between actual and desired relationships and is different from the concept of aloneness or living alone. Loneliness was studied in older persons living with HIV/AIDS by Greene and colleagues, who found that 58% of the participants reported at least some loneliness. Compared to participants who did not report feeling lonely, those who did report loneliness were more likely to smoke, misuse alcohol, or use illicit drugs. They also reported less physical social supports in place, depressive symptoms, poor or fair health-related quality of life, and functional impairment in one or more Instrumental Activities of Daily Living (IADLs) (Greene, Hessol, Perissinotto, et al., 2018). Loneliness has been associated with increased mortality in the general population.

Prevention of HIV Infection

Nurses need to participate in efforts to prevent HIV infection by educating patients how to eliminate or reduce risks associated with HIV infection and AIDS, particularly in younger adults, in order to promote a healthy lifestyle and longevity (Eliopoulos, 2018). HIV is transmitted through the exchange of some infected body fluids (see Chart 32-2). While behavioral interventions such as encouraging the use of condoms are highly effective in reducing the transmission of HIV, the HIV-negative person must be motivated and have the freedom to choose to use the method. In some situations, however, that freedom is absent. For example, a lack of freedom exists in a discordant couple (those in which only one partner has HIV) if the husband refuses to use

condoms and the wife's cultural and religious beliefs require sexual activity with her husband. In this context, **pre-exposure prophylaxis (PrEP)** might be appropriate. PrEP involves taking one pill containing two HIV medications (tenofovir disoproxil fumarate 300 mg and emtricitabine 200 mg) daily in order to avoid the risk of sexual HIV acquisition in adults and adolescents age 12 and older. HIV status should be checked every 3 months to be sure that the person has not become infected. The ultimate goal of PrEP is to reduce the acquisition of HIV infection with its resulting morbidity, mortality, and cost to individuals and society (CDC, 2019c). For persons taking ART as prescribed and achieving and maintaining viral suppression, there is no risk of transmitting HIV through sex. Since PrEP does not prevent other sexually transmitted infections, which are increasing (CDC, 2019d), it is important for couples to also use a condom.

Preventive Education

Prevention of HIV infection is achieved through: (a) behavioral interventions have been effective in reducing the risk of acquiring or transmitting HIV by ensuring that people have the information, motivation, and skills necessary to reduce their risk; (b) HIV testing, because most people change behaviors to protect their partners if they know they are infected with HIV; and (c) linkage to treatment and care, which enables individuals with HIV to live longer, healthier lives and reduce their risk of transmitting HIV (CDC, 2019e). The CDC (2019f), through the HIV/AIDS Prevention Research Synthesis Project, provides information about evidence-based behavioral interventions that can be used in a number of settings with targeted populations. Strategies to protect against infection are outlined in Chart 32-3. Other than abstinence, consistent and correct use of condoms (see Chart 32-4) is the only effective method to decrease the risk of sexual transmission of HIV infection. When latex male condoms are used consistently and correctly during vaginal or anal intercourse, they are highly effective in preventing the sexual transmission of HIV. Nonlatex condoms made of natural materials such as lambskin are available for people with latex allergy but will not protect against HIV infection. A male condom should be used for oral contact with the penis, and a dental dam (a flat piece of latex used by dentists to isolate a tooth for treatment) or an altered condom can be used for oral contact with the vagina or rectum. Voluntary medical male circumcision (VMMC) is 50% to 60% effective at preventing the acquisition of HIV infection. This is a key intervention in generalized epidemic settings with high HIV prevalence and low male circumcision rates (Ensor, Davies, Rai, et al., 2019).

Chart 32-3 HEALTH PROMOTION

Protecting Against HIV Infection
All patients should be advised to:

- Abstain from exchanging sexual fluids (semen and vaginal fluid).
- Reduce the number of sexual partners to one.
- Always use latex condoms. If the patient is allergic to latex, nonlatex condoms should be used; however, they will not protect against HIV infection.
- Not reuse condoms.
- Avoid using cervical caps or diaphragms without using a condom as well.
- Always use dental dams for oral–genital or anal stimulation.
- Avoid anal intercourse, because this practice may injure tissues; if not possible, use lubricant—there are water and silicone-based products designed for anal sex.
- Avoid manual–anal intercourse ("fisting").
- Avoid sharing needles, razors, toothbrushes, sex toys, or blood-contaminated articles.
- Consider PrEP if regularly engage in high-risk behaviors.
- Use needle-exchange programs (as appropriate) and do not share drug-using equipment.

Patients who are HIV seropositive should also be advised to:

- Take ART regularly to achieve viral suppression.
- Inform previous, present, and prospective sexual and drug-using partners of their HIV-positive status. If the patient is concerned for their safety, advise the patient that many states have established mechanisms through the public health department in which professionals are available to notify exposed contacts.
- Avoid having unprotected sex with another HIV-seropositive person. Cross-infection with that person's HIV can increase the severity of infection.
- Not donate blood, plasma, body organs, or sperm.

ART, antiretroviral therapy; PrEP, pre-exposure prophylaxis.

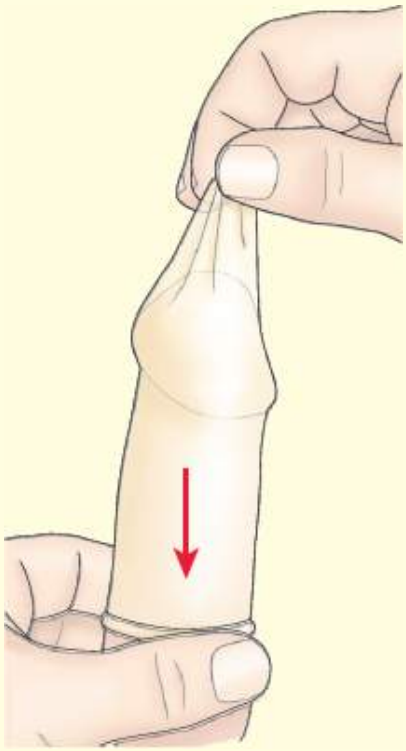
Chart 32-4 PATIENT EDUCATION

The Correct Way to Use a Male Condom

The nurse instructs the patient to:

- Put on a new condom before any kind of sex.
- Hold the condom by the tip to squeeze out the air.

- Unroll the condom all the way over the erect penis.



- Have sex.
- Hold the condom so it cannot come off the penis.
- Pull out.

- Use a new condom if you want to have sex again or if you want to have sex in a different place (e.g., in the anus and then in the vagina).

Note: Keep condoms cool and dry. Never use skin lotions, baby oil, petroleum jelly, or cold cream as lubricants; the oil in these products will cause the latex condom to break. Products made with water (such as K-Y jelly or glycerin) are safer to use.

The polyurethane female condom, which is an effective contraceptive, provides a physical barrier that prevents exposure to genital secretions containing HIV, such as semen and vaginal fluid, and is inserted by the woman (see Chapter 50). Other safe and effective woman-controlled methods such as microbicides remain elusive although clinical trials continue globally. Microbicides are gels, films, or suppositories that can kill or neutralize viruses and bacteria; vaginal and rectal microbicides are being researched to see if they can prevent sexual transmission of HIV.

Total abstinence from addictive drugs might not be a realistic short-term goal. The harm reduction framework uses practical strategies and ideas aimed at reducing negative consequences associated with drug use. It is also a movement for social justice built on a belief in, and respect for, the rights of people who use drugs. Using a harm reduction framework, the nurse works with people who inject drugs to assist them to increase their healthy behaviors. Sharing of drug-use equipment is a high-risk behavior for a number of bloodborne infections and should be avoided. Syringe services programs are also referred to as syringe exchange programs and needle exchange programs. Although the services they provide may vary, they are community-based programs that provide access to sterile needles and syringes, facilitate safe disposal of used syringes, and provide and link to other important services and programs (CDC, 2019g). Therefore, under the harm reduction framework, participation in needle exchange programs is encouraged since they do not promote increased drug use; on the contrary, they have been found to decrease the incidence of bloodborne infections in people who inject drugs. Nurses should refer patients to accessible needle exchange programs whenever available.

Related Reproductive Education

Because HIV infection in women often occurs during the childbearing years, family planning issues need to be addressed. Attempts to achieve pregnancy by couples in which only one partner has HIV (known as discordant couples) expose the unaffected partner to the virus. Efforts at artificial insemination using processed semen from an HIV-infected partner continue. Studies are needed, because HIV has been found in the spermatozoa of patients with HIV infection, and it is possible that HIV can replicate in the male germ cell. Women considering pregnancy need to have accurate information about the

risks of transmitting HIV infection to themselves, their partner, and their future children, and about the benefits of taking ART to reduce perinatal HIV transmission. Results from the Evidence for Contraceptive Options and HIV Outcomes (ECHO) Trial Consortium found that, among African women seeking effective contraception and living in areas of high HIV incidence, there was no substantial difference in HIV risk among the methods evaluated (DMPA-IM, a copper IUD, and a levonorgestrel implant) and all methods were safe and highly effective (ECHO Trial Consortium, 2019). HIV-infected women in resource-rich settings should be instructed not to breast-feed their infants, because HIV is transmitted through breast milk.

Prevention in Lesbian, Gay, Bisexual, Transgender, and Queer Persons

Many health care providers are insufficiently prepared to meet the unique health needs of those who identify as lesbian, gay, bisexual, transgender, and queer (LGBTQ). Young gay men, in particular, are at higher risk for contracting HIV (CDC, 2019a). At the same time, these sexual and gender minorities experience significant challenges due to family rejection, lack of social support, stigma, isolation, minority stress, as well as abuse and harassment. Nurses need to be culturally competent in order to be effective in educating these unique populations about prevention methods (see Chapter 54).

Reducing the Risk of Transmission to Health Care Providers

Prevention of HIV and AIDS among health care providers involves the use of standard precautions to prevent exposure, using post-exposure prophylaxis when exposure does occur and hopefully, in the near future, the use of a vaccine.

Standard Precautions

Implementation of appropriate hand hygiene measures (see Chapter 66, Chart 66-1 for further information on hand hygiene methods) remains the most effective measure to prevent transmission of organisms. To reduce the risk of exposure of health care workers to HIV, the CDC developed standard precautions (see Chart 32-5; also see Chapter 66, Chart 66-2) which are designed to reduce the risk of transmission of pathogens. Standard precautions are used when working with all patients in all health care settings, regardless of their diagnosis or presumed infectious status.

Post-Exposure Prophylaxis for Health Care Providers

Post-exposure prophylaxis (PEP) includes taking antiretroviral medicines as soon as possible, but no more than 72 hours (3 days) after possible HIV exposure; three drugs are prescribed. Health care workers who are exposed to a needle stick involving HIV-infected blood in a health care setting have a 0.3% risk of becoming HIV infected; the risk of infection due to occupational exposure is very low (CDC, 2018a).

Occupational exposure is an urgent medical concern and should be managed immediately after possible exposure—the sooner the better; every hour counts (CDC, 2018a). The CDC suggests that these post-exposure guidelines be followed after occupational and other exposures such as sexual assault. Chart 32-6 provides the strategies and emphasizes the need for quick action. See the Resources section for the phone number for the Health Resources and Service Administration (HRSA) Post-exposure Prophylaxis Hotline which is answered by a health care provider.

Chart 32-5

Recommendations for Standard Precautions

- **Hand hygiene:** Use after touching blood, body fluids, secretions, excretions, or contaminated items; immediately after removing gloves; and between patient contacts.
- **Personal protective equipment:**
  - *Gloves:* Use for touching blood, body fluids, secretions, excretions, and contaminated items, and for touching mucous membranes and nonintact skin.
  - *Gown:* Use during procedures and patient care activities when contact of clothing/exposed skin with blood or body fluids, secretions, and excretions is anticipated.
  - *Mask, eye protection (goggles), face shield*[1]: Use during procedures and patient care activities likely to generate splashes or sprays of blood, body fluids, and secretions, especially suctioning or endotracheal intubation.
- **Soiled patient care equipment:** Handle in a manner that prevents transfer of microorganisms to others and to the environment; wear gloves if visibly contaminated; and perform hand hygiene.
- **Environmental control:** Develop procedures for routine care, cleaning, and disinfection of environmental surfaces, especially frequently touched surfaces in patient care areas.
- **Textiles and laundry:** Handle in a manner that prevents transfer of microorganisms to others and to the environment.
- **Needles and other sharps:** Do not recap, bend, break, or hand manipulate used needles; if recapping is required, use a one-handed scoop technique only; use safety features when available; and place used sharps in a puncture-resistant container.
- **Patient resuscitation:** Use mouthpiece, resuscitation bag, and other ventilation devices to prevent contact with mouth and oral secretions.
- **Patient placement:** Prioritize for single-patient room if patient is at increased risk for transmission, is likely to contaminate the environment, does not maintain appropriate hygiene, or is at increased risk for acquiring infection or developing adverse outcome following infection.
- **Respiratory hygiene/cough etiquette** (source containment of infectious respiratory secretions in symptomatic patients, beginning at initial point of encounter, such as triage and reception areas in emergency departments and provider offices): Instruct symptomatic people to cover mouth and nose when sneezing or coughing, use tissues and dispose in no-touch receptacle, observe hand hygiene after soiling of hands with respiratory secretions, and wear surgical mask if tolerated.

[1]During aerosol-generating procedures on patients with suspected or proven infections transmitted by respiratory aerosols (e.g., severe acute

respiratory syndrome), wear a fit-tested N95 or higher respirator in addition to gloves, gown, and face/eye protection.

Adapted from Centers for Disease Control and Prevention (CDC). (2018a). Updated U.S. Public Health Service guidelines for the management of occupational exposures to HIV and recommendations for postexposure prophylaxis. Retrieved on 10/27/2019 at: stacks.cdc.gov/view/cdc/20711

Vaccination

In the face of a global pandemic, the search for an effective vaccine against the HIV remains an urgent priority. The first U.S. government-sponsored phase I trial of an HIV vaccine was launched in 1987 and intensive efforts worldwide using a variety of strategies continue (NIAID, 2019b).

Chart 32-6

Post-HIV Exposure Prophylaxis for Health Care Providers

If you sustain an occupational exposure to HIV, take the following actions immediately:

- Alert your supervisor and initiate the occupational exposure reporting system used in the setting.
- Determine the HIV status of the exposure source (i.e., patient) when possible to guide appropriate use of HIV post-exposure prophylaxis (PEP). Use rapid-testing if the HIV status of the patient is unknown. Check laws in your state as you proceed to determine HIV status of the source patient.

Get counseling at the time of exposure and at follow-up appointments:

- Exposed health care providers (HCP) are advised to use precautions (e.g., use of barrier contraception and avoidance of blood or tissue donations, pregnancy, and, if possible, breast-feeding) to prevent secondary transmission, especially during the first 6 to 12 weeks after exposure.
- For exposures for which PEP is prescribed, HCPs are informed regarding the following:
  - Possible drug toxicities (e.g., rash and hypersensitivity reactions that could imitate acute HIV seroconversion and the need for monitoring)
  - Possible drug interactions
  - The need for adherence to PEP regimens

Undergo early reevaluation after exposure:

- Regardless of whether an HCP is taking PEP, reevaluation of exposed HCP within 72 hours after exposure is strongly recommended, as additional information about the exposure or the source patient may be available.

Follow up with HIV testing and appointments. At a minimum, this follow-up should include:

- HIV testing at baseline and at 6 weeks, 12 weeks, and 6 months after exposure; alternatively, if the HCP is certain that a fourth-generation combination HIV p24 antigen–HIV antibody test is being utilized, then HIV testing could be performed at baseline, 6 weeks after exposure, and 4 months after exposure
- Complete blood counts and renal and hepatic function tests (at baseline and 2 weeks after exposure; further testing may be indicated if abnormalities are detected)

Note: All HIV testing results should preferably be given to the exposed HCP during face-to-face appointments.

Adapted from Centers for Disease Control and Prevention (CDC). (2018a). Updated U.S. Public Health Service guidelines for the management of

occupational exposures to HIV and recommendations for postexposure prophylaxis. Retrieved on 10/27/2019 at: stacks.cdc.gov/view/cdc/20711

Pathophysiology

Because HIV is an infectious disease, it is important to understand how HIV-1 integrates itself into a person's immune system and how the immune response plays a pivotal role in the course of HIV disease. This knowledge is also essential for understanding medication therapy and vaccine development. Viruses are intracellular parasites. HIV is in the subfamily of lentiviruses and is a **retrovirus** because it carries its genetic material in the form of ribonucleic acid (RNA) rather than deoxyribonucleic acid (DNA) (Norris, 2019).

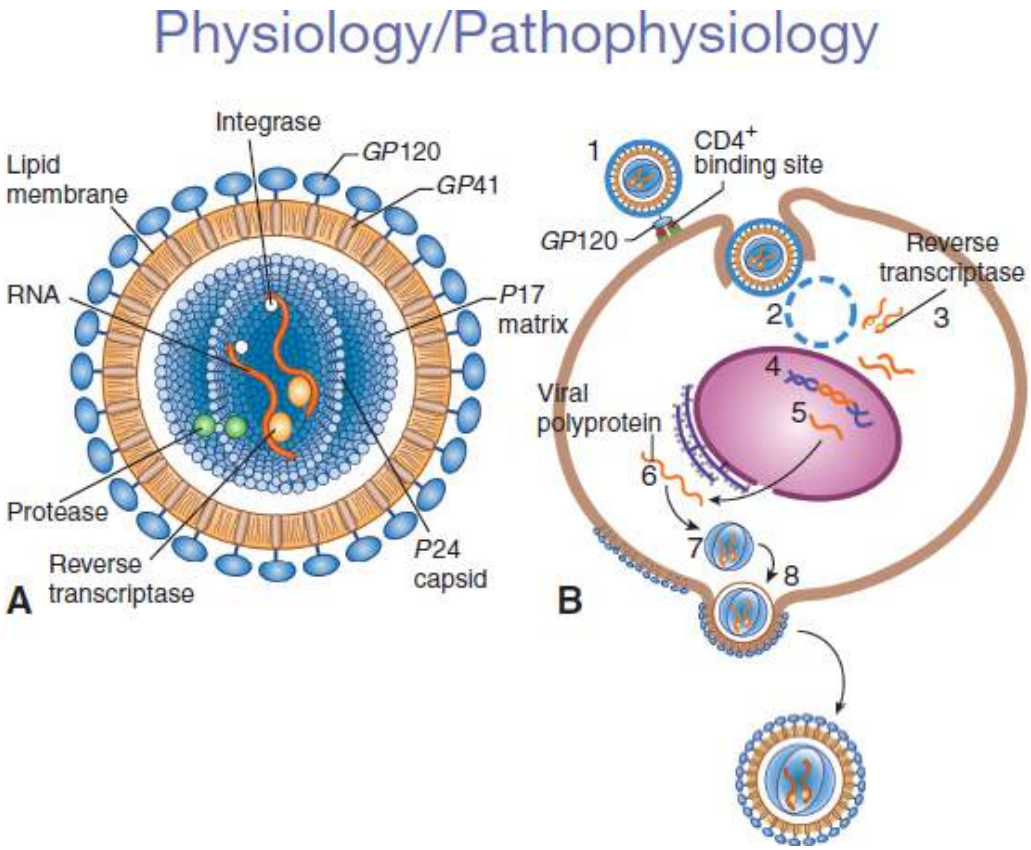


Figure 32-1 • Structure of HIV-1 virus. The virus surrounded by a lipid envelope. Reprinted with permission from Norris, T. L., & Lalchandani, R. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed., Fig. 12.7 (left side)). Philadelphia, PA: Wolters Kluwer.

Two genetically different but closely related forms of HIV (HIV-1 and HIV-2) have been identified. Globally, it has been estimated that one to two million individuals have HIV-2, including people with HIV-1/HIV-2 dual infection.

The course of illness is slower when infection is caused by HIV-2, which seems to be more common in Western Africa compared to HIV-1, which is more common in other regions of the globe (Panel, 2019). Blood tests may be used to screen for both forms of HIV. As shown in Figure 32-1, HIV consists of a viral core, containing viral RNA, which is surrounded by an envelope consisting of protruding glycoproteins.

All viruses target specific cells. HIV targets cells with $CD4^+$ receptors, which are expressed on the surface of T lymphocytes, monocytes, dendritic cells, and brain microglia. Mature T cells (T lymphocytes) are composed of two major subpopulations that are defined by cell surface receptors of $CD4^+$ or $CD8^+$. Approximately two thirds of peripheral blood T cells are $CD4^+$, and approximately one third is $CD8^+$. Most people have about 700 to 1000 $CD4^+$ cells/mm^3, but a level as low as 500 cells/mm^3 can be considered within normal limits.

The HIV life cycle is complex. Figure 32-2 illustrates the seven stages of the life cycle and the various classes of antiretroviral medications that target each specific stage (HIV Information, 2020; Norris, 2019).

In resting (nondividing) $CD4^+$ cells, HIV survives in a latent state as an integrated **provirus** that produces few or no viral particles. These resting $CD4^+$ T cells can be stimulated to produce new particles if something activates them, such as another infection. When a resting T cell that harbors this integrated DNA (also known as provirus) becomes activated against HIV or other microbes, the cell begins to produce new copies of both RNA and viral proteins. Consequently, whenever the infected $CD4^+$ cell is activated, HIV replication and budding occur, which can destroy the host cell. Newly formed HIV released into the blood can infect other $CD4^+$ cells.

HIV-1 mutates quickly, at a relatively constant rate, with about 1% of the virus's genetic material changing annually. HIV-1 exhibits substantial genetic diversity, and several different genotypes of HIV-1 exist throughout the world. There is a major group (group M), which consists of subtypes A through L, and a more diverse collection of outliers, which has been referred to as groups N and O. Subtype B HIV-1 viruses predominate in the Western world; this genetic variation is one of the major reasons why effective vaccine development has been such a challenge.

Stages of HIV Infection

There are five stages of HIV infection based on clinical history, physical examination, laboratory evidence (CDC, 2014), signs and symptoms, and associated infections and malignancies. See Table 32-2.

The period from infection with HIV to the development of HIV-specific antibodies is known as **primary infection or acute HIV infection** (previously known as the window period) and is part of stage 0 (CDC, 2014). Acute HIV

infection is the interval between the appearance of detectable HIV RNA and the first detection of antibodies. Initially, persons test negative on the HIV antibody blood test, although they are not only infected, but also highly contagious because their viral loads are very high. About 40% to 80% of patients develop clinical symptoms of a nonspecific viral illness (e.g., fever, fatigue, or rash) lasting 1 to 2 weeks. After 2 to 3 weeks, antibodies to the glycoproteins of the HIV envelope can be detected in the sera of people infected with HIV, but most of these antibodies lack the ability to totally control the virus. By the time neutralizing antibodies can be detected, HIV-1 is firmly established in the host.

Primary or acute infection is characterized by high levels of viral replication, widespread dissemination of HIV throughout the body, and destruction of $CD4^+$ T cells, which leads to dramatic drops in $CD4^+$ T-cell counts (normally 500 to 1500 cells/mm^3 of blood). The host responds to the HIV infection through a $CD4^+$ T-cell response that causes other immune cells, such as $CD8^+$ lymphocytes, to increase their killing of infected, virus-producing cells. The body produces antibody molecules in an effort to contain the free HIV particles (outside cells) and assist in their removal. During this stage, the virus is widely disseminated in lymphoid tissue, and a **latent reservoir** within resting memory $CD4^+$ T cells is created.

During stage 1, the amount of virus in the body after the initial immune response subsides results in a **viral set point** which reflects an equilibrium between HIV levels and the immune response. Untreated, this set point can last for years and is inversely correlated with disease prognosis. The higher the viral set point, the poorer the prognosis. After the viral set point is reached, a chronic stage persists in which the immune system cannot eliminate the virus despite its best efforts. This set point varies greatly from patient to patient and dictates the subsequent rate of disease progression; on average, 8 to 10 years can pass before a major HIV-related complication develops. In this prolonged, chronic stage (stage 1), patients feel well and have few, if any, symptoms, which is why this stage had been referred to as asymptomatic. Apparent good health continues because $CD4^+$ T-cell levels remain high enough to preserve immune defensive responses, but, over time, the number of $CD4^+$ T cells decrease.

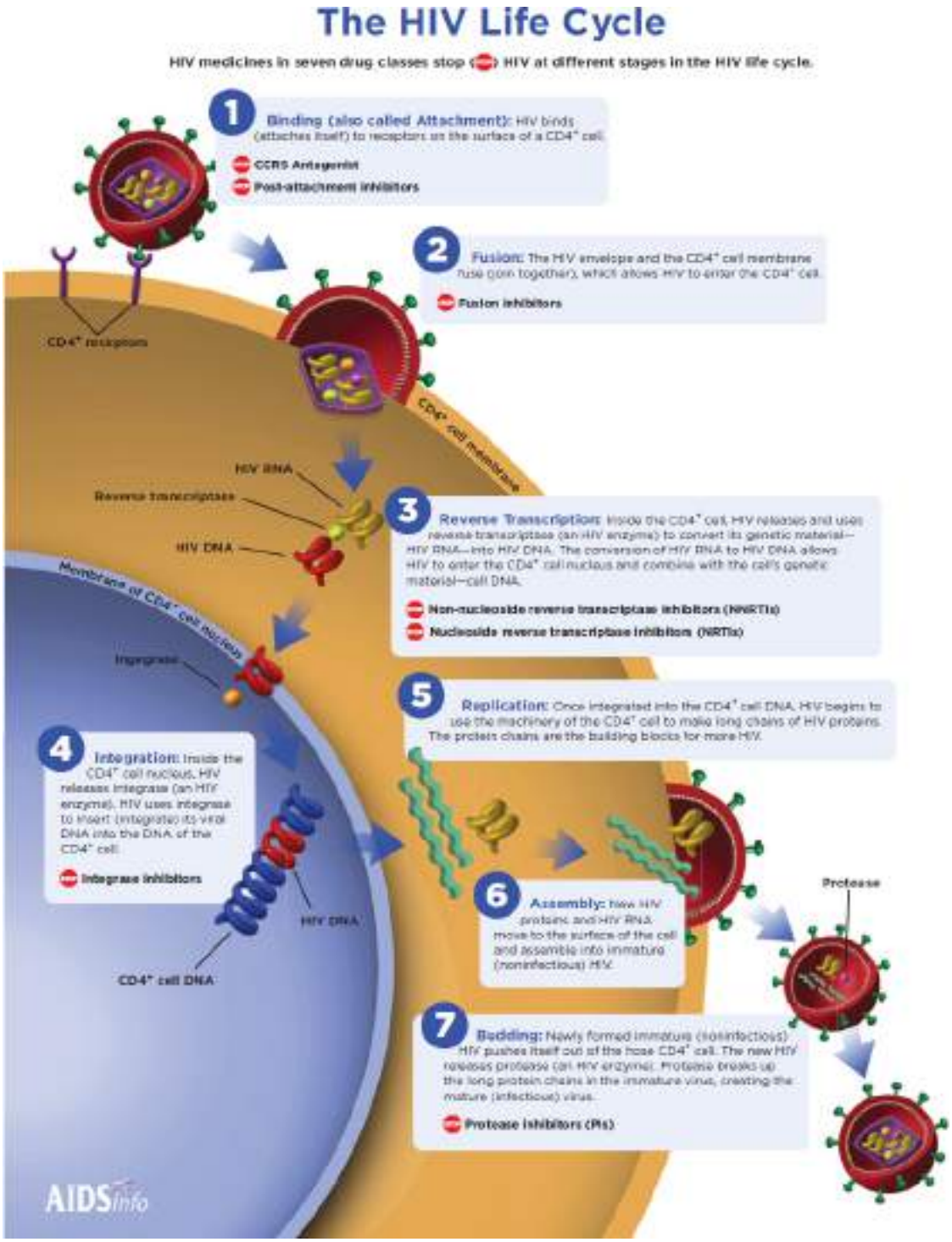


Figure 32-2 • The HIV life cycle. Adapted from HIV Information, 2020.

Stage 2 occurs when CD4+ T-lymphocyte cells decrease to between 200 and 499 cells/mm^3 and had previously been referred to as the symptomatic stage. Stage 3 is diagnosed when the count drops below 200 cells/mm^3 and the person has AIDS. HIV disease progression is classified from less to more severe; once a case is classified into a surveillance severity stage, it cannot be

reclassified into a less severe stage even if the $CD4^+$ T lymphocytes increase, which often occurs when a person receives ART. A stage 3, AIDS, diagnosis has implications for services (e.g., disability benefits, housing, and food stamps), because these programs are often linked to living with severe immune dysfunction.

Assessment and Diagnostic Findings in HIV Infection

During the first stage of HIV infection, the patient may have no symptoms or generalized signs and symptoms such as fatigue or skin rash. Patients who are in later stages of HIV infection may have a variety of symptoms related to their immunosuppressed state. The staging system requires laboratory evidence of HIV infection in order to diagnose HIV or AIDS (see Table 32-2).

HIV Tests

Several tests are used to diagnose HIV infection, and others are used to determine the stage and severity of the infection. A serologic testing algorithm for recent HIV seroconversion (STARHS) analyzes HIV-positive blood samples to determine whether an HIV infection is recent or has been ongoing. There are three types of HIV diagnostic tests: antibody tests, antigen/antibody tests, and nucleic acid (RNA) tests. Antibody tests detect antibodies, not HIV itself, while antigen and RNA tests directly detect HIV. The CDC recommends tests for HIV antigens and HIV nucleic acid because studies from high-risk populations found that antibody testing alone might miss a considerable percentage of HIV infections detectable by virologic tests, especially during stage 0.

Blood tests can detect HIV infection sooner after exposure compared to oral fluid tests because the level of antibody in blood is higher than it is in oral fluid. Likewise, antigen/antibody and RNA tests detect infection in blood before antibody tests. Some newer antigen/antibody laboratory tests can sometimes find HIV as soon as 3 weeks after exposure to the virus.

Follow-up testing is performed if the initial test result is positive to ensure a correct diagnosis. These tests include:

- antibody *differentiation tests,* which distinguishes HIV-1 from antibodies
- *HIV-1 nucleic acid tests,* which looks for the virus RNA directly

Table 32-3 identifies common blood tests used for screening.

Since negative perceptions and judgments associated with being HIV infected continue to persist, stigma remains one of the biggest social challenges (Glynn, Llabre, Lee, et al., 2019). When the result of the HIV antibody test is received, it is carefully explained to the patient in private (see Chart 32-7). All test results are confidential. Education and counseling about

the test result and about preventing transmission are essential. The patient's psychological response to a positive test result may include feelings of panic, depression, and hopelessness. The social and interpersonal consequences of a positive test result can be devastating. The patient may lose their sexual partner, housing, and their job because of disclosure. They may be subjected to physical abuse and, although illegal, experience discrimination in employment as well as social ostracism. For these reasons and others, patients who test positive may need ongoing counseling as well as referrals for social, financial, medical, and psychological support services. The HIV Care Continuum (CDC, 2019h) starts when patients receive their positive HIV blood test results. They must be connected to health care services to evaluate their stage of HIV infection and start treatment.

TABLE 32-3 HIV Screening Blood Tests

Laboratory Test	Indications
HIV-1/HIV-2 immunoassay	Tests for both HIV-1 and HIV-2 antibodies
HIV/1-HIV-2 antigen/antibody combination immunoassay	Tests for both virus (antigen) and antibody for both HIV-1 and HIV-2
HIV-1 differentiation assay	Differentiates HIV-1 from HIV-2
HIV-1 nucleic acid amplification test	Tests directly for virus
HIV-1 p24 antigen	Tests directly for virus

HIV, human immune deficiency virus.

Adapted from Centers for Disease Control and Prevention. (2018b). Quick reference guide: Recommended laboratory HIV testing algorithm for serum or plasma specimens. Retrieved on 10/28/2019 at: stacks.cdc.gov/view/cdc/50872

Chart 32-7

HIV Test Results: Implications for Patients

Interpretation of Positive Antibody Test Results

- Antibodies to HIV are present in the blood (the patient has been infected with the virus, and the body has produced antibodies).
- HIV is active in the body, and the patient can transmit the virus to others.
- Despite HIV infection, the patient does not necessarily have AIDS.
- The patient is not immune to HIV (the antibodies do not indicate immunity).

Interpretation of Negative Test Results

- Antibodies to HIV are not present in the blood at this time, which can mean that the patient has not been infected with HIV or, if infected, the body has not yet produced antibodies (stage 0).
- The patient should continue taking precautions. The test result does not mean that the patient is immune to the virus, nor does it mean the patient is not infected; it just means that the body may not have produced antibodies yet. If viral test used, a negative result is more consistent with the conclusion that the patient is uninfected.

AIDS, acquired immune deficiency syndrome; HIV, human immune deficiency virus.

Adapted from Centers for Disease Control and Prevention (CDC). (2018b). Quick reference guide: Recommended laboratory HIV testing algorithm for serum or plasma specimens. Retrieved on 10/28/2019: stacks.cdc.gov/view/cdc/50872

Patients whose test results are seronegative may develop a false sense of security, possibly resulting in continued high-risk behaviors or feelings that they are immune to the virus. These patients may need ongoing counseling to help modify high-risk behaviors and to encourage returns for repeated testing. Other patients may experience anxiety regarding the uncertainty of their status. In addition to screening for HIV, patients should be screened for other bloodborne coinfections such as hepatitis; other STIs such as syphilis; and other infections associated with T-cell immunity such as tuberculosis (TB). The rates of coinfection of hepatitis C and HIV are approximately 25% (Starbird, Hong, Sulkowski, et al., 2020).

Staging

Two surrogate markers are used routinely to assess immune function and level of HIV viremia: $CD4^+$ T-cell count ($CD4^+$ count) and plasma HIV RNA (viral load). $CD4^+$ count should be measured in all patients at entry into care. **Viral**

load tests use target amplification methods to quantify HIV RNA or DNA levels in the plasma. Target amplification methods include reverse transcriptase–**polymerase chain reaction** (RT-PCR) and nucleic acid sequence–based amplification (NAT). A widely used viral load test measures plasma HIV RNA levels. Currently, these tests are used to track viral load and response to treatment of HIV infection. RT-PCR is also used to detect HIV in high-risk seronegative people before antibodies are measurable, to confirm a positive EIA result, and to screen neonates. HIV culture or quantitative plasma culture and plasma viremia are additional tests that measure viral burden, but they are used infrequently. Viral load is a better predictor of the risk of HIV disease progression than the $CD4^+$ count. The lower the viral load, the longer the time to AIDS diagnosis and the longer the survival time.

Treatment of HIV Infection

The U.S. Department of Health and Human Services Panel on Antiretroviral Guidelines for Adults and Adolescents (Panel) (2019) is composed of HIV specialists from across the country who regularly meet to review the latest scientific evidence. The $CD4^+$ count serves as the major laboratory indicator of immune function and prophylaxis for opportunistic infections, and is the strongest predictor of subsequent disease progression and survival (Panel, 2019). New drugs offer strategies based on the interaction between the life cycle of HIV and the host response, improvements in potency and activity even against multidrug-resistant viruses, dosing convenience, and tolerability. Goals of ART treatment include: (1) reduce HIV-associated morbidity and prolong the duration and quality of survival, (2) restore and preserve immunologic function, (3) maximally and durably suppress plasma HIV viral load, and (4) prevent HIV transmission (Panel, 2019). HIV suppression with ART may also decrease inflammation and immune activation thought to contribute to higher rates of cardiovascular and other end-organ damage. ART is recommended for all HIV-infected patients regardless of their viral load or $CD4^+$ count (Panel, 2019). Optimal viral suppression is defined generally as a viral load persistently below the level of detection (HIV RNA less than 20 to 75 copies/mL, depending on the assay used). Providers, in partnership with patients, make treatment decisions based on a number of factors, including whether the patient has already taken ART or is ART-naive and the willingness of the patient to adhere to the lifelong treatment regimen.

Achieving viral suppression requires the use of combination ART regimens that generally include three active drugs from two or more drug classes (Panel, 2019). Viral load suppression to below limits of assay detection usually occurs within the first 12 to 24 weeks of taking ART. Predictors of virologic reduction include: (1) low baseline viremia; (2) high potency of the ART regimen; (3)

tolerability of the regimen; (4) convenience of the regimen; and (5) excellent adherence to the regimen.

More than 30 antiretroviral (ARV) drugs in seven classes are Food and Drug Administration (FDA)–approved for treatment of HIV infection. These seven classes target different stages of the HIV/host interaction. Examples include the nucleoside/nucleotide reverse transcriptase inhibitors (NRTIs) (stage 3), non-nucleoside reverse transcriptase inhibitors (NNRTIs) (stage 3), protease inhibitors (PIs) (stage 7), integrase strand transfer inhibitors (INSTIs) (stage 4), a fusion inhibitor (stage 2), a CCR5 antagonist (stage 1), and a $CD4^+$ post-attachment inhibitor (stage 1) (see Fig. 32-2). In addition, some drugs are used as pharmacokinetic enhancers (or boosters) to improve the effectiveness of other ARV drugs (Panel, 2019). The Panel (2019) provides clear directions regarding which medications should be prescribed for both ART-naive and experienced patients.

The CDC estimates that HIV has not yet been diagnosed in about 13% of the people living with HIV in the United States. After receiving an HIV diagnosis, about 75% of individuals are linked to care within 30 days, but only 57% of persons who receive an HIV diagnosis are retained in HIV care. It is estimated that only 55% of persons with diagnosed HIV are virally suppressed because of poor linkage to care and retention in care (Panel, 2019). Viral loads are often not suppressed because the patient is not adhering to the treatment plan. Psychosocial barriers such as depression and other mental illnesses, neurocognitive impairment, low health literacy, low levels of social support, stressful life events, high levels of alcohol consumption and active substance use, homelessness, poverty, nondisclosure of HIV serostatus, denial, stigma, and inconsistent access to medications affect adherence to ART. Failure to adopt practices that facilitate adherence, such as linking medication taking to daily activities or using a medication reminder system or a pill organizer, is also associated with treatment failure (Panel, 2019). Simplifying treatment regimens and decreasing the number of medications that must be taken each day also helps to increase patients' adherence to therapy. Although antiretroviral regimens have become less complex, side effects create barriers to adherence and inadequate dosing can lead to viral resistance. It is difficult to predict patients' adherence to medication regimens, but a positive relationship between the patient and health care provider is associated with better adherence (Hill, Golin, Pack, et al., 2020).

Chart 32-8 summarizes strategies that health care providers can encourage to promote treatment regimen adherence. Many real-time monitoring systems, such as electronic pill boxes, are under investigation as well as pharmacologic monitoring of blood and hair (Hill et al., 2020). Real-time monitoring has the potential to enhance ART intervention programs by providing objective information about medication taking behaviors. Every health care encounter

should be used as an opportunity to briefly review the treatment regimen, identify any new issues, and reinforce successful behaviors.

Laboratory tests evaluate whether ART is effective for a specific patient. An adequate $CD4^+$ response for most patients on ART is an increase in $CD4^+$ count in the range of 50 to 150 mm^3 per year, generally with an accelerated response in the first 3 months (Panel, 2019). Viral load should be measured at baseline and on a regular basis thereafter because viral load is the most important indicator of response to ART.

Adverse effects associated with all HIV treatment regimens include hepatotoxicity, nephrotoxicity, and osteopenia, along with increased risk of cardiovascular disease and myocardial infarction (see Table 32-4). Many of the antiretroviral agents may cause fat redistribution syndrome and metabolic alterations such as dyslipidemia and insulin resistance, which put the patient at risk for early-onset heart disease and diabetes. The fat redistribution syndrome (lipodystrophy) consists of lipoatrophy (localized subcutaneous fat loss in the face, arms, legs, and buttocks) and lipohypertrophy (central visceral fat [lipomata] accumulation in the abdomen, although possibly in the breasts, dorsocervical region [buffalo hump], and within the muscle and liver). Facial wasting, characterized as a sinking of the cheeks, eyes, and temples caused by the loss of fat tissue under the skin, may be treated by injectable fillers such as poly-l-lactic acid (see Fig. 32-3). These changes can disturb the body image of people living with HIV/AIDS and may be a reason that they decline or stop ART.

Chart 32-8

Promoting Adherence to ART

Strategies	Examples
Use a multidisciplinary team approach. Provide an accessible, trustworthy health care team.	• Nonjudgmental providers, nurses, social workers, pharmacists, and medication managers.
Strengthen early linkage to care and retention in care.	• Encourage health care team participation in linkage to and retention in care.
Assess patient readiness to start ART.	• Address specific concerns such as drug interactions between ART and hormones for transgender patients.
Evaluate patient's knowledge about HIV disease, prevention and treatment and, on the basis of the assessment, provide HIV-related information.	• Consider the patient's current knowledge base, provide information about HIV, including the natural history of the disease, HIV viral load and $CD4^+$ count and expected clinical outcomes according to these parameters, and therapeutic and prevention consequences of nonadherence.
Identify facilitators, potential barriers to adherence, and necessary medication management skills before starting ART medication.	• Assess patient's cognitive competence and any impairment. • Assess behavioral and psychosocial challenges including depression, mental illnesses, levels of social support, high levels of alcohol consumption and active substance use, nondisclosure of HIV serostatus and stigma. • Identify and address language and literacy barriers. • Assess beliefs, perceptions, and expectations about taking ART (e.g., impact on health, side effects, disclosure issues, consequences of nonadherence). • Ask about medication taking skills and foreseeable challenges with adherence (e.g., past difficulty keeping appointments, adverse effects from previous medications, issues managing other chronic medications, need for medication reminders and organizers). • Assess structural issues including unstable housing, lack of income, unpredictable daily schedule, lack of prescription drug coverage, lack of continuous access to medications.
Provide needed resources.	• Provide or refer for mental health and/or substance abuse treatment.

	• Provide resources to obtain prescription drug coverage, stable housing, social support, and income and food security. • Encourage use of valid Internet sites for health-related information.
Involve the patient in ARV regimen selection.	• Review regimen potency, potential side effects, dosing frequency, pill burden, storage requirements, food requirements, and consequences of nonadherence. • Assess daily activities and tailor regimen to predictable and routine daily events. • Use single tablet fixed-dose combination formulation. • Assess if cost/co-payment for drugs can affect access to medications and adherence.
Assess adherence at every clinic visit.	• Monitor viral load as a strong biologic measure of adherence. • Use a simple behavioral rating scale. • Employ a structured format that normalizes or assumes less-than-perfect adherence and minimizes socially desirable or “white coat adherence” responses. • Ensure that other members of the health care team also assess adherence.
Use positive reinforcement to foster adherence success.	• Inform patients of low or nondetectable levels of HIV viral load and increases in $CD4^+$ cell counts. • When needed, consider providing incentives and rewards for achieving high levels of adherence and treatment success.
Identify the type of and reasons for nonadherence.	• Failure to fill the prescription(s). • Failure to understand dosing instructions. • Complexity of regimen (e.g., pill burden, size, dosing schedule, food requirements). • Pill aversion. • Pill fatigue. • Adverse effects. • Inadequate understanding of drug resistance and its relationship to adherence. • Cost-related issues. • Depression, drug and alcohol use, homelessness, poverty.

	• Stigma. • Nondisclosure. • Other potential barriers.
Select from among available effective treatment adherence interventions.	• Use evidence-based interventions to promote adherence. • Use adherence-related tools to complement education and counseling interventions (e.g., pill boxes, dose planners, reminder devices). • Use community resources to support adherence (e.g., visiting nurses, community workers, family, peer advocates). • Use patient prescription assistance programs. • Use motivational interviews.
Systematically monitor retention in care.	• Record and follow up on missed visits.
On the basis of any problems identified through systematic monitoring, consider options to enhance retention in care given resources available.	• Provide outreach for those patients who drop out of care. • Use peer or paraprofessional treatment navigators. • Employ incentives to encourage clinic attendance or recognize positive clinical outcomes resulting from good adherence. • Arrange for directly observed therapy (if feasible).

Adapted from Panel on Antiretroviral Guidelines for Adults and Adolescents (Panel). (2019). Guidelines for the use of antiretroviral agents in HIV-1-infected adults and adolescents. Department of Health and Human Services. Strategies to Improve Linkage to Care, Retention in Care, Adherence to Appointments, and Adherence to Antiretroviral Therapy (pp. 236–237).

TABLE 32-4 Select Antiretroviral Agents

Generic Name (Abbreviation) and Single-Tablet Combination Names (Italic)	Food Interactions	Adverse Effects
Nucleoside Reverse Transcriptase Inhibitors (NRTIs)		
Abacavir (ABC) *Trizivir* (ABC/ZDV/3TC) *Epzicom* (ABC/3TC) (ABC/3TC/DTG)	Take without regard to meals	Hypersensitivity reaction, which can be fatal; symptoms may include fever, rash, nausea, vomiting, diarrhea, abdominal pain, malaise or fatigue, loss of appetite, and respiratory symptoms such as sore throat, cough, shortness of breath.
Didanosine (ddl)	Take half hour before or 2 h after meals	Pancreatitis, peripheral neuropathy, retinal changes, nausea, diarrhea, lactic acidosis with fatty degeneration of the liver, insulin resistance/diabetes.
Emtricitabine (FTC) *Atripla* (FTC/EFV/TDF) *Biktarvy* (BIC/TAF/FTC) *Complera* (RPV/TDF/FTC) *Descovy* (TAF/FTC) *Genvoya* (EVG/c/TAF/FTC) *Odefsey* (RPV/TAF/FTC) *Symtuza* (DRV/c/TAF) *Stribild* (FTC/EVG/c/TDF) *Truvada* (FTC/TDF)	Take without regard to meals	Minimal toxicity; hyperpigmentation/skin discoloration. Severe acute exacerbation of hepatitis may occur in patients with HBV/HIV coinfection who discontinue FTC.
Lamivudine (3TC) *Cimduo* (TDF/3TC) *Combivir* (ZDV/3TC) *Epzicom* (ABC/3TC) *Temixys* (TDF/3TC) *Trizivir* (ABC/ZDV/3TC) *Delstrigo* (DOR/TDF/3TC)	Take without regard to meals	Minimal toxicity. Severe acute exacerbation of hepatitis may occur in patients with HBV/HIV coinfection who discontinue 3TC.

Dovato (DTG/3TC) *Symfi/Symfi LO* (EFV/TDF/3TC) *Triumeq* (DTG/ABC/3TC)		
Stavudine (d4T)	Take without regard to meals	Peripheral neuropathy; lipoatrophy; pancreatitis; lactic acidosis/severe hepatomegaly with hepatic steatosis (this is a rare, but potentially life-threatening, toxicity); hyperlipidemia; insulin resistance/diabetes mellitus; rapidly progressive ascending neuromuscular weakness (rare)
Tenofovir alafenamide (TAF) *Biktarvy* (BIC/TAF/FTC) *Descovy* (TAF/FTC) *Genvoya* (EVG/c/TAF/FTC) *Odefsey* (RPV/TAF/FTC) *Symtuza* (DRV/c/TAF/FTC)	Take without regard to meals	Renal insufficiency, Fanconi syndrome, and proximal renal tubulopathy are less likely to occur with TAF than with TDF. Osteomalacia and decrease in bone mineral density are less likely to occur with TAF than with TDF. Severe acute exacerbation of hepatitis may occur in patients with HBV/HIV coinfection who discontinue TAF. Diarrhea, nausea, headache
Tenofovir disoproxil fumarate (TDF) *Atripla* (EFV/TDF/FTC) *Cimduo* (TDF/3TC) *Complera* (RPV/TDF/FTC) *Delstrigo* (DOR/TDF/3TC) *Stribild* (EVG/c/TDF/FTC) *Symfi/Symfi Lo* (EFV/TDF/3TC) *Temixys* (TDF/3TC) *Truvada* (TDF/FTC)	Take without regard to meals	Renal insufficiency, Fanconi syndrome, proximal renal tubulopathy, osteomalacia, decrease in bone mineral density. Severe acute exacerbation of hepatitis may occur in patients with HBV/HIV coinfection who discontinue TDF. Asthenia, headache, diarrhea, nausea, vomiting, flatulence
Zidovudine (AZT or ZDV) *Combivir* (3TC/AZT) *Trizivir* (ABC/3TC/AZT)	Take without regard to meals	Bone marrow suppression; macrocytic anemia or neutropenia; nausea, vomiting, headache, insomnia, asthenia, nail pigmentation; lactic acidosis/severe hepatomegaly with hepatic steatosis (this is a rare, but potentially life-threatening, toxicity). Hyperlipidemia; insulin resistance/diabetes mellitus; lipoatrophy; myopathy
Non-Nucleoside Reverse Transcriptase Inhibitors		
Doravirine (DOR)	Take without	Nausea, dizziness, abnormal dreams

Delstrigo (DOR/TDF/3TC)	regard to meals	
Efavirenz (EFV) *Atripla* (EFV/TDF/FTC) *Symfi/Symfi Lo* (EFV/TDF/3TC)	Take on empty stomach at bedtime	Rash; neuropsychiatric symptoms; serum transaminase elevations; hyperlipidemia; QT interval prolongation Use of EFV may lead to false-positive results with some cannabinoid and benzodiazepine screening assays.
Etravirine (ETR)	Take following a meal	Rash, including Stevens–Johnson syndrome; HSRs, characterized by rash, constitutional findings, and sometimes organ dysfunction (including hepatic failure), have been reported; nausea.
Nevirapine (NVP)	Take without regard to meals	Rash (reported in approximately 50% of cases), including Stevens–Johnson syndrome; symptomatic hepatitis, including fatal hepatic necrosis; symptomatic hepatitis occurs at a significantly higher frequency in ARV-naive female patients with pre-NVP $CD4^+$ counts >250 cells/mm^3 and in ARV-naive male patients with pre-NVP $CD4^+$ counts >400 cells/mm^3. NVP should not be initiated in these patients unless the benefit clearly outweighs the risk.
Rilpivirine (RPV) *Complera* (RPV/TDF/FTC) *Juluca* (DTG/RPV) *Odefsey* (RPV/TAF/FTC)	Take with a meal	Rash, depression, insomnia, headache, hepatotoxicity, QT interval prolongation
Protease Inhibitors		
Atazanavir (ATV) *Evotaz (ATV/c)*	Take with food	Indirect hyperbilirubinemia; prolonged PR interval (some patients experience asymptomatic first-degree AV block); EKG changes; hyperglycemia; fat maldistribution; possible increased bleeding episodes in patients with hemophilia; Cholelithiasis; nephrolithiasis; renal insufficiency; serum transaminase elevations; hyperlipidemia (especially with RTV boosting); rash; hyperglycemia; fat maldistribution
Darunavir (DRV) *Prezcobix (DRV/c)*	Take with food	Rash: DRV has a higher allergy risk, Stevens–Johnson syndrome, toxic epidermal necrolysis, acute generalized exanthematous pustulosis, and erythema multiforme have been reported. Hepatotoxicity; diarrhea; nausea; headache; hyperlipidemia; serum

		transaminase elevation; hyperglycemia; fat maldistribution. An increase in serum creatinine may occur when DRV is administered with COBI.
Fosamprenavir (FPV)	Tablets may be taken with or without food	Rash has been reported in 12–19% of patients on FPV. FPV has an increased allergy risk. Diarrhea, nausea, vomiting, headache, hyperlipidemia, serum transaminase elevation, hyperglycemia, fat maldistribution, possible increase in the frequency of bleeding episodes in patients with hemophilia, nephrolithiasis.
Indinavir (IDV)	For upboosted IDV: Should be taken 1 h before or 2 h after meals; may take with skim milk or low-fat meal For RTV-boosted IDV: Can be taken with or without food Drink at least 48 oz of water daily	Nephrolithiasis, GI intolerance, nausea, hepatitis, indirect hyperbilirubinemia, hyperlipidemia, headache, asthenia, blurred vision, dizziness, rash, metallic taste, thrombocytopenia, alopecia, hemolytic anemia, hyperglycemia, fat maldistribution, possible increased bleeding episodes in patients with hemophilia.
Lopinavir + ritonavir (LPV/r)	Tablet: take without regard to meals Oral solution: take with food; contains 42% alcohol	GI intolerance, nausea, vomiting, diarrhea, asthenia, pancreatitis, hyperlipidemia (especially hypertriglyceridemia), elevated serum transaminase, hyperglycemia, insulin resistance/diabetes mellitus, fat maldistribution, possible increased bleeding episodes in patients with hemophilia, EKG changes.
Nelfinavir (NFV)	Dissolve tablets in a small amount of water, mix admixture well, and consume immediately. Take with food	Diarrhea, hyperlipidemia, hyperglycemia, fat maldistribution, possible increased bleeding episodes in patients with hemophilia, serum transaminase elevation.
Ritonavir (RTV)	Take with food	GI intolerance, nausea, vomiting, diarrhea, paresthesias (circumoral and extremities), hyperlipidemia (especially

		hypertriglyceridemia), hepatitis, asthenia, taste perversion, hyperglycemia, fat maldistribution, possible increased bleeding in patients with hemophilia.
Saquinavir (SQV)	Take with meals or within 2 h after meal	GI intolerance, nausea, diarrhea, abdominal pain and dyspepsia, headache, hyperlipidemia, elevated transaminase enzymes, hyperglycemia, fat maldistribution, possible increased bleeding episodes in patients with hemophilia, EKG changes.
Tipranavir (TPV)	Take with food	Hepatotoxicity; clinical hepatitis (including hepatic decompensation and hepatitis-associated fatalities) has been reported. Skin rash. Rare cases of fatal and nonfatal intracranial hemorrhages have been reported. Hyperlipidemia, hyperglycemia, fat maldistribution. Possible increase in the frequency of bleeding episodes in patients with hemophilia.
Integrase Strand Transfer Inhibitors		
Dolutegravir (DTG) *Dovato* (DTG/3TC) *Juluca* (DTG/RPV) *Triumeq* (DTG/ABC/3TC)	Take without regard to meals	Insomnia, headache, depression and suicidal ideation (rare; usually occurs in patients with preexisting psychiatric conditions). Weight gain, hepatotoxicity. Preliminary data suggest an increased rate of neural tube defects in infants born to mothers who were taking DTG at the time of conception. Hypersensitivity reaction, including rash, constitutional symptoms, and organ dysfunction (including liver injury), have been reported.
Elvitegravir (EVG) *Stribild (EVG/c/FTC/TDF)*	Take with food	Nausea, diarrhea, depression and suicidal ideation (rare; usually occurs in patients with preexisting psychiatric conditions).
Raltegravir (RAL)	Take without regard to meals	Rash including Stevens–Johnson, hypersensitivity reaction and toxic epidermal necrolysis. Nausea, headache, diarrhea, pyrexia, CPK elevation, muscle weakness, rhabdomyolysis, insomnia. Depression and suicidal ideation (rare; usually occurs in patients with preexisting psychiatric conditions).
Fusion Inhibitor		
Enfuvirtide (T-20)	Injected	Local injection site reactions (e.g., pain, erythema, induration, nodules and cysts, pruritus, ecchymosis) in almost 100% of patients. Increased incidence of bacterial

		pneumonia. Hypersensitivity reaction can occur and rechallenge is not recommended.
CCR5 Antagonist		
Maraviroc (MVC)	Take without regard to meals; requires CCR5 tropism blood test before starting	Abdominal pain, cough, fever, dizziness, headache, orthostatic hypotension, nausea, bladder irritation; possible liver problems and cardiac events; an increased risk for some infections; a slight increase in cholesterol levels; orthostatic hypotension, especially in patients with severe renal insufficiency.
CD4 Post-Attachment Inhibitor		
Ibalizumab (IBA)	IV administration	Diarrhea, dizziness, nausea, rash

Adapted from Panel on Antiretroviral Guidelines for Adults and Adolescents (Panel). (2019). Guidelines for the use of antiretroviral agents in HIV-1-infected adults and adolescents. Department of Health and Human Services. Retrieved on 10/28/18 at: aidsinfo.nih.gov/contentfiles/lvguidelines/adultandadolescentgl.pdf

ART Drug Resistance

Drug resistance is the ability of pathogens to withstand the effects of medications that should be toxic to them. There are two major components of ART resistance: (1) transmission of drug-resistant HIV at the time of initial infection and (2) selective drug resistance in patients who are receiving nonsuppressive regimens. Genotypic and phenotypic resistance assays are used to assess viral strains and inform selection of treatment strategies. Genotypic assays detect drug-resistant mutations present in relevant viral genes while phenotypic assays measure the ability of a virus to grow in different concentrations of ART drugs. Resistance testing in persons who are chronically infected is recommended at the time of entry into HIV care. Although no definitive prospective data exist to support the choice of one type of resistance testing over another, genotypic testing is generally preferred because of lower cost, more rapid turnaround time, the assay's ability to detect mixtures of wild-type and resistant virus, and the relative ease of interpreting test results. If therapy is deferred, repeat testing soon before initiation of ART should be considered because the patient may have acquired drug-resistant virus (i.e., superinfection) (Panel, 2019).

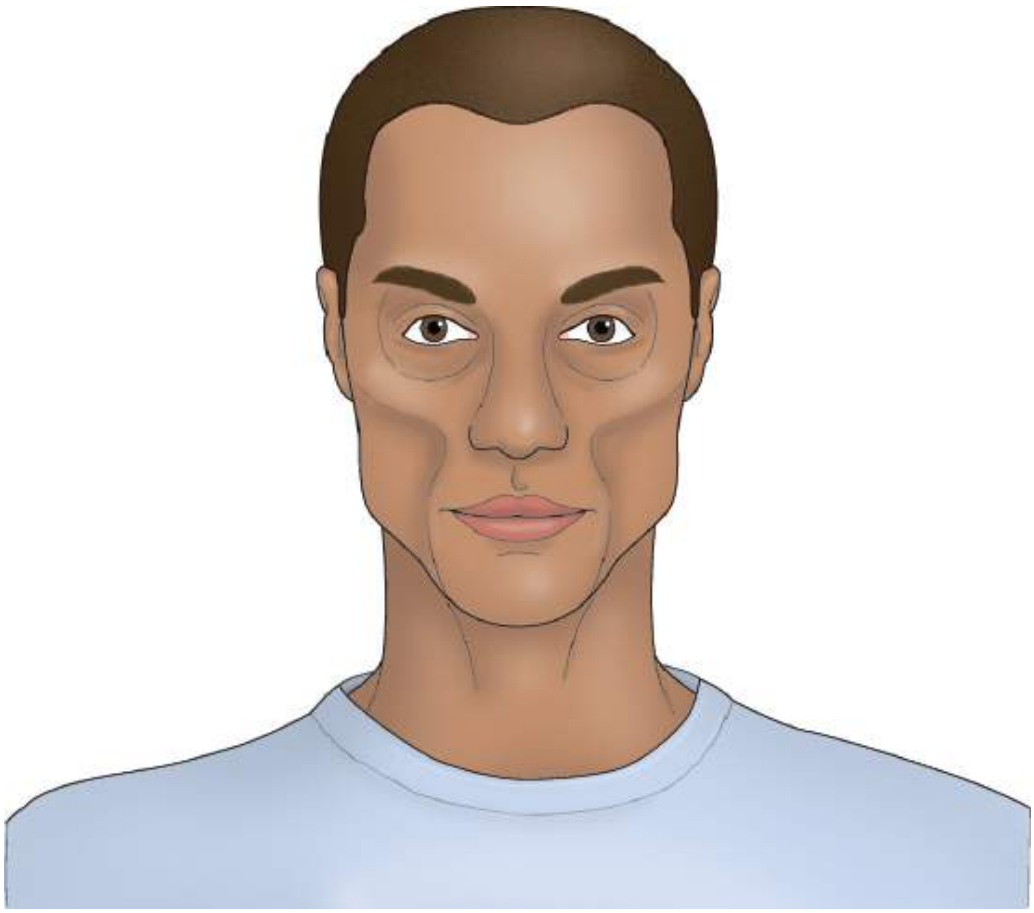


Figure 32-3 • Facial lipoatrophy.

Immune Reconstitution Inflammatory Syndrome

Immune reconstitution inflammatory syndrome (IRIS) results from rapid restoration of organism-specific immune responses to infections that cause either the deterioration of a treated infection or new presentation of a subclinical infection. This syndrome typically occurs during the initial months after beginning ART and is associated with a wide spectrum of organisms, most commonly mycobacteria, herpes viruses, and deep fungal infections. IRIS is characterized by fever, respiratory and/or abdominal symptoms, and worsening of the clinical manifestations of an opportunistic infection or the appearance of new manifestations. IRIS is treated with anti-inflammatory medications such as cortisone. The nurse should be alert to the possibility of IRIS, especially in the 3-month period after treatment with ART is initiated, because this syndrome is associated with significant morbidity and patients often require hospital admission.

Paradoxical tuberculosis-associated immune reconstitution inflammatory syndrome (TB-IRIS) is a serious complication that arises during successful ART in patients with HIV-TB co-infection who are receiving TB treatment. In the majority of patients, TB-IRIS occurs within the first few weeks of ART but can occur much later. Patients with HIV-TB co-infection with low $CD4^+$

counts who start ART are at high risk of developing TB-IRIS. Although the immunopathogenesis of TB-IRIS is still not completely understood, the explosive restoration of T-cell function is believed to play a distinct role (Narendran, Oliveira-de-Souza, Vinhaes, et al., 2019).

Clinical Manifestations

Patients with HIV/AIDS experience a number of symptoms related to the disease, side effects of treatment, and other comorbidities, including pancreatitis, hepatitis, and cardiometabolic abnormalities. The clinical manifestations of HIV/AIDS are widespread and may involve virtually any organ system. Patients in stage 3 or AIDS (see Table 32-2) are severely immune depressed and can develop opportunistic infections. Nurses need to understand the causes, signs and symptoms, and interventions, including self-management strategies that can enhance the quality of life for patients throughout the different stages of the illness. Symptom assessment tools can be used to assess patients' symptom intensity and severity. PLWHA use a variety of self-management strategies to minimize common symptoms.

Respiratory Manifestations

Shortness of breath, dyspnea (labored breathing), cough, chest pain, and fever are associated with various opportunistic infections, such as those caused by *Pneumocystis jirovecii, Mycobacterium avium-intracellulare,* cytomegalovirus (CMV), and *Legionella* species.

Pneumocystis Pneumonia

***Pneumocystis* pneumonia (PCP)** is caused by *P. jirovecii* (formerly *P. carinii*) (Panel on Opportunistic Infections in Adults and Adolescents with HIV [OI-Panel], 2019) and is associated with $CD4^+$ T-lymphocyte ($CD4^+$) cell counts less than 200 cells/mm^3. The most common manifestations of PCP are subacute onset of progressive dyspnea, fever, nonproductive cough, and chest discomfort that worsens within days to weeks. In mild cases, pulmonary examination usually is normal at rest. With exertion, tachypnea, tachycardia, and diffuse dry (cellophane) rales may be auscultated. Fever is apparent in most cases and may be the predominant symptom. Hypoxemia is the most characteristic laboratory abnormality, along with elevated lactate dehydrogenase levels. Because clinical presentation, blood tests, and chest X-rays are not pathognomonic for PCP, and because the organism cannot be cultivated routinely, histopathologic or cytopathologic demonstration of organisms in tissue, bronchoalveolar lavage fluid, or induced sputum samples is required for a definitive diagnosis (OI-Panel, 2019).

Mycobacterium Avium Complex

***Mycobacterium avium* complex (MAC)** disease is a common opportunistic infection that typically occurs in patients with $CD4^+$ T-lymphocyte ($CD4^+$) cell counts less than 50 cells/mm^3. MAC is caused by infection with different types of mycobacterium: *Mycobacterium avium, Mycobacterium intracellulare,* or *Mycobacterium kansasii.* Early symptoms may be minimal and can precede detectable mycobacteremia by several weeks and include fever, night sweats, weight loss, fatigue, diarrhea, and abdominal pain. A confirmed diagnosis of disseminated MAC disease is based on compatible clinical signs and symptoms coupled with the isolation of MAC from cultures of blood, lymph node, bone marrow, or other normally sterile tissue or body fluids (OI-Panel, 2019).

Tuberculosis

The estimated annual risk of reactivation with TB among those with untreated HIV infection and latent TB infection is 3% to 16% and approximates the lifetime risk for individuals without HIV infection who have latent TB infection. TB disease can occur at any $CD4^+$ T-lymphocyte ($CD4^+$ cell) count, although the risk increases with progressive immune deficiency. Testing for latent TB at the time of HIV diagnosis should be routine, regardless of an individual's risk of TB exposure. Individuals with negative diagnostic tests for latent TB who have stage 3 HIV infection should be retested once their $CD4^+$ count increases due to ART. Screening for symptoms (asking for cough of *any* duration) coupled with chest radiography is recommended to exclude TB disease in a patient with a positive skin test or interferon-gamma release assays. Latent TB in a person with HIV infection is treated with isoniazid, supplemented with pyridoxine to prevent peripheral neuropathy, for 9 months since it has proven efficacy, good tolerability, and infrequent severe toxicity (OI-Panel, 2019).

TB disease can develop in the lungs as well as in extrapulmonary sites such as the central nervous system (CNS), bone, pericardium, stomach, peritoneum, and scrotum and initial diagnostic testing is directed at the anatomic site of symptoms or signs, such as the lungs, lymph nodes, and cerebrospinal fluid. TB in individuals with advanced immune deficiency can be rapidly progressive and fatal if treatment is delayed and such patients often have smear-negative sputum specimens. Therefore, after collection of available specimens for culture and molecular diagnostic tests, empiric treatment for TB is warranted in patients with clinical and radiographic presentation suggestive of HIV-related TB. Treatment of suspected TB in individuals with HIV infection is the same as for those who are HIV uninfected and should include an initial four-drug combination of isoniazid, rifampin, pyrazinamide, and ethambutol (OI-Panel, 2019).

Gastrointestinal Manifestations

The gastrointestinal manifestations of HIV infection and AIDS include loss of appetite, nausea, vomiting, oral and esophageal candidiasis, and chronic diarrhea. Gastrointestinal symptoms may be related to the direct inflammatory effect of HIV on the cells lining the intestines. Some of the enteric pathogens that occur most frequently, identified by stool cultures or intestinal biopsy, are *Cryptosporidium muris, Salmonella* species, *Isospora belli, Giardia lamblia,* cytomegalovirus (CMV), *Clostridium difficile,* and *M. avium-intracellulare.* In patients with AIDS, the effects of diarrhea can be devastating in terms of profound weight loss (more than 10% of body weight), fluid and electrolyte imbalances, perianal skin excoriation, weakness, and inability to perform the usual activities of daily living.

Candidiasis

Oropharyngeal and esophageal **candidiasis** (fungal infections) are common in patients with HIV infection. Oropharyngeal candidiasis is characterized by painless, creamy white, plaquelike lesions that can occur on the buccal surface, hard or soft palate, oropharyngeal mucosa, or tongue surface. Lesions can be easily scraped off with a tongue depressor or other instrument which is in contrast to lesions associated with oral hairy leukoplakia. In women with early-stage HIV infection, *Candida* vulvovaginitis usually presents the same as in women without HIV infection, with white adherent vaginal discharge associated with mucosal burning and itching of mild-to-moderate severity and sporadic recurrences (OI-Panel, 2019).

HIV Wasting Syndrome

Wasting syndrome is the involuntary loss of more than 10% of one's body weight while having experienced diarrhea or weakness and fever for more than 30 days. Wasting refers to the loss of muscle mass, although part of the weight loss may also be due to loss of fat.

Oncologic Manifestations

Those with HIV/AIDS are at greater risk of developing certain cancers. These include **Kaposi sarcoma** (KS), lymphoma, and invasive cervical cancer. KS and lymphomas are discussed next. Cervical carcinoma is described later in the Gynecologic Manifestations section.

Kaposi Sarcoma

KS is caused by human herpesvirus-8 (HHV-8); affects eight times more men than women; and may spread through sexual contact. It involves the epithelial layer of blood and lymphatic vessels. AIDS-related KS exhibits a variable and aggressive course, ranging from localized cutaneous lesions to disseminated disease involving multiple organ systems. Cutaneous signs may be the first

manifestation of HIV; they can appear anywhere on the body and are usually brownish pink to deep purple. They may be flat or raised and surrounded by ecchymosis (hemorrhagic patches) and edema (see Fig. 32-4). Rapid development of lesions involving large areas of skin is associated with extensive disfigurement and significant body image issues. The location and size of some lesions can lead to venous stasis, lymphedema, and pain. Ulcerative lesions disrupt skin integrity and increase discomfort and susceptibility to infection. The most common sites of visceral involvement are the lymph nodes, gastrointestinal tract, and lungs. Involvement of internal organs may eventually lead to organ failure, hemorrhage, infection, and death.

Figure 32-4 • Lesions of the AIDS-related Kaposi sarcoma. Whereas some patients may have lesions that remain flat, others experience extensively disseminated, raised lesions with edema. Reprinted with permission from DeVita, V. T., Jr., Hellman, S., & Rosenberg, S. (Eds.). (1993). *AIDS: Etiology, diagnosis, treatment, and prevention* (4th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Diagnosis of KS is confirmed by biopsy of suspected lesions. Prognosis depends on the extent of the tumor, the presence of other symptoms of HIV infection, and the $CD4^+$ count. Death may result from tumor progression, but more often it results from other complications of HIV infection.

AIDS-Related Lymphomas

AIDS-related lymphomas include both Hodgkin lymphoma and non-Hodgkin lymphoma. Non-Hodgkin lymphoma is more common. AIDS-related

lymphoma is usually aggressive; there are three main types: diffuse large B-cell; B-cell immunoblastic; and small noncleaved cell lymphoma. Symptoms include weight loss, night sweats, and fever. The complete blood count might be abnormal and a biopsy will confirm the diagnosis.

Neurologic Manifestations

HIV-related brain changes have profound effects on cognition, including motor function, executive function, attention, visual memory, and visuospatial function. Neurologic dysfunction results from direct effects of HIV on nervous system tissue, opportunistic infections, primary or metastatic neoplasm, cerebrovascular changes, metabolic encephalopathies, or complications secondary to therapy. Immune system response to HIV infection in the CNS includes inflammation, atrophy, demyelination, degeneration, and necrosis.

Subcortical Neurodegenerative Disease

Approximately 20% of those living with HIV infection are at risk for developing a subcortical neurodegenerative disease known as HIV-associated neurocognitive disorder (HAND) (Cummins, Waters, Aggar, et al., 2019). The signs of HAND can be subtle and include changes in language, memory, problem solving and slowing of psychomotor skills (Cummins et al., 2019). Early identification is important as HAND can be treated by changing ART medications.

Peripheral Neuropathy

Peripheral neuropathy is a common neurologic symptom at any stage of HIV infection. It may be a side effect of some ART drugs, and may occur in a variety of patterns, with distal sensory polyneuropathy or distal symmetric polyneuropathy the most frequently occurring type. It can lead to significant pain of feet and hands and functional impairment. Patients use a variety of physical and psychological self-management strategies to minimize this symptom.

HIV Encephalopathy

HIV encephalopathy was formerly referred to as AIDS dementia complex (see Chart 32-9). It is a clinical syndrome that is characterized by a progressive decline in cognitive, behavioral, and motor functions as a direct result of HIV infection. HIV has been found in the brain and cerebrospinal fluid (CSF) of patients with HIV encephalopathy. The brain cells infected by HIV are predominantly the $CD4^+$ cells of monocyte–macrophage lineage. HIV infection is thought to trigger the release of toxins or lymphokines that result in cellular dysfunction, inflammation, or interference with neurotransmitter function rather than cellular damage.

Chart 32-9

Care of the Patient with HIV Encephalopathy

Chronic Confusion

- Assess mental status and neurologic functioning.
- Monitor for medication interactions, infections, electrolyte imbalance, and depression.
- Frequently orient the patient to time, place, person, reality, and the environment.
- Use simple explanations.
- Instruct the patient to perform tasks in incremental steps.
- Provide memory aids (clocks and calendars).
- Provide memory aids for medication administration.
- Post activity schedule.
- Give positive feedback for appropriate behavior.
- Educate caretakers about orienting patient to time, place, person, reality, and the environment.
- Encourage the patient to designate a responsible person to assume power of attorney.

Disturbed Sensation

- Assess sensory impairment.
- Decrease number of stimuli in the patient's environment.
- Correct inaccurate perceptions.
- Provide reassurance and safety if the patient displays fear.
- Provide a secure and stable environment.
- Educate caregivers about recognizing inaccurate sensory perceptions.
- Provide caregivers techniques to correct inaccurate perceptions.
- Instruct the patient and caregivers to report any changes in the patient's vision to the patient's health care provider.

Risk for Injury

- Assess the patient's level of anxiety, confusion, or disorientation.
- Assess the patient for delusions or hallucinations.
- Remove potentially dangerous objects from the patient's environment.
- Structure the environment for safety (ensure adequate lighting, avoid clutter, provide bed rails if needed).
- Supervise smoking.
- Do not let the patient drive a car if confusion is present.
- Instruct the patient and caregiver in home safety.
- Provide assistance as needed for ambulation and in getting in and out of bed.
- Pad headboard and side rails if the patient has seizures.

Self-Care Deficits

- Encourage activities of daily living within the patient's level of ability.
- Encourage independence, but assist if the patient cannot perform an activity.
- Demonstrate any activity that the patient is having difficulty accomplishing.
- Monitor food and fluid intake.
- Weigh patient weekly.
- Encourage the patient to eat, and offer nutritious meals, snacks, and adequate fluids.
- If patient is incontinent, establish a routine toileting schedule.
- Educate caregivers about meeting the patient's self-care needs.

Signs and symptoms may be subtle and difficult to distinguish from fatigue, depression, or the adverse effects of treatment for infections and malignancies. Early manifestations include memory deficits, headache, difficulty concentrating, progressive confusion, psychomotor slowing, apathy, and ataxia. Later stages include global cognitive impairments, delay in verbal responses, a vacant stare, spastic paraparesis, hyperreflexia, psychosis, hallucinations, tremor, incontinence, seizures, mutism, and death.

Confirming the diagnosis of HIV encephalopathy can be difficult. Extensive neurologic evaluation includes a computed tomography scan, which may indicate diffuse cerebral atrophy and ventricular enlargement. Other tests that may detect abnormalities include magnetic resonance imaging, analysis of CSF through lumbar puncture, and brain biopsy.

Cryptococcus Neoformans

A fungal infection *Cryptococcus neoformans* is another common opportunistic infection among patients with AIDS, and it causes neurologic disease. Cryptococcal meningitis is characterized by symptoms such as fever, headache, malaise, stiff neck, nausea, vomiting, mental status changes, and seizures. Diagnosis is confirmed by CSF analysis.

Progressive Multifocal Leukoencephalopathy

Progressive multifocal leukoencephalopathy (PML) is a demyelinating CNS disorder that affects the oligodendroglia. Clinical manifestations often begin with mental confusion and rapidly progress to include blindness, aphasia, muscle weakness, paresis (partial or complete paralysis), and death. ART has greatly reduced the mortality associated with this disorder.

Other Neurologic Disorders

Other infections involving the nervous system include *Toxoplasma gondii,* CMV, and *Mycobacterium tuberculosis* infections.

Depressive Manifestations

Depression and apathy are neuropsychiatric complications of HIV infection. Estimates suggest that the prevalence of current depression is between 12% and 60% in persons with HIV/AIDS (Lu, Hsiao, Sheng, et al., 2018). Similarly, apathy, which refers to reduced, self-initiated, cognitive, emotional, and behavioral activity, is also commonly reported among those living with a diagnosis of HIV. Alcohol and cocaine use—both current and former—have been associated with depression and apathy in this population, and depression has been associated with less adherence with ART medications (Lu et al., 2018).

Integumentary Manifestations

Cutaneous manifestations are associated with HIV infection and the accompanying opportunistic infections and malignancies. KS (described earlier) and opportunistic infections such as herpes zoster and herpes simplex are associated with painful vesicles that disrupt skin integrity. Molluscum contagiosum is a viral infection characterized by deforming plaque formation. Seborrheic dermatitis is associated with an indurated, diffuse, scaly rash involving the scalp and face. Patients with AIDS may also exhibit a generalized folliculitis associated with dry, flaking skin or atopic dermatitis, such as eczema or psoriasis. Many patients treated with the antibacterial agent trimethoprim–sulfamethoxazole develop a drug-related rash that is pruritic with pinkish-red macules and papules (Panel, 2019). Patients with any of these rashes experience discomfort, have body image changes, and are at increased risk for infection from disrupted skin integrity.

Gynecologic Manifestations

Persistent, recurrent vaginal candidiasis may be the first sign of HIV infection in women. Past or present genital ulcers are a risk factor for the transmission of HIV infection. Women with HIV infection are more susceptible to genital ulcers and venereal warts and have increased rates of incidence and recurrence of these conditions. Ulcerative STIs such as chancroid, syphilis, and herpes are more severe in women with HIV infection. Human papillomavirus (HPV) causes venereal warts and is a risk factor for cervical intraepithelial neoplasia, a cellular change that is frequently a precursor to cervical cancer. Women who are HIV seropositive and have cervical carcinoma present at a more advanced stage of disease and have more persistent and recurrent disease and a shorter interval to recurrence and death than women without HIV infection.

Women with HIV are at increased risk for pelvic inflammatory disease, a reportable infection, and the associated inflammation may increase HIV transmission to the uninfected sexual partner. Moreover, women with HIV infection appear to have a higher incidence of menstrual abnormalities,

including amenorrhea or bleeding between periods, than do women without HIV infection.

Medical Management

Treatment of Opportunistic Infections and Coinfection with Hepatitis C

Guidelines for the treatment of opportunistic infections should be consulted for the most current recommendations (OI-Panel, 2019). Although ART is highly effective in keeping the $CD4^+$ cell count high, opportunistic infections continue to cause considerable morbidity and mortality for three main reasons: (1) many patients are unaware of their HIV infection and present with an opportunistic infection as the initial indicator of their disease, (2) some patients are aware of their HIV infection but do not take antiretroviral agents because of psychosocial or economic factors, and (3) others receive prescriptions for antiretroviral medications but fail to attain adequate virologic and immunologic response as a result of issues related to adherence, pharmacokinetics, or unexplained biologic factors.

Coinfection with hepatitis C requires careful medical management for the PLWHA. Hepatitis C is curable with an 8- to 12-week drug therapy in most patients. However, the medications for the treatment of hepatitis C interact with many ART medications and therefore need to be carefully managed to avoid interactions and maximize adherence (OI-Panel, 2019; Starbird et al., 2020).

Pneumocystis Pneumonia

Persons in stage 3 HIV infection should receive chemoprophylaxis to prevent PCP with trimethoprim–sulfamethoxazole if they have $CD4^+$ counts less than 200 cells/mm^3 or a history of oropharyngeal candidiasis (OI-Panel, 2019). Once the $CD4^+$ count improves, prophylaxis can be discontinued. When a person is diagnosed with PCP, trimethoprim–sulfamethoxazole is the treatment of choice, lowering the dose if there is abnormal renal function. Adjunctive corticosteroids are indicated as early as possible, preferentially within 72 hours after starting specific PCP therapy. Treatment duration is usually 21 days; rates of adverse reaction to trimethoprim–sulfamethoxazole are high including rash (30% to 55%) (including Stevens–Johnson syndrome), fever (30% to 40%), leukopenia (30% to 40%), hepatitis (20%), thrombocytopenia (15%), azotemia (1% to 5%), and hyperkalemia. Because long-term survival is possible for patients in whom ART is effective, individuals with AIDS and severe PCP should be given the option to choose mechanical ventilation and critical care management if their functional status is such that it would be appropriate, just

as with patients without HIV infection. Paradoxical IRIS has been reported following PCP and starting ART (OI-Panel, 2019).

Mycobacterium Avium Complex

Initial treatment of MAC disease should consist of two or more antimycobacterial drugs to prevent or delay the emergence of resistance. Clarithromycin is the preferred first agent; however, azithromycin can be substituted for clarithromycin when drug interactions or intolerance to clarithromycin preclude its use. Ethambutol is the recommended second drug (OI-Panel, 2019).

Cryptococcal Meningitis

Cryptococcosis among patients with HIV infection most commonly occurs as a subacute meningitis or meningoencephalitis with fever, malaise, and headache. Treating cryptococcosis consists of three phases: induction, consolidation, and maintenance therapy. The preferred induction treatment for cryptococcal meningitis and other forms of extrapulmonary cryptococcosis is the IV lipid formulation of amphotericin B in combination with fluconazole. Serious potential adverse effects of amphotericin B include anaphylaxis, kidney and hepatic impairment, electrolyte imbalances, anemia, fever, and severe chills. After at least 2 weeks of successful induction therapy—defined as substantial clinical improvement and a negative CSF culture after repeat lumbar puncture—amphotericin B and flucytosine can be discontinued. Follow-up or consolidation therapy is then initiated with oral fluconazole daily which should continue for at least 8 weeks (OI-Panel, 2019).

Cytomegalovirus Retinitis

Retinitis caused by CMV is a leading cause of blindness in patients with AIDS. Oral valganciclovir, IV ganciclovir, IV ganciclovir followed by oral valganciclovir, IV foscarnet, IV cidofovir, and a ganciclovir intraocular implant coupled with valganciclovir are all effective treatments for CMV retinitis (OI-Panel, 2019). All of these drugs have significant toxicities (bone marrow suppression, neutropenia, hepatitis, renal toxicity, seizures, etc.) and are used with caution.

Antidiarrheal Therapy

Although many forms of diarrhea respond to treatment, it is not unusual for this condition to recur and become a chronic problem for the patient with HIV infection. Therapy with octreotide acetate, a synthetic analogue of somatostatin, has been shown to effectively manage chronic severe diarrhea. High concentrations of somatostatin receptors have been found in the gastrointestinal tract and in other tissues. Somatostatin inhibits many

physiologic functions, including gastrointestinal motility and intestinal secretion of water and electrolytes.

Chemotherapy

Kaposi Sarcoma

KS can be treated with local therapy, radiation therapy, chemotherapy, and biologic therapy depending upon the location of the lesions.

Lymphoma

There is no standard treatment for AIDS-related peripheral or systemic lymphoma. The treatment plan is adjusted for each patient and usually includes one or more of combination chemotherapy, high-dose chemotherapy and stem cell transplant.

Antidepressant Therapy

Treatment for depression in people with HIV infection involves cognitive behavioral therapy integrated with pharmacotherapy (Lu et al., 2018). If depressive symptoms are severe and of sufficient duration, treatment with antidepressants may be initiated. Antidepressants such as imipramine, desipramine, and fluoxetine may be used, because these medications also alleviate the fatigue and lethargy that are associated with depression. A psychostimulant such as methylphenidate may be used in low doses in patients with neuropsychiatric impairment. Electroconvulsive therapy may be an option for patients with severe depression who do not respond to pharmacologic interventions.

Nutrition Therapy

Alterations in lipid metabolism are associated with HIV infection and ART. Malnutrition increases the risk of infection and the incidence of opportunistic infections. Nutrition therapy should be part of the overall management plan and should be tailored to meet the nutritional needs of the patient, whether by oral diet, enteral tube feedings, or parenteral nutritional support, if needed. As with all patients, a healthy diet is essential for the patient with HIV infection. For all patients with AIDS who experience unexplained weight loss, calorie counts and weight monitoring should be obtained to evaluate nutritional status and initiate appropriate therapy. The goal is to maintain the ideal weight and, when necessary, to increase weight.

Appetite stimulants have been successfully used in patients with AIDS-related anorexia. Megestrol acetate, a synthetic oral progesterone preparation, promotes significant weight gain and inhibits cytokine IL-1 synthesis. In patients with HIV infection, it increases body weight primarily by increasing

body fat stores. Dronabinol, which is a synthetic tetrahydrocannabinol, the active ingredient in marijuana, has been used to relieve nausea and vomiting associated with cancer chemotherapy. After beginning dronabinol therapy, almost all patients with HIV infection experience a modest weight gain. The effects on body composition are unknown.

Oral supplements may be used when the diet is deficient in calories and protein. Ideally, oral supplements should be lactose free (people with HIV infection may be intolerant to lactose), high in calories and easily digestible protein, low in fat with the fat easily digestible, palatable, inexpensive, and tolerated without causing diarrhea. Nutritional supplements have been developed specifically for people with HIV infection and AIDS. Parenteral nutrition is the final option because of its prohibitive cost and associated risks, including possible infection.

Complementary, Alternative, and Integrative Health Therapies

People with HIV infection, along with many Americans, report the use of complementary, alternative, and integrative therapies. Combined with traditional therapies, these may improve the patient's overall well-being. However, there can be adverse drug–drug interactions between certain therapies (e.g., St. John's wort) and some ART.

Although there is insufficient research on the effects of complementary, alternative, and integrative therapies, a growing body of literature reports benefits for modalities involving nutrition, exercise, psychosocial treatment, and Chinese medicine. See Chapter 4 for further information on complementary, alternative, and integrative therapies.

Many patients who use these therapies do not report their use to their health care providers. To obtain a complete health history, the nurse should ask about the patient's use of complementary, alternative, and integrative therapies. Patients may need to be encouraged to report their use of these therapies to their primary provider. Problems may arise, for example, when patients are using complementary, alternative, and integrative therapies while participating in clinical drug trials; alternative therapies can have significant adverse side effects, making it difficult to assess the effects of the medications in the clinical trial. The nurse needs to become familiar with the potential adverse side effects of these therapies; if it is suspected that the therapy is causing side effects, the nurse needs to discuss this with the patient, the alternative therapy provider, and the primary provider. The nurse needs to view complementary, alternative, and integrative therapies with an open mind and try to understand the importance of this treatment to the patient. This approach will improve communication with the patient and reduce conflict.

Supportive Care

Patients who are weak and debilitated as a result of chronic illness associated with HIV infection and AIDS typically require many kinds of supportive care. Nutritional support may be as simple as providing assistance in obtaining or preparing meals. For patients with more advanced nutritional impairment resulting from decreased intake, wasting syndrome, or gastrointestinal malabsorption associated with diarrhea, parenteral feedings may be required. Imbalances that result from nausea, vomiting, and profuse diarrhea often necessitate IV fluid and electrolyte replacement.

Management of skin breakdown associated with KS, perianal skin excoriation, or immobility entails thorough and meticulous skin care that involves regular turning, cleansing, and applications of medicated ointments and dressings. To combat pain associated with skin breakdown, abdominal cramping, peripheral neuropathy, or KS, the nurse administers analgesic agents at regular intervals around the clock. Patients with a history of drug abuse will need to have tailored approaches for pain management. Relaxation and guided imagery may help reduce pain and anxiety.

Pulmonary symptoms, such as dyspnea and shortness of breath, may be related to opportunistic infections, KS, or fatigue. For patients with these symptoms, oxygen therapy, relaxation training, and energy conservation techniques may be effective. Patients with severe respiratory dysfunction may require mechanical ventilation. Before mechanical ventilation is instituted, the procedure is explained to the patient and the caregiver.

As noted previously, with the advent of ART, there are generally more positive outcomes than could be achieved years ago, and a patient mechanically ventilated has a reasonable likelihood of survival. However, if the patient decides to forego mechanical ventilation, those wishes must be followed. Ideally, the patient has prepared an advance directive identifying preferences for treatments and end-of-life care, including hospice care. If the patient has not identified preferences in advance, treatment options are described so that the patient can make informed decisions and have those wishes respected.

Nurses should anticipate that patients as well as family and friends will need support and time to share concerns. In some family systems, more than one person might be living with HIV/AIDS.

NURSING PROCESS

The Patient with HIV Infection

The nursing care of patients with HIV infection is complicated by many emotional, social, and ethical issues. The plan of care for the patient with AIDS (see Chart 32-10) is individualized to meet the needs of the patient. Care includes many of the interventions and concerns cited in the Supportive Care section.

Assessment

Nursing assessment includes identification of potential risk factors, including a history of risky sexual practices or IV/injection drug use. The patient's physical status and psychological status are assessed.

Nutritional status is assessed by obtaining a dietary history and identifying factors that may interfere with oral intake, such as anorexia, nausea, vomiting, oral pain, or difficulty swallowing. In addition, the patient's ability to purchase, prepare, and store food safely is assessed. Weight history (i.e., changes over time), anthropometric measurements, and blood urea nitrogen (BUN), serum protein, albumin, and transferrin levels provide objective measurements of nutritional status.

Chart 32-10 PLAN OF NURSING CARE

Care of the Patient with AIDS

NURSING DIAGNOSIS: Diarrhoae associated with enteric pathogens or HIV infection

GOAL: Resumption of usual bowel habits

Nursing Interventions	Rationale	Expected Outcomes
1. Assess patient's normal bowel habits. 2. Assess for diarrhea: frequent, loose stools; abdominal pain or cramping, volume of liquid stools, and exacerbating and alleviating factors. 3. Obtain stool cultures, and administer antimicrobial therapy as prescribed. 4. Initiate measures to reduce hyperactivity of bowel. a. Maintain food and fluid restrictions as prescribed. Suggest BRAT diet (*b*ananas, *r*ice, *a*pplesauce, *t*ea, and *t*oast). b. Discourage smoking and use of electronic nicotine delivery systems (ENDS) including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars. c. Avoid bowel irritants such as fatty or fried foods, raw vegetables, and nuts. Offer small, frequent meals.	1. Provides baseline for evaluation. 2. Detects changes in status, quantifies loss of fluid, and provides basis for nursing measures. 3. Identifies pathogenic organism; therapy targets specific organism. 4. Promotes bowel rest, which may decrease acute episodes. a. Reduces stimulation of bowel. b. Eliminates nicotine, which acts as bowel stimulant. c. Prevents stimulation of bowel and abdominal	• Exhibits return to normal bowel patterns • Reports decreasing episodes of diarrhea and abdominal cramping • Identifies and avoids foods that irritate the gastrointestinal tract • Takes appropriate therapy as prescribed • Exhibits normal stool cultures • Maintains adequate fluid intake • Maintains body weight and reports no additional weight loss • States rationale for avoiding smoking • Enrolls in program to stop smoking and using ENDS • Uses medication as prescribed

5. Administer anticholinergic antispasmodics and opioids or other medications as prescribed. 6. Maintain fluid intake of at least 3 L/day unless contraindicated.	distention and promotes adequate nutrition. 5. Decreases intestinal spasms and motility. 6. Prevents hypovolemia.	• Maintains adequate fluid status • Exhibits normal skin turgor, moist mucous membranes, adequate urine output, and absence of excessive thirst

NURSING DIAGNOSIS: Risk for infection associated with immune deficiency
GOAL: Absence of infection

Nursing Interventions	Rationale	Expected Outcomes
1. Monitor for infection: fever, chills, and diaphoresis; cough; shortness of breath; oral pain or painful swallowing; creamy-white patches in oral cavity; urinary frequency, urgency, or dysuria; redness, swelling, or drainage from wounds; vesicular lesions on face, lips, or perianal area. 2. Educate patient or caregiver about need to report possible infection. 3. Monitor white blood cell (WBC) count and differential. 4. Obtain cultures of wound drainage, skin lesions, urine, stool, sputum, mouth, and blood as prescribed. Administer	1. Allows for early detection of infection, essential for prompt initiation of treatment. Repeated and prolonged infections contribute to patient's debilitation. 2. Allows early detection of infection. 3. Elevated WBC count possibly associated with infection. 4. Assists in determining offending organism to	• Identifies reportable signs and symptoms of infection • Reports signs and symptoms of infection if present • Exhibits and reports absence of fever, chills, and diaphoresis • Exhibits normal (clear) breath sounds without adventitious breath sounds • Maintains weight • Reports adequate energy level without excessive fatigue

antimicrobial therapy as prescribed. 5. Instruct patient in ways to prevent infection. a. Clean kitchen and bathroom surfaces with disinfectants. b. Clean hands thoroughly after exposure to body fluids. c. Avoid exposure to others' body fluids or sharing eating utensils. d. Turn, cough, and deep breathe, especially when activity is decreased. e. Maintain cleanliness of perianal area. f. Avoid handling pet excreta or cleaning litter boxes, birdcages, or aquariums. g. Cook meat and eggs thoroughly. 6. Maintain aseptic technique when performing invasive procedures such as venipunctures, bladder catheterizations, and injections.	initiate appropriate treatment. 5. Minimizes exposure to infection and transmission of HIV infection to others. 6. Prevents hospital-acquired infections.	• Reports absence of shortness of breath and cough • Exhibits pink, moist oral mucous membranes without fissures or lesions • Takes appropriate therapy as prescribed • Experiences no infection • States rationale for strategies to avoid infection • Modifies activities to reduce exposure to infection or infectious persons • Practices "safer sex" • Avoids sharing eating utensils and toothbrush • Exhibits normal body temperature • Uses recommended techniques to maintain cleanliness of skin, skin lesions, and perianal area • Has others handle pet

		excreta and cleanup • Uses recommended cooking techniques

NURSING DIAGNOSIS: Impaired airway clearance associated with *Pneumocystis* pneumonia, increased bronchial secretions, and decreased ability to cough associated with weakness and fatigue

GOAL: Improved airway clearance

Nursing Interventions	Rationale	Expected Outcomes
1. Assess and report signs and symptoms of altered respiratory status, tachypnea, the use of accessory muscles, cough, color and amount of sputum, abnormal breath sounds, dusky or cyanotic skin color, restlessness, confusion, or somnolence. 2. Obtain sputum sample for culture as prescribed. Administer antimicrobial therapy as prescribed. 3. Provide pulmonary care (cough, deep breathing, postural drainage, and vibration) every 2 to 4 hours. 4. Assist patient in attaining semi- or high Fowler position. 5. Encourage adequate rest periods.	1. Indicates abnormal respiratory function. 2. Aids in identification of pathogenic organisms. 3. Prevents stasis of secretions and promotes airway clearance. 4. Facilitates breathing and airway clearance. 5. Maximizes energy expenditure and prevents excessive fatigue. 6. Facilitates expectoration of secretions; prevents stasis of secretions.	• Maintains normal airway clearance: • Respiratory rate <20 breaths/min • Unlabored breathing without the use of accessory muscles and flaring nares (nostrils) • Skin color pink (without cyanosis) • Alert and aware of surroundings • Arterial blood gas values normal • Normal breath sounds without adventitious

6. Initiate measures to decrease viscosity of secretions. a. Maintain fluid intake of at least 3 L/day unless contraindicated. b. Humidify inspired air as prescribed. c. Consult with primary provider concerning the use of mucolytic agents delivered through nebulizer or intermittent positive pressure breathing treatment. 7. Perform tracheal suctioning as needed. 8. Administer oxygen therapy as prescribed. 9. Assist with endotracheal intubation; maintain ventilator settings as prescribed.	7. Removes secretions if patient is unable to do so. 8. Increases availability of oxygen. 9. Maintains ventilation.	breath sounds • Begins appropriate therapy • Takes medication as prescribed • Reports improved breathing • Maintains clear airway • Coughs and takes deep breaths every 2 to 4 hours as recommended • Demonstrates appropriate positions and practices postural drainage every 2 to 4 hours • Reports reduced breathing difficulty when in semi- or high Fowler position • Practices energy-conserving strategies and alternates rest with activity • Demonstrates reduction in thickness (viscosity) of pulmonary secretions

- Reports increased ease in coughing up sputum
- Uses humidified air or oxygen as prescribed and indicated
- Indicates need for assistance with removal of pulmonary secretions
- Understands need for and cooperates with endotracheal intubation and the use of a mechanical ventilator
- Verbalizes concerns about respiratory difficulty, intubation, and mechanical ventilation

NURSING DIAGNOSIS: Impaired nutritional intake associated with decreased oral intake
GOAL: Intake of nutrients sufficient to meet metabolic needs

Nursing Interventions	Rationale	Expected Outcomes
1. Assess nutritional status with height, weight, age; blood urea nitrogen, serum protein, albumin, transferrin, hemoglobin, and hematocrit levels; and cutaneous anergy. 2. Obtain dietary history, including likes and dislikes and food intolerances. 3. Assess factors that interfere with oral intake. 4. Consult with dietitian to determine patient's nutritional needs.	1. Provides objective measurement of nutritional status. 2. Defines need for nutritional education; helps individualize interventions. 3. Provides basis and directions for interventions. 4. Facilitates meal planning.	• Identifies factors limiting oral intake, and uses resources to promote adequate dietary intake • Reports increased appetite • States understanding of nutritional needs • Identifies ways to reduce factors that limit oral intake • Rests before meals • Eats in pleasant, odor-free environment • Arranges meals to coincide with visitors' visits
5. Reduce factors limiting oral intake. a. Encourage patient to rest before meals b. Plan meals so that they do	5. Addresses factors limiting intake. a. Minimizes fatigue, which can decrease appetite. b. Decreases noxious stimuli.	• Reports increased dietary intake • Uses oral hygiene before meals • Takes analgesic agents before

not occur immediately after painful or unpleasant procedures. c. Encourage patient to eat meals with visitors or others when possible. d. Encourage patient to prepare simple meals or to obtain assistance with meal preparation if possible. e. Serve small, frequent meals: 6/day. f. Limit fluids 1 hour before meals and with meals. 6. Instruct patient in ways to supplement nutrition: consume protein-rich foods (meat, poultry, fish) and carbohydrates (pasta, fruit, breads). 7. Consult with primary provider and dietitian about alternative feeding (enteral or parenteral nutrition). 8. Consult with social worker or	c. Limits social isolation. d. Limits energy expenditure. e. Prevents overwhelming patient. f. Reduces satiety. 6. Provides additional proteins and calories. 7. Provides nutritional support if patient is unable to take sufficient amounts by mouth. 8. Increases availability of resources and nutrition.	meals as prescribed • Identifies ways to increase protein and caloric intake • Identifies foods high in protein and calories • Consumes foods high in protein and calories • Reports decreased rate of weight loss • Maintains adequate caloric intake • States rationale for enteral or parenteral nutrition if needed • Demonstrates skill in preparing alternate sources of nutrition

community liaison about financial assistance if patient cannot afford food.		

NURSING DIAGNOSIS: Lack of knowledge associated with means of preventing HIV transmission
GOAL: Increased knowledge concerning means of preventing disease transmission

Nursing Interventions	Rationale	Expected Outcomes
1. Instruct patient, family, and friends about routes of transmission of HIV. 2. Instruct patient, family, and friends about means of preventing transmission of HIV. a. Avoid sexual contact with multiple partners, and use precautions if sexual partner's HIV status is not certain. b. Use condoms during sexual intercourse (vaginal, anal, oral–genital); avoid mouth contact with the penis, vagina, or rectum; avoid	1. Knowledge about disease transmission can help prevent spread of disease; may also alleviate fears. 2. Reduces transmission risk. a. The risk of infection increases with the number of sexual partners, male or female, and sexual contact with those who engage in high-risk behaviors. b. Risk of HIV transmission is reduced. c. Many sex workers are infected with HIV through sexual contact with multiple partners or	• Patient, family, and friends state means of transmission • Reports and demonstrates practices to reduce exposure of others to HIV • Demonstrates knowledge of safer sexual practices • Identifies means of preventing disease transmission • States that sexual partners are informed about patient's positive HIV status in blood • Avoids IV/injection drug use and sharing of drug

sexual practices that can cause cuts or tears in the lining of the rectum, vagina, or penis. c. Avoid sex with sex workers and others at high risk. d. Do not use IV/injection drugs; if addicted and unable or unwilling to change behavior, use clean needles and syringes. e. Women who may have been exposed to HIV through sexual or drug practices should consult with a primary provider before becoming pregnant; consider the use of antiretroviral agents if pregnant. f. Consider using PrEP	IV/injection drug use. d. Clean needles and syringes are the only way to prevent HIV transmission for those who continue to use drugs. Taking precautions is important for those who are antibody positive to prevent transmitting HIV. e. HIV can be transmitted from mother to child in utero; the use of antiretroviral agents during pregnancy significantly reduces perinatal transmission of HIV. f. Taking ART before engaging in high-risk activity seems to protect against infection.	equipment with others • Understands risks and benefits associated with PrEP

NURSING DIAGNOSIS: Social isolation associated with stigma of the disease, withdrawal of support systems, isolation procedures, and fear of infecting others

GOAL: Decreased sense of social isolation

Nursing Interventions	Rationale	Expected Outcomes
1. Assess patient's usual patterns of social interaction. 2. Observe for behaviors indicative of social isolation, such as decreased interaction with others, hostility, noncompliance, sad affect, and stated feelings of rejection or loneliness. 3. Provide instruction concerning modes of transmission of HIV. 4. Assist patient to identify and explore resources for support and positive mechanisms for coping (e.g., contact with family, friends, AIDS task force). 5. Allow time to be with patient other than for medications and procedures. 6. Encourage participation in diversional activities such as reading,	1. Establishes basis for individualized interventions. 2. Promotes early detection of social isolation, which may be manifested in several ways. 3. Provides accurate information, corrects misconceptions, and alleviates anxiety. 4. Enables mobilization of resources and supports. 5. Promotes feelings of self-worth and provides social interaction. 6. Provides distraction.	• Shares with others the need for valued social interaction • Demonstrates interest in events, activities, and communication • Verbalizes feelings and reactions to diagnosis, prognosis, and life changes • Identifies modes of transmission of HIV • States ways of preventing transmission of HIV to others while maintaining contact with valued friends and relatives • Reveals HIV/AIDS diagnosis to others when appropriate • Identifies resources (i.e., family, friends, and support groups) • Uses resources

television, or handcrafts.		when appropriate • Accepts offers of assistance and support • Reports decreased sense of isolation • Maintains contacts with those of importance to them • Develops or continues hobbies that effectively serve as diversion or distraction

Collaborative Problems: Opportunistic infections; impaired breathing; wasting syndrome and fluid and electrolyte imbalances; adverse reaction to medications

Goal: Absence of complications

Nursing Interventions	Rationale	Expected Outcomes
Opportunistic Infections		
1. Monitor vital signs including temperature. 2. Obtain laboratory specimens, and monitor test results. 3. Instruct the patient and caregiver about signs and symptoms of infection and the need to report them early.	1. Changes in vital signs such as increases in pulse rate, respirations, blood pressure, and temperature may indicate infection. 2. Smears and cultures can identify causative agents such as bacteria, fungi, and protozoa, and sensitivity studies can identify antibiotics or other medications effective against the causative agent. 3. Early recognition of symptoms facilitates prompt treatment and avoids extra complications.	• Exhibits stable vital signs • Experiences control of infection • Identifies signs and symptoms correctly and experiences no complications • Identifies signs and symptoms that are reportable to the primary provider • Takes medications as prescribed
Impaired Breathing		
1. Monitor respiratory rate and pattern. 2. Auscultate the chest for breath sounds and	1. Rapid shallow breathing, diminished breath sounds, and shortness of breath may indicate respiratory failure resulting in hypoxia. 2. Crackles and wheezes may indicate fluid in the	• Maintains stable respiratory rate and pattern within the normal limits

abnormal lung sounds. 3. Monitor pulse rate, blood pressure, and oxygen saturation levels.	lungs, which disrupts respiratory function and alters the blood's oxygen-carrying capacity. 3. Changes in pulse rate, blood pressure, and oxygen levels may indicate the development of respiratory or cardiac failure.	• Exhibits no adventitious lung sounds; normal breath sounds • Has stable pulse rate and blood pressure within normal limits, and exhibits no evidence of hypoxia • Oxygen saturation levels within acceptable range
Wasting Syndrome and Fluid and Electrolyte Disturbances		
1. Monitor weight and laboratory values for nutritional status. 2. Monitor intake and output and laboratory values for fluid and electrolyte imbalance (potassium, sodium, calcium, phosphorus, magnesium, and zinc). 3. Monitor for and report	1. Weight loss, malnutrition, and anemia are common in HIV infection and increase risk of superinfection. 2. Chronic diarrhea, inadequate oral intake, vomiting, and profuse sweating deplete electrolytes. Small intestine inflammation may impair the absorption of fluids and electrolytes. 3. Fluid loss results in decreased circulating volume leading to tachycardia, dry skin and mucous membranes, poor skin turgor, elevated urine specific gravity, and	• Maintains stable weight • Eats a nutritious diet • Attains and maintains hemoglobin, hematocrit, and ferritin levels within normal limits • Sustains fluid and electrolyte balance within normal limits • Exhibits no signs and symptoms of dehydration

signs and symptoms of dehydration.	thirst. Early detection allows early treatment.	
Reactions to Medications		
1. Monitor for medication interactions. 2. Monitor for and promptly report side effects from antiretroviral agents. 3. Instruct the patient and caregiver in the medication regimen.	1. People with HIV infection receive many medications for HIV and for disease complications. Early detection of medication interactions is necessary to prevent complications. 2. Side effects from antiretroviral agents can be life-threatening. Serious side effects include anemia, pancreatitis, peripheral neuropathy, mental confusion, and persistent nausea and vomiting. Corrective measures need to be instituted. 3. Knowledge of the medication purpose, correct administration, side effects, and strategies to manage or prevent side effects promotes safety and greater compliance with treatment.	• Experiences no serious side effects or complications from medications • Correctly describes medication regimen and complies with therapy, including adaptations in eating routines and type of food used with prescribed medications

The patient's level of knowledge about HIV infection, modes of disease transmission, and adherence to ART are evaluated. In addition, the level of knowledge of family (biologic and family of choice) and friends is assessed. The patient's psychological reaction to the diagnosis of HIV infection is important to explore. Reactions vary among patients and may include denial, anger, fear, shame, withdrawal from social interactions, and depressive symptoms (Lu et al., 2018). It is often helpful to gain an

understanding of how the patient has dealt with illness and major life stresses in the past. The patient's resources for support are also identified.

Diagnosis

Nursing Diagnoses

Based on the assessment data, major nursing diagnoses may include the following:

- Impaired nutritional intake associated with decreased oral intake
- Social isolation associated with stigma of HIV infection, withdrawal of support systems, isolation procedures, and fear of infecting others
- Grief associated with changes in lifestyle and roles
- Lack of knowledge associated with HIV infection, means of preventing HIV transmission, ART, and self-management strategies

Collaborative Problems/Potential Complications

Possible complications may include the following:

- Adverse effects of medications
- Development of HAND
- Body image changes

Planning and Goals

Goals for the patient may include improved nutritional status, increased socialization, expression of grief, increased knowledge regarding disease prevention and self-care, and absence of complications.

Nursing Interventions

Improving Nutritional Status

Nutritional status is assessed by monitoring weight; dietary intake; and serum albumin, BUN, protein, and transferrin levels. The patient is also assessed for factors that interfere with oral intake, such as anorexia and lactose intolerance. Based on the results of assessment, the nurse can implement specific measures to facilitate oral intake. The dietitian is consulted to determine the patient's nutritional requirements.

The patient is encouraged to eat foods that are easy to swallow and to avoid spicy or sticky food items and foods that are excessively hot or cold. Oral hygiene before and after meals is encouraged. The patient who is underweight is instructed about ways to enhance the nutritional value of meals. Adding eggs, butter, or fortified milk (milk to which powdered skim milk has been added to increase the caloric content) to gravies, soups, or milkshakes can provide additional calories and protein. High-calorie,

nutritional foods such as puddings, powders, milkshakes, and nutritional supplements may also be useful.

Decreasing the Sense of Isolation

People with HIV are at risk for double stigmatization. They have what society refers to as a "dreaded disease," and they may have a lifestyle that differs from what is considered acceptable by many people. The diagnosis might prompt disclosure about hidden lifestyles or behaviors to family, friends, coworkers, and health care providers. As a result, people with HIV infection may be overwhelmed with emotions such as anxiety, guilt, shame, and fear. They also may be faced with multiple losses, such as loss of financial security, normal roles and functions, self-esteem, privacy, ability to control bodily functions, ability to interact meaningfully with the environment, and sexual functioning as well as rejection by sexual partners, family, and friends. Some patients may harbor feelings of guilt because of their lifestyle or because they may have infected others in current or previous relationships. Other patients may feel anger toward sexual partners who transmitted the virus to them. Infection control measures used in the hospital or at home may further contribute to the patient's emotional isolation. Any or all of these stressors may cause the patient to withdraw both physically and emotionally from social contact.

Nurses are in a key position to provide an atmosphere of acceptance and understanding for people with HIV infection and their social networks. The patient's usual level of social interaction is assessed as early as possible to provide a baseline for monitoring changes in behaviors that suggest social isolation (e.g., decreased interaction with staff or family, hostility, nonadherence). Patients are encouraged to express feelings of isolation and loneliness, with the assurance that these feelings are not unique or abnormal.

Providing information about how to protect themselves and others may help patients avoid social isolation. Patients, family, and friends must be reassured that HIV is not spread through casual contact. Education of ancillary personnel, nurses, and physicians helps reduce factors that might contribute to patients' feelings of isolation.

Coping with Grief

The nurse can help the patient verbalize feelings and explore and identify resources for support and mechanisms for coping, especially when the patient is grieving anticipated losses. The patient is encouraged to maintain contact with family, friends, and coworkers and to use local or national support groups and hotlines. If possible, losses are identified and addressed. The patient is encouraged to continue usual activities whenever possible. Consultations with mental health counselors are useful for many patients and their families.

Improving Knowledge of HIV

The patient and family are educated about HIV infection, means of preventing HIV transmission, ART, and appropriate self-care measures. Information about the purpose of the medications, their correct administration, side effects, and strategies to manage or prevent side effects is provided.

Monitoring and Managing Potential Complications

Side Effects of Medications. Adverse effects are of concern in patients who receive numerous medications for HIV infection. Many medications can cause severe toxic effects. Patients and their caregivers need to know which signs and symptoms of side/toxic effects should be reported immediately to their primary care provider (see Table 32-4).

In addition to medications used to treat HIV infection, other medications that may be required include opioids, tricyclic antidepressants, and NSAIDs for pain relief; medications for treatment of opportunistic and coinfections; antihistamines (diphenhydramine for relief of pruritus; acetaminophen or aspirin for management of fever; and antiemetic agents for control of nausea and vomiting). Concurrent use of these medications can cause many drug interactions, resulting in hepatic and hematologic abnormalities. Therefore, careful monitoring of laboratory test results is essential.

During each contact with the patient, the nurse not only asks about side effects, but also about how well the patient is adhering to the medication regimen. To promote adherence, the nurse should assist the patient to organize and plan the medication schedule. Individualized adherence plans should consider housing and social support issues, in addition to health indicators including possible drug–drug interactions. Self-reported adherence measures can distinguish clinically meaningful patterns of medication-taking behaviors; therefore, nurses should assess if patients can describe how they are taking their ART.

Research suggests that the development of effective self-management strategies leads to increased ART adherence (Schreiner, Perazzo, Currie, et al., 2019), PLWHA at risk for high treatment burden and subsequent nonadherence are those with multiple comorbidities and low social support (Schreiner et al., 2019). See the Nursing Research Profile in Chart 32-11.

Monitoring for HAND. Each contact with the patient is also an opportunity to assess for the presence of HAND. A baseline assessment and then an annual assessment for signs and symptoms are recommended (Cummins et al., 2019). Nurses also need to educate caregivers about signs and symptoms of this subtle disorder.

Body Image Changes. Body image changes often occur in patients with HIV and are an important collaborative problem. The nurse helps the patient verbalize feelings and explore and identify resources for support and mechanisms for coping with body image changes. Consultations with

mental health counselors may be indicated for patients adjusting to body image changes.

Chart 32-11 **NURSING RESEARCH PROFILE**

Treatment Burden in People Living with HIV

Schreiner, N., Perazzo, J., Currie, J., et al. (2019). A descriptive, cross-sectional study examining treatment burden in people living with HIV. *Applied Nursing Research*, *46*, 31–36.

Purpose

Successful HIV treatment associated with advances in ART has resulted in HIV being classified as a chronic condition. The purposes of this study were to: (1) describe persons living with HIV/AIDS (PLWHA) experiencing high levels of treatment burden who are at high risk for self-management nonadherence, and (2) test the relationship between known antecedent correlates (the number of chronic conditions, social capital, and age) of self-management and treatment burden in community dwelling sample of PLWHA while controlling for socio-demographics. As an indicator of social support, the relationship between social capital and treatment burden was tested.

Design

This was a descriptive, correlational, cross-sectional secondary analysis of a larger, multi-site study that examined physical activity patterns of PLWHA. Participants were ≥18 years of age and had confirmed HIV (HIV+ ELISA with confirmatory PCR or Western blot). An additional inclusion criterion was diagnosis of two or more chronic conditions identified in the patient's medical record. The Treatment Burden Questionnaire-13 (TBQ-13) was used to measure participant treatment burden. The TBQ-13 is a psychometrically tested instrument containing 13 items inquiring about burden associated with self-management tasks such as medication administration, self-monitoring of chronic conditions, or changes in diet. The TQB-13 asks the respondent to rank the level of burden for each question with responses ranging from 0-No Burden, to 10-Very High Burden, with summed scores ranging from 0 to 130 (higher scores indicating greater treatment burden). The Social Capital Measurement Tool was used to measure social resources.

Findings

Participants were on average 50 years of age; most were African American, male, Medicaid insured, and had a high school diploma. There was a mean of 3.63 (SD = 1.76) chronic conditions and the mean treatment burden score was 22.84 (SD = 24.57). Based on established cut-off points for low, medium, and high treatment burden, the sample experienced low levels of treatment burden, though there was wide variation in treatment burden scores. Approximately 60 PLWHA (58%) reported low treatment burden, 27 (26%) moderate treatment burden, and 16 (16%) high treatment burden. The number of comorbidities was

positively associated with treatment burden, and social resources were negatively correlated with treatment burden.

Nursing Implications

Nurses need to be aware that there are potential benefits of treatment burden screening that may help to improve self-management adherence. These results can help inform nurses how to improve the self-management adherence in PLWHA who are affected by treatment burden in the clinical setting.

PROMOTING, HOME, COMMUNITY-BASED, AND TRANSITIONAL CARE

Educating Patients About Self-Care. Patients, families, and friends are educated about the routes of transmission of HIV. The nurse discusses precautions the patient can use to avoid transmitting HIV sexually (see Charts 32-2 and 32-3) or through sharing of body fluids, especially blood. Patients and their families or caregivers must receive instructions about how to prevent disease transmission, including hand hygiene techniques and methods for safely handling and disposing of items soiled with body fluids. Clear guidelines about avoiding and controlling infection, keeping regular health care appointments, symptom management, nutrition, rest, and exercise are necessary (see Chart 32-12). The importance of personal and environmental hygiene is emphasized. Caregivers are taught hand hygiene and appropriate infection prevention precautions (see Chapter 66, Charts 66-1 and 66-2). Kitchen and bathroom surfaces should be cleaned regularly with disinfectants to prevent growth of fungi and bacteria. Patients with pets are encouraged to have another person clean areas soiled by animals, such as birdcages and litter boxes. If this is not possible, patients should use gloves to clean the area and then wash their hands afterward. Patients are advised to avoid exposure to others who are sick or who have been recently vaccinated, especially with live vaccine. The importance of avoiding smoking, excessive alcohol, and over-the-counter and street drugs is emphasized. Patients who are HIV positive or who inject drugs are instructed not to donate blood. IV/injection drug users who are unwilling to stop using drugs are advised to avoid sharing drug equipment with others.

Caregivers in the home are taught how to administer medications. The medication regimens used for patients with HIV infection can be complex and expensive. Patients receiving combination therapies for the treatment of HIV infection require careful education about the importance of taking medications as prescribed and explanations and assistance in fitting the medication regimen into their lives (see Chart 32-8). If the patient requires enteral or parenteral nutrition, instruction is provided to the patient and family about how to administer nutritional therapies at home. Nurses provide ongoing education and support for the patient and family.

Continuing and Transitional Care. Many people with HIV remain in their community and continue their usual daily activities, whereas others can no longer work or maintain their independence. Families or caregivers may need assistance in providing supportive care. Many community-based organizations provide a variety of services for people living with HIV infection; nurses can help identify these services.

Home, community-based, transitional, and hospice nurses are in an excellent position to provide the support and guidance that is so often needed in the home setting. Home health nurses are key to the safe and effective administration of parenteral antibiotics, chemotherapy, and nutrition in the home.

During home visits, the nurse assesses the patient's physical and emotional status and home environment. The patient's adherence to the therapeutic regimen is assessed, and strategies are suggested to assist with adherence. The patient is assessed for progression of disease and for adverse side effects of medications. Previous education is reinforced, and the importance of keeping follow-up appointments is stressed.

Chart 32-12 **HOME CARE CHECKLIST**

Infection Prevention for the Patient with Immune Deficiency

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of immune deficiency on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- State changes in lifestyle (e.g., hygiene, activity) necessary to decrease risk for infection.
  - Maintain good hand hygiene technique before eating, after using the bathroom, and before and after performing health care procedures.
  - Maintain total body hygiene and foot care to prevent bacterial and fungal diseases.
  - Maintain skin integrity, using cream and emollients to prevent or manage dry, chafed, or cracked skin.
  - Maintain good oral hygiene and dental checkups.
  - Avoid people with infections, recent vaccinations, and crowds.
  - Perform deep breathing; use incentive spirometer every 4 hours while awake if mobility is restricted.
  - Provide adequate lubrication with gentle vaginal manipulation during sexual intercourse; avoid anal intercourse.
- State changes in home environment necessary to decrease risk for infection.
  - Avoid cleaning birdcages and litter boxes; consider avoiding garden work (soil) and fresh flowers in stagnant water.
  - Identify the rationale for frequent cleaning of kitchen and bathroom surfaces with disinfectant.
- Verbalize understanding of ways to maintain a nutritious diet and adequate calories and necessary changes to decrease risk of infection.
- State the reason for avoiding the eating of raw fruits and vegetables, cooking all foods thoroughly, and immediately refrigerating all leftover food.
- Identify rationale and benefits of avoiding alcohol, tobacco, and unprescribed medications.
- State the name, dose, side effects, frequency, and schedule for all medications.
- Verbalize ways to cope with stress successfully, plans for regular exercise, and rationale for obtaining adequate rest.
- Identify signs and symptoms of infection to report to the primary provider, such as fever; chills; wet or dry cough; breathing problems; white patches in the mouth; swollen glands; nausea; vomiting; persistent abdominal pain; persistent diarrhea; problems

with urination or changes in the character of the urine; red, swollen, or draining wounds; sores or lesions on the body; persistent vaginal discharge with or without itching; and severe fatigue.
- Demonstrate how to monitor for signs of infection.
- Describe to whom, how, and when to report signs of infection.
- Describe appropriate actions to take should infection occur.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Complex wound care or respiratory care may be required in the home. Patients and families are often unable to meet these skilled care needs without assistance. Nurses may refer patients to community programs that offer a range of services for patients, friends, and families, including help with housekeeping, hygiene, and meals; transportation and shopping; individual and group therapy; support for caregivers; telephone networks for the homebound; and legal and financial assistance. These services are typically provided by both professionals and nonprofessional volunteers. A social worker may be consulted to identify sources of financial support, if needed.

Home health and hospice nurses are increasingly called on to provide physical and emotional support to patients and families as patients with AIDS enter the terminal stages of disease. This support takes on special meaning when people with AIDS lose friends and when family members fear the disease or feel anger concerning the patient's lifestyle. The nurse encourages the patient and family to discuss end-of-life decisions and to ensure that care is consistent with those decisions, all comfort measures are employed, and the patient is treated with dignity at all times.

Evaluation

Expected patient outcomes may include:

1. Maintains adequate nutritional status
2. Experiences decreased sense of social isolation
3. Progresses through grieving process
4. Reports increased understanding of HIV infection, prevention of HIV transmission, and ART, and participates in self-management strategies as possible
5. Remains free of complications

Emotional and Ethical Concerns

Nurses in all settings are called on to provide care for patients with HIV infection. In doing so, they encounter not only the physical challenges of this epidemic but also emotional and ethical concerns. The concerns raised by health care professionals involve issues such as fear of infection, responsibility for giving care, values clarification, confidentiality, developmental stages of patients and caregivers, and poor prognostic outcomes.

Many patients with HIV infection have engaged in "stigmatized" behaviors. Because these behaviors challenge some traditional religious and moral values, nurses may feel reluctant to care for these patients. In addition, health care providers may still have fear and anxiety about disease transmission despite education concerning infection control and the low incidence of transmission to health care providers. Nurses are encouraged to examine their personal beliefs and to use the process of values clarification to approach controversial issues (see Chapter 1, Chart 1-10). The ANA's Code of Ethics for Nurses (ANA, 2015) provides guidance including the first provision which states, "The nurse practices with compassion and respect for the inherent dignity, worth, and unique attributes of every person" (p. 1).

Nurses are responsible for protecting the patient's right to privacy by safeguarding confidential information. Inadvertent disclosure of confidential patient information may result in personal, financial, and emotional hardships for the patient. The controversy surrounding confidentiality concerns the circumstances in which information may be disclosed to others (see Chart 32-13). Health care team members need accurate patient information to conduct assessment, planning, implementation, and evaluation of patient care. Failure to disclose HIV status could compromise the quality of patient care. Sexual partners of patients infected with HIV should know about the potential for infection and the need to engage in safer sex practices, as well as the possible need for testing and health care. Nurses are advised to discuss concerns about confidentiality with nurse administrators and to consult professional nursing organizations such as the Association of Nurses in AIDS Care and legal experts in their state to identify the most appropriate course of action.

Chart 32-13 ETHICAL DILEMMA

What if Maintaining Confidentiality Results in Harm?

Case Scenario

You are a nurse employed on a *per diem* basis for a home health agency. A nursing professor whom you know has received funding to conduct a mixed methods research study on men in your community who are experiencing homelessness and living with being human immune deficiency virus (HIV) positive. She has funds to pay nurses with community health experience to gather data for her study, and you were solicited and received education to serve as one of her nurse data collectors. You are assigned to conduct interviews at a homeless shelter for veterans. Eligible participants must sign an informed consent prior to being interviewed; this informed consent was approved by an institutional review board (IRB) at the nursing professor's university and was also approved by the governance board of the homeless shelter for veterans. One day while you are conducting an interview with T.M., a 28-year-old man with a history of male prostitution and substance use disorder (SUD), he suddenly begins to cry softly and says to you "I am sorry…. I just feel life is no longer worth living. I need to end things and stop going on like this." After further validating the meaning of his words, you learn that T.M. has made a plan to commit suicide. The informed consent that T.M. has signed contains assurances that his name and any information that he shares will not be divulged to anyone outside of the research team. You are conflicted about whether or not you may share his suicidal intentions with anyone.

Discussion

It is standard practice that participants who enroll in research studies are guaranteed confidentiality of their identities. However, T.M. is a particularly vulnerable research participant because he is homeless and HIV positive. Interviewing a participant in a research study who is vulnerable can cause emotional distress that might cause harm. Ideally, this contingency should have been identified by the nursing professor and the IRB, and there should have been additional information in the informed consent that identified a behavioral health professional who could be contacted should participants experience distress. Furthermore, the clause in the informed consent that assured T.M. of the confidential nature of the interview should have specified that this confidentiality would need to be breached if it was determined that participant safety was compromised.

Analysis

- Describe the ethical principles that are in conflict in this case (see Chapter 1, Chart 1-7). Can the principle of nonmaleficence be considered the preeminent principle that guides your decision regarding next steps?

- Assume that the informed consent does not make any of the specifications previously noted to protect vulnerable participants. Would you feel obligated to relay these findings to the nursing professor who serves as the principal investigator of the research team? Would you feel obligated to relay these findings to the social worker at the homeless shelter? Now assume that the provisions to protect T.M. were indeed specified in the informed consent. Would that change whether or not you would notify either the nursing professor or the social worker?
- What resources might be mobilized to be of assistance to you as you navigate your role as a research assistant? What are your legal and ethical obligations? Do you have the right or the responsibility to contact the nursing professor's IRB?

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Resources

See Chapter 1, Chart 1-10, for Steps of an Ethical Analysis and Ethics Resources.

Education and provision of up-to-date information help to alleviate apprehension and prepare nurses to deliver safe, high-quality patient care. Interdisciplinary meetings allow participants to support one another and provide comprehensive patient care. Staff support groups give nurses an opportunity to solve problems and explore values and feelings about caring for patients with AIDS and their families; they also provide a forum for grieving. Other sources of support include nursing administrators, peers, and spiritual advisors.

CRITICAL THINKING EXERCISES

1 ebp Your patient is a 33-year-old transgender woman who has been diagnosed as HIV infected, stage 2. The patient tells you that they do not want to take ART because it is interfering with their self-managed hormone therapy. What is the evidence about the drug/drug interaction between ART and transitional hormone therapy? What strategies could you identify to promote adherence to ART regimen? What are the consequences of discontinuing ART?

2 pq A 55-year-old male who uses injection drugs and is HIV infected comes to the clinic where you work. He tells you that he has been experiencing night sweats, late afternoon fevers, cough, and weight loss. Identify this patient's health priorities and state the next steps you will use to meet his identified needs and other health promotion needs.

3 ipc Your patient, a heterosexual woman who is HIV infected, tells you that she wants to have unprotected sexual relations with her male partner who is HIV negative. What preventive measures should you educate this patient about? What additional members of the health care team should be included in the care of this patient?

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*Asterisk indicates nursing research.

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World Health Organization. (2019). HIV/AIDS. Retrieved on 10/30/2019 at: www.who.int/en/news-room/fact-sheets/detail/hiv-aids

Resources

AIDS Community Research Initiative of America (ACRIA), www.acria.org
AIDS Education and Training Centers (AETCs) Program (regional, national, and international training opportunities), www.aidsetc.org
AIDSinfoglossary 9th edition (2018), clinicalinfo.hiv.gov/themes/custom/aidsinfo/documents/glossaryhivrelatedterms_english.pdf
AIDS vaccines, http://www.avac.org/prevention-option/aids-vaccines
Antiretroviral medication information websites: www.sfaf.org; hivinsite.ucsf.edu/; www.amfAR.org; www.natap.org; www.thebody.com
Centers for Disease Control and Prevention, HIV/AIDS Prevention Research Synthesis Project, http://www.cdc.gov/hiv/dhap/prb/prs/
Gay Men's Health Crisis Network (GMHC), www.gmhc.org
Harm Reduction Coalition, http://harmreduction.org/about-us/

Health Resources and Service Administration (HRSA), National Clinician's Post-exposure Prophylaxis Hotline (health care providers only), 1-888-448-4911
Health Resources and Service Administration (HRSA), National HIV Telephone Consultation Service, 1-800-933-3413
International AIDS Vaccine Initiative (AVI), www.iavi.org
International Partnership for Microbicides, www.ipmglobal.org
National Institutes of Health, HIV/AIDS Treatment, Prevention, and Research, www.aidsinfo.nih.gov
Office of Minority Health Resource Center, www.minorityhealth.hhs.gov/omh/browse.aspx?lvl=4&lvlid=21
POZ, Health, Life, & HIV. Published by Smart+Strong, 500 Fifth Avenue, Suite 320, New York, NY 10110, www.poz.com/
Prevention Access Campaign, www.preventionaccess.org

33 Assessment and Management of Patients with Allergic Disorders

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the physiologic events involved with allergic reactions and types of hypersensitivity.
2. Use appropriate parameters for assessment of the status of patients with allergic disorders.
3. Identify the pathophysiology, clinical manifestations, and management of patients with allergic disorders.
4. Specify measures to prevent and manage anaphylaxis.
5. Use the nursing process as a framework for care of the patient with allergic rhinitis.

NURSING CONCEPTS

Cellular Regulation
Immunity
Infection

GLOSSARY

allergen: substance that causes manifestations of allergy

allergy: inappropriate and often harmful immune system response to substances that are normally harmless

anaphylaxis: rapid clinical response to an immediate immunologic reaction between a specific antigen and antibody

angioedema: condition characterized by urticaria and diffuse swelling of the deeper layers of the skin (*synonym*: angioneurotic edema)

antibody: protein substance developed by B cells in response to and interacting with a specific antigen

antigen: substance that the body identifies as a foreign invader; antigens induce the production of antibodies

antihistamine: medication that opposes the action of histamine

atopic dermatitis: type I hypersensitivity involving inflammation of the skin evidenced by itching, redness, and a variety of skin lesions

atopic march: a progression of allergic disease beginning with atopic dermatitis continuing to IgE-mediated food allergy, asthma, and allergic rhinitis

atopy: term often used to describe immunoglobulin E–mediated diseases (i.e., atopic dermatitis, asthma, and allergic rhinitis) with a genetic component

B cells: lymphocyte cells that are stimulated to produce antibodies

bradykinin: a substance that stimulates nerve fibers and causes pain

eosinophil: granular leukocyte

erythema: diffuse redness of the skin

hapten: incomplete antigen

histamine: substance in the body that causes increased gastric secretion, dilation of capillaries, and constriction of the bronchial smooth muscle

hypersensitivity: abnormal heightened reaction to a stimulus of any kind

immunoglobulins: a family of closely related proteins capable of acting as antibodies

leukotrienes: a group of chemical mediators that initiate the inflammatory response

mast cells: connective tissue cells that contain heparin and histamine in their granules

plasma cells: upon stimulation by antigen, B lymphocytes differentiate into plasma cells that secrete antibodies

prostaglandins: unsaturated fatty acids that have a wide assortment of biologic activity

serotonin: chemical mediator that acts as a potent vasoconstrictor and bronchoconstrictor

T cells: lymphocyte cells that participate in cellular immunity and assist in humoral (B-cell) immunity

urticaria: a round, reddened skin elevation or hives

Allergic disorders are common and are encountered by nurses in every setting, from the community to the intensive care unit. Expert management of patients with allergic disorders is integral to nursing regardless of the practice setting. This chapter covers general allergic assessment and management of various allergic disorders including anaphylaxis.

The human body is bombarded by a host of potential invaders—allergens as well as microbial organisms—that constantly threaten its defenses. These invaders are termed **antigens**. After penetrating the body's defenses, these antigens, if allowed to continue unimpeded, disrupt the body's enzyme systems and destroy its vital tissues. To protect against these antigens, the body is equipped with an elaborate defense system.

The epithelial cells that coat the skin and make up the lining of the respiratory, gastrointestinal, and genitourinary tracts provide the first line of defense against microbial invaders. The structure and continuity of these surfaces and their resistance to penetration are initial deterrents to antigens (Marshall, Warrington, Watson, et al., 2018).

One of the most effective defense mechanisms is the body's capacity to equip itself rapidly with antibodies specifically designed to combat each new invader—namely, specific protein antigens. Antibodies react with antigens in a variety of ways: (1) by coating the antigens' surfaces, (2) by neutralizing the antigens, and (3) by precipitating the antigens out of solution if they are dissolved. The antibodies prepare the antigens so that the phagocytic cells of the blood and the tissues can eliminate them. However, although this system is normally protective, in some cases the body produces inappropriate or exaggerated responses to specific antigens, and the result is an allergic or hypersensitivity disorder.

Physiologic Overview

An allergic reaction is a manifestation of tissue injury resulting from interaction between an antigen and an **antibody** (a protein substance developed by B cells in response to and interacting with a specific antigen) (Marshall et al., 2018). **Allergy** is an inappropriate and often harmful response of the immune system to normally harmless substances, called **allergens** (e.g., dust, weeds, pollen, dander). Chemical mediators released in allergic reactions may produce symptoms that range from mild to life-threatening.

In allergic reactions, the body encounters allergens that are types of antigens, usually proteins that the body's defenses recognize as foreign, and a series of events occurs in an attempt to render the invaders harmless, destroy them, and remove them from the body. There is a generalized white blood cell response to the entrance of antigens into the body. Specific types of white blood cells, called B lymphocytes (also called B cells), are specifically triggered by the presence of antigen. B lymphocytes differentiate into **plasma cells**, which then secrete antibodies that attack the antigen.

Specific antibodies develop in response to specific antigens. Antibodies combine with antigens in a special way, which has been likened to a lock and key. Antigens (the keys) fit only certain antibodies (the locks). Hence, the term *specificity* refers to the specific reaction of an antibody to an antigen. There are many variations and complexities in these patterns. In addition, antibodies have memory for the specific antigen, so that upon future exposure, the lock and key reaction occurs again (Actor, 2019).

Function of Immunoglobulins

Antibodies that are formed by plasma cells in response to an immunogenic stimulus constitute a group of serum proteins called **immunoglobulins**. Grouped into five classes (IgG, IgA, IgM, IgD, and IgE), immunoglobulins can be found in the lymph nodes, tonsils, appendix, and Peyer patches of the intestinal tract or circulating in the blood and lymph. These antibodies are capable of binding with a wide variety of antigens. Immunoglobulins of the IgE class are involved in allergic disorders and some parasitic infections. IgE-producing cells are located in the respiratory and intestinal mucosa. Two or more IgE molecules bind together to an allergen and trigger **mast cells** or basophils to release chemical mediators, such as histamine, serotonin, kinins, slow-reacting substances of anaphylaxis, and the neutrophil factor, which produces allergic skin reactions, asthma, and hay fever. **Atopy** refers to IgE-mediated diseases, such as allergic rhinitis, that have a genetic component (Actor, 2019). See Chapter 31 for more information on immunoglobulins.

Role of B Cells

B cells, or B lymphocytes, are programmed to produce one specific antibody. On encountering a specific antigen, B cells generate plasma cells, at the site of antibody production. The plasma cells secrete antibodies for the purpose of destroying and removing the antigens. B cells participate in humoral immunity (also called antibody-mediated immunity), which is one kind of adaptive immunity (Marshall et al., 2018).

Role of T Cells

There are different types of **T cells**, or T lymphocytes, that participate in cellular immunity (also called cell-mediated immunity), a type of adaptive immunity. T helper cells are specific types of T lymphocytes that assist B cells in the immune response. T cells secrete substances that direct the flow of cell activity and stimulate macrophages. Macrophages present the antigens to the T cells and initiate the immune response. They also digest antigens and assist in removing cells and other debris (Marshall et al., 2018).

Function of Antigens

Antigens are divided into two groups: complete protein antigens and low-molecular-weight substances. Complete protein antigens, such as animal dander, pollen, and horse serum, stimulate a complete humoral response. A humoral response is another name for a B lymphocyte–mediated response. See Chapter 31 for a discussion of humoral immunity. Low-molecular-weight substances, such as medications, function as **haptens** (incomplete antigens), binding to tissue or serum proteins to produce a carrier complex that initiates an antibody response. In an allergic reaction, the production of antibodies requires active communication between cells. When the allergen is absorbed through the respiratory tract, gastrointestinal tract, or skin, allergen sensitization occurs. In the humoral response, B cells mature into allergen-specific secreting plasma cells that synthesize and secrete antigen-specific antibodies (Marshall et al., 2018).

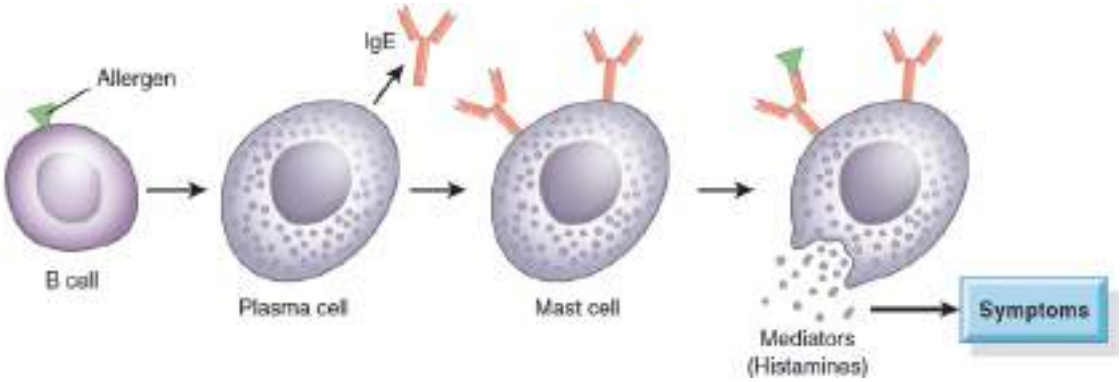


Figure 33-1 • Antigen stimulates activation of a B cell (B lymphocyte), which then transforms into a plasma cell that secretes immunoglobulins. Immunoglobulins stimulate mast cells to release histamine and other inflammatory mediators.

Function of Chemical Mediators

Mast cells, which are located in the skin, respiratory tract, and gastrointestinal tract, play a major role in IgE-mediated immediate hypersensitivity. When mast cells are stimulated by antigens, powerful chemical mediators, such as

histamine, are released, causing a sequence of physiologic events that result in symptoms of immediate hypersensitivity (see Fig. 33-1). There are two types of chemical mediators: primary and secondary. Primary mediators are preformed and are found in mast cells or basophils. Secondary mediators are inactive precursors that are formed or released in response to primary mediators. Table 33-1 summarizes the actions of primary and secondary chemical mediators (Castells, 2017).

Primary Mediators

Histamine, eosinophil chemotactic factor of anaphylaxis, platelet-activating factor, and prostaglandins are primary chemical mediators in allergic responses.

Histamine

Histamine, which is released by mast cells, plays an important role in the immune response. It is the first chemical mediator to be released in immune and inflammatory responses. It is synthesized and stored in high concentrations in body tissues exposed to environmental substances. Histamine's effects peak 5 to 10 minutes after antigen contact and include the following: erythema; localized edema in the form of wheals; pruritus; contraction of bronchial smooth muscle, resulting in wheezing and bronchospasm; dilation of small venules and constriction of larger vessels; and increased secretion of gastric and mucosal cells, resulting in diarrhea. Histamine action results from stimulation of histamine-1 (H_1) and histamine-2 (H_2) receptors. H_1 receptors are found predominantly on bronchiolar and vascular smooth muscle cells; H_2 receptors are found on gastric parietal cells (Castells, 2017).

Certain medications are categorized by their action at these receptors. Diphenhydramine is an example of an **antihistamine**, a medication that displays an affinity for H_1 receptors. Cimetidine targets H_2 receptors to inhibit gastric secretions in peptic ulcer disease.

TABLE 33-1 Chemical Mediators of Hypersensitivity

Mediators	Action
Primary Mediators	
Preformed and Found in Mast Cells or Basophils	
Histamine (preformed in mast cells)	Vasodilation Smooth muscle contraction, increased vascular permeability, increased mucus secretions
Eosinophil chemotactic factor of anaphylaxis (preformed in mast cells)	Attracts eosinophils
Platelet-activating factor (requires synthesis by mast cells, neutrophils, and macrophages)	Smooth muscle contraction Incites platelets to aggregate and release serotonin and histamine
Prostaglandins (chemically derived from arachidonic acid; require synthesis by cells)	D and F series → bronchoconstriction E series → bronchodilation D, E, and F series → vasodilation
Basophil kallikrein (preformed in mast cells)	Frees bradykinin, which causes bronchoconstriction, vasodilation, and nerve stimulation
Secondary Mediators	
Inactive Precursors Formed or Released in Response to Primary Mediators	
Bradykinin (derived from precursor kininogen)	Smooth muscle contraction, increased vascular permeability, stimulates pain receptors, increased mucus production
Serotonin (preformed in platelets)	Smooth muscle contraction, increased vascular permeability
Heparin (preformed in mast cells)	Anticoagulant
Leukotrienes (derived from arachidonic acid and activated by mast cell degranulation) C, D, and E or slow-reacting substance of anaphylaxis	Smooth muscle contraction, increased vascular permeability

Adapted from Norris, T. (2019). *Porth's pathophysiology: Concepts of altered health states* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Eosinophil Chemotactic Factor of Anaphylaxis

Eosinophil chemotactic factor of anaphylaxis affects the movement of **eosinophils** (granular leukocytes) to the site of allergens. It is preformed in the mast cells and is released from disrupted mast cells.

Platelet-Activating Factor

Platelet-activating factor is responsible for initiating platelet aggregation and leukocyte infiltration at sites of immediate hypersensitivity reactions. It also causes vasodilation, bronchoconstriction, and increased vascular permeability (Castells, 2017).

Prostaglandins

Prostaglandins produce smooth muscle contraction as well as vasodilation and increased capillary permeability. They sensitize pain receptors and increase the pain associated with inflammation. In addition, prostaglandins induce inflammation and enhance the effects of mediators of inflammatory response. Local manifestations include erythema, heat, and edema (Castells, 2017).

Secondary Mediators

Leukotrines, bradykinin, and serotonin are all secondary chemical mediators.

Leukotrienes

Leukotrienes are chemical mediators that initiate the inflammatory response. Many manifestations of inflammation can be attributed in part to leukotrienes. In addition, leukotrienes cause smooth muscle contraction, bronchial constriction, mucus secretion in the airways, and the typical wheal-and-flare reactions of the skin. Compared with histamine, leukotrienes are 100 to 1000 times more potent in causing bronchospasm (Castells, 2017).

Bradykinin

Bradykinin is a substance that has the ability to cause increased vascular permeability, vasodilation, hypotension, and contraction of many types of smooth muscle, such as the bronchi. Increased permeability of the capillaries results in edema. Bradykinin stimulates nerve cell fibers and produces pain.

Serotonin

Serotonin is a chemical mediator that acts as a potent vasoconstrictor and causes contraction of bronchial smooth muscle.

Hypersensitivity

Although the immune system defends the host against infections and foreign antigens, immune responses can themselves cause tissue injury and disease. **Hypersensitivity** is an excessive or aberrant immune response to any type of stimulus (Actor, 2019). It usually does not occur with the first exposure to an allergen. Rather, the reaction follows a re-exposure after sensitization, or buildup of antibodies, in a predisposed person. Injurious or pathologic immune

reactions are classed as hypersensitivity reactions. To promote understanding of the immunopathogenesis of disease, hypersensitivity reactions have been classified into four specific types of reactions (see Fig. 33-2).

Anaphylactic (Type I) Hypersensitivity

The most severe hypersensitivity reaction is **anaphylaxis**. An unanticipated severe allergic reaction that is rapid in onset, anaphylaxis is characterized by edema in many tissues, including the larynx, and is often accompanied by hypotension, bronchospasm, and cardiovascular collapse in severe cases. Anaphylaxis is a severe type I hypersensitivity reaction, which is an immediate reaction beginning within minutes of exposure to an antigen. Primary chemical mediators are responsible for the symptoms of type I hypersensitivity because of their effects on the skin, lungs, and gastrointestinal tract. If chemical mediators continue to be released, a delayed reaction may occur and may last for up to 24 hours (Marshall et al., 2018).

Clinical symptoms are determined by the amount of the allergen, the amount of mediator released, the sensitivity of the target organ, and the route of allergen entry. Type I hypersensitivity reactions may include both local and systemic anaphylaxis (Actor, 2019).

Cytotoxic (Type II) Hypersensitivity

Type II, or cytotoxic hypersensitivity occurs when antibodies are directed against antigens on cells or basement membranes of tissues. This reaction can lead to cell lysis and tissue damage. Type II hypersensitivity reactions are associated with several disorders. The best example is a hemolytic transfusion reaction. For example, if a person with type A blood is mistakenly given type B blood, anti-B antibodies are triggered in the recipient that attack the infused type B blood cells and cause hemolysis (Actor, 2019).

Immune Complex (Type III) Hypersensitivity

Type III, or immune complex hypersensitivity, is a damaging inflammatory reaction caused by the insoluble immune complexes formed by antigens that bind to antibodies. These complexes are too large to be cleared from the circulation by phagocytic action. The immune complexes are deposited in tissues or vascular endothelium and trigger inflammation at different sites throughout the body. An example of this kind of hypersensitivity reaction occurs in rheumatoid arthritis. An unknown antigen triggers antibody formation, which then forms immune complexes that are deposited in the joints. Many autoimmune disorders are type III hypersensitivity reactions. In autoimmune reactions, such as systemic lupus erythematosus, patients form autoantibodies that form immune complexes that deposit in the lungs, skin, and kidney (Actor, 2019).

Delayed (Type IV) Hypersensitivity

Type IV, or delayed hypersensitivity, is a T cell–mediated immune reaction after exposure to an antigen. This immune reaction typically occurs 24 to 48 hours after exposure to an antigen. The prototypical type IV hypersensitivity reaction occurs in response to the subcutaneous injection of purified protein derivative (PPD) antigen from *Mycobacterium tuberculosis*. Patients who have had previous exposure or have tuberculosis (TB) infection will demonstrate a reaction of erythema and induration due to sensitized T cells (Actor, 2019).

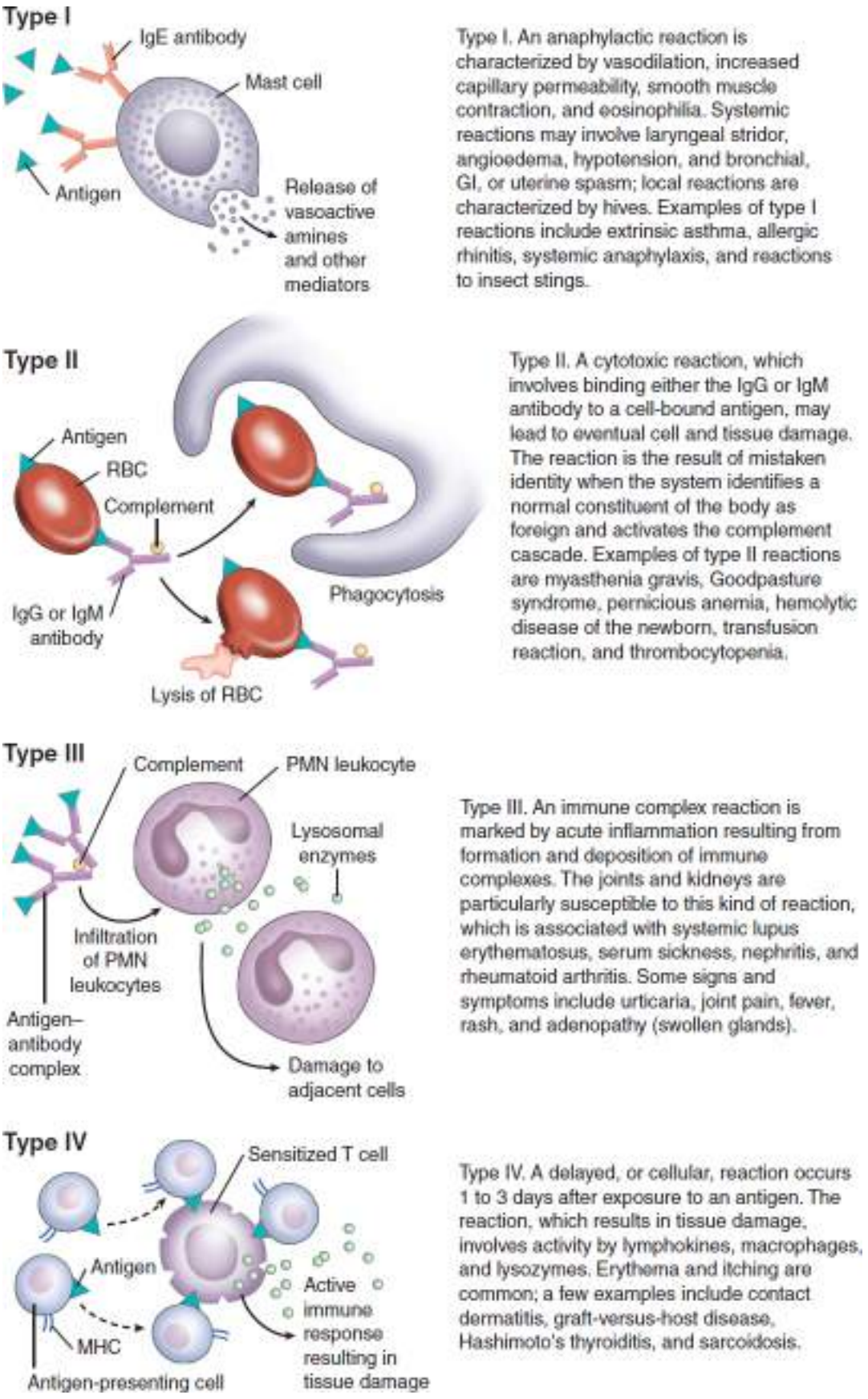


Figure 33-2 • Four types of hypersensitivity reactions. GI, gastrointestinal; Ig, immunoglobulin; PMN, polymorphonuclear;

RBC, red blood cell.

Assessment

A comprehensive allergy history and a thorough physical examination provide useful data for the diagnosis and management of allergic disorders. An allergy assessment form is useful for obtaining and organizing pertinent information (see Chart 33-1).

The degree of difficulty and discomfort experienced by the patient because of allergic symptoms and the degree of improvement in those symptoms with and without treatment are assessed and documented. The relationship of symptoms to exposure to possible allergens is noted.

Chart 33-1 ASSESSMENT

Allergy Assessment Form

Name _____ Age _____ Sex _____ Date _____

I. Chief complaint: _____

II. Present illness: _____

III. Collateral allergic symptoms: _____

Eyes: Pruritus _____ Burning _____ Lacrimation _____
Swelling _____ Injection _____ Discharge _____

Ears: Pruritus _____ Fullness _____ Popping _____
Frequent infections _____

Nose: Sneezing _____ Rhinorrhea _____ Obstruction _____
Pruritus _____ Mouth breathing _____
Purulent discharge _____

Throat: Soreness _____ Postnasal discharge _____
Palatal pruritus _____ Mucus in the morning _____

Chest: Cough _____ Pain _____ Wheezing _____
Sputum _____ Dyspnea _____
Color _____ Rest _____
Amount _____ Exertion _____

Skin: Dermatitis _____ Eczema _____ Urticaria _____

IV. Family allergies: _____

V. Previous allergic treatment or testing: _____

Prior skin testing: _____

Medications:

Antihistamines	Improved _____	Unimproved _____
Bronchodilators	Improved _____	Unimproved _____
Nose drops	Improved _____	Unimproved _____
Hyposensitization	Improved _____	Unimproved _____
Duration _____		
Antigens _____		
Reactions _____		
Antibiotics	Improved _____	Unimproved _____
Corticosteroids	Improved _____	Unimproved _____

VI. Physical agents and habits: _____

Tobacco for ____ years
Cigarettes ____ packs/day
Cigars ____ per day
Pipes ____ per day
Never smoked _____
Bothered by smoke _____

Bothered by:

Alcohol _____	Air-conditioning _____
Heat _____	Muggy weather _____
Cold _____	Weather changes _____
Perfumes _____	Chemicals _____
Paints _____	Hair spray _____
Insecticides _____	Newspapers _____
Cosmetics _____	Latex _____

VII. When symptoms occur: _____

Time and circumstances of 1st episode: _____

Prior health: _____

Course of illness over decades: progressing _____ regressing _____

Time of year: _____ Exact dates: _____

Perennial _____
Seasonal _____
Seasonally exacerbated _____

Monthly variations (menses, occupation): _____

Time of week (weekends vs. weekdays): _____

Time of day or night: _____

After insect stings: _____

VIII. Where symptoms occur: _____

Living where at onset: _____

Living where since onset: _____

Effect of vacation or major geographic change: _____

Symptoms better indoors or outdoors: _____

Effect of school or work: _____

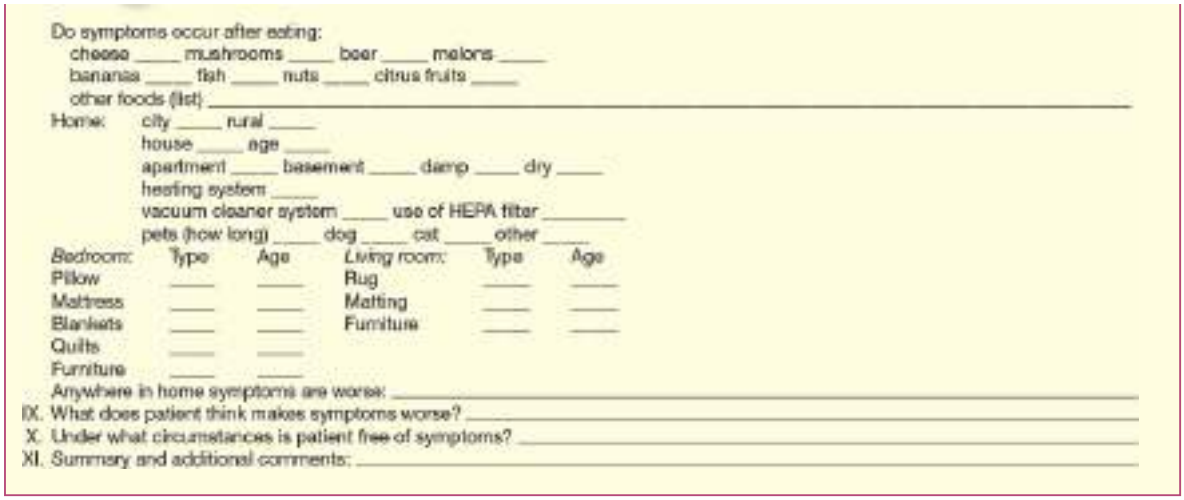
Effect of staying elsewhere nearby: _____

Effect of hospitalization: _____

Effect of specific environments: _____

Do symptoms occur around: _____

old leaves ____ hay ____ lakeside ____ barns _____
summer homes ____ damp basement ____ dry attic ____
lawn mowing ____ animals ____ other ____



Do symptoms occur after eating:
cheese ____ mushrooms ____ beer ____ melons ____
bananas ____ fish ____ nuts ____ citrus fruits ____
other foods (list) ____

Home: city ____ rural ____
house ____ age ____
apartment ____ basement ____ damp ____ dry ____
heating system ____
vacuum cleaner system ____ use of HEPA filter ____
pets (how long) ____ dog ____ cat ____ other ____

Bedroom:	Type	Age	Living room:	Type	Age
Pillow	____	____	Rug	____	____
Mattress	____	____	Matting	____	____
Blankets	____	____	Furniture	____	____
Quilts	____	____			
Furniture	____	____			

Anywhere in home symptoms are worse: ____

IX. What does patient think makes symptoms worse? ____
X. Under what circumstances is patient free of symptoms? ____
XI. Summary and additional comments: ____

Diagnostic Evaluation

Diagnostic evaluation of the patient with allergic disorders commonly includes blood tests, smears of body secretions, skin tests, and the serum-specific IgE test (formerly known as radioallergosorbent test [RAST]). Results of laboratory blood studies provide supportive data for various diagnostic possibilities; however, they are not the major criteria for the diagnosis of allergic disease (Kowal & DuBuske, 2017).

Complete Blood Count with Differential

The white blood cell (WBC) count is usually within normal limits except when infection and inflammation are present along with an allergic disorder. Eosinophils, which are granular leukocytes, normally make up 2% to 5% of the total number of WBCs. They can be found in blood, sputum, and nasal secretions. A level greater than 5% to 10% is considered abnormal and may be found in patients with allergic disorders (Kowal & DuBuske, 2017).

Eosinophil Count

An actual count of eosinophils can be obtained from blood samples or smears of secretions. During symptomatic episodes, smears obtained from nasal secretions and sputum of patients with allergies usually reveal an increase in eosinophils, indicating an active allergic response (Kowal & DuBuske, 2017).

Total Serum Immunoglobulin E Levels

High total serum IgE levels support the diagnosis of allergic disease. In the majority of cases, the antibody typically responsible for an allergic reaction

belongs to the IgE isotype. Patients with this disorder are said to have an IgE-mediated allergic disease (Kowal & DuBuske, 2017).

Skin Tests

Skin testing entails the intradermal injection or superficial application (epicutaneous) of solutions at several sites. Depending on the suspected cause of allergic signs and symptoms, many different solutions may be applied at separate sites. These solutions contain individual antigens representing an assortment of allergens most likely to be implicated in the patient's disease. Positive (wheal-and-flare) reactions are clinically significant when correlated with the history, physical findings, and results of other laboratory tests. Skin testing is considered the most accurate confirmation of allergy (Kowal & DuBuske, 2016).

The results of skin tests complement the data obtained from the history. They indicate which of several antigens are most likely to provoke symptoms and indicate the intensity of the patient's sensitization. The dosage of the antigen (allergen) injected is also important. Most patients are hypersensitive to more than one allergen. Under testing conditions, they may not react (although they usually do) to the specific allergens that induce their attacks.

When there is doubt about the validity of the skin tests, a serum-specific IgE test or a provocative challenge test may be performed. If a skin test is indicated, there is a reasonable suspicion that a specific allergen is producing symptoms in a patient with allergies. However, several precautionary steps must be observed before skin testing with allergens is performed:

- Testing is not performed during periods of bronchospasm.
- Epicutaneous tests (scratch or prick tests) are performed before other testing methods, in an effort to minimize the risk of systemic reaction.
- Emergency equipment must be readily available to treat anaphylaxis.

Types of Skin Tests

The methods of skin testing include prick skin tests, scratch tests, and intradermal skin testing. After negative prick or scratch tests, intradermal skin testing is performed with allergens that are suggested by the patient's history to be problematic. The back is the most suitable area of the body for skin testing because it permits the performance of many tests. A multitest applicator with multiple test heads is commercially available for simultaneous administration of antigens by multiple punctures at different sites. Research suggests that use of a multi-prong applicator for allergy testing decreases patient discomfort and application time (Pestotnik & Krueger, 2018). A negative response on a skin test cannot be interpreted as an absence of sensitivity to an allergen. Such a

response may occur with insufficient sensitivity of the test or with the use of an inappropriate allergen in testing. Therefore, it is essential to observe the patient undergoing skin testing for an allergic reaction even if the previous response was negative (Kowal & DuBuske, 2016).

Interpretation of Skin Test Results

Familiarity with and consistent use of a grading system are essential. The grading system used should be identified on a skin test record for later interpretation. A positive reaction, evidenced by the appearance of an urticarial wheal (round, reddened skin elevation) (see Fig. 33-3), localized **erythema** (diffuse redness) in the area of inoculation or contact, or pseudopodia (irregular projection at the end of a wheal) with associated erythema is considered indicative of sensitivity to the corresponding antigen. False-positive results may occur because of improper preparation or administration of allergen solutions (Kowal & DuBuske, 2016).

Quality and Safety Nursing Alert

Corticosteroids and antihistamines, including over-the-counter allergy medications, suppress skin test reactivity and should be stopped 48 to 96 hours before testing, depending on the duration of their activity. False-positive results may occur because of improper preparation or administration of allergen solutions.

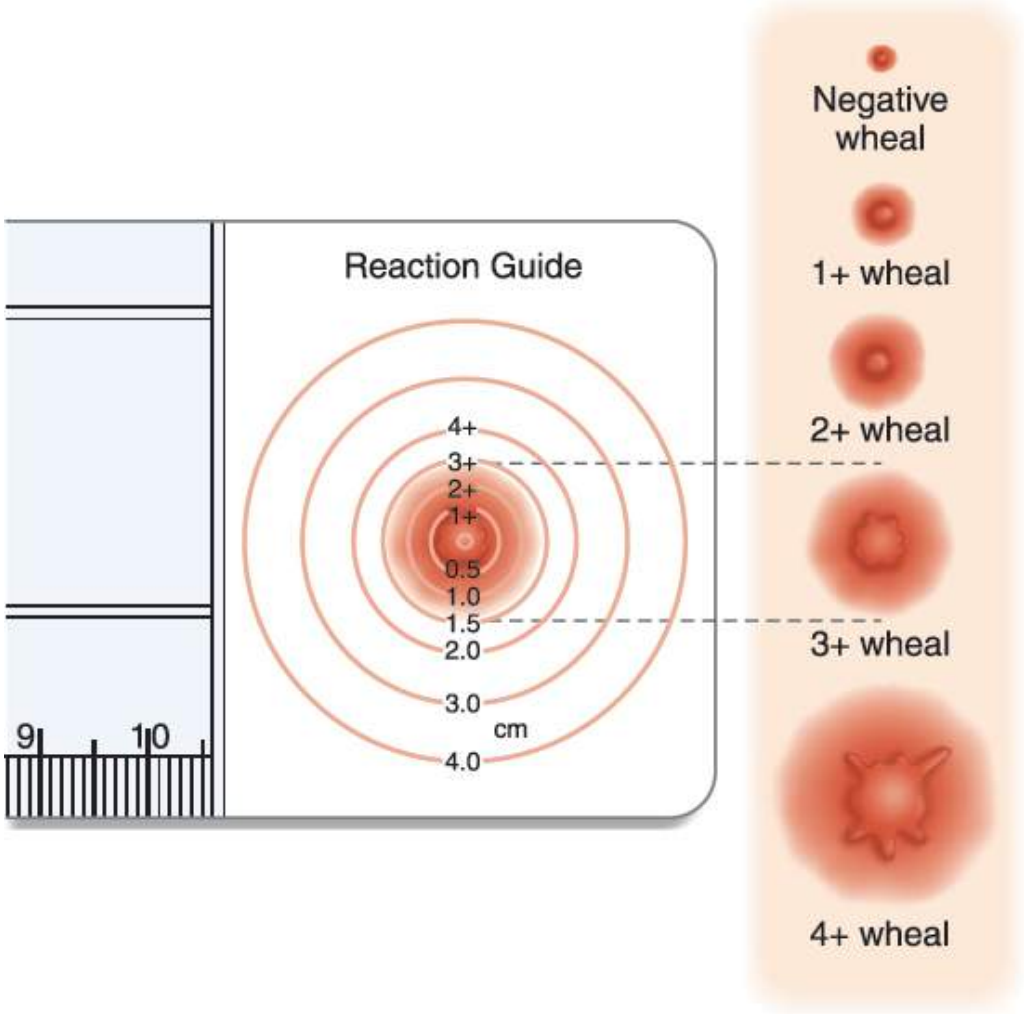


Figure 33-3 • Interpretation of reactions: Negative = wheal soft with minimal erythema; 1+ = wheal present (5 to 8 mm) with associated erythema; 2+ = wheal (7 to 10 mm) with associated erythema; 3+ = wheal (9 to 15 mm), slight pseudopodia possible with associated erythema; 4+ = wheal (12 mm+) with pseudopodia and diffuse erythema.

Positive or negative skin tests are interpreted in the context of a patient's history, clinical signs, and exposure to allergens. The following guidelines are used for the interpretation of skin test results:

- Skin tests are used most frequently with the diagnosis of allergic rhinitis.
- Negative test results are helpful in ruling out food allergy.
- Positive skin tests correlate highly with food allergy.

The use of skin tests to diagnose immediate hypersensitivity to medications is limited, because metabolites of medications, not the medications themselves, are usually responsible for causing hypersensitivity.

Provocative Testing

Provocative testing involves the direct administration of the suspected allergen to the sensitive tissue, such as the conjunctiva, nasal or bronchial mucosa, or gastrointestinal tract (by ingestion of the allergen), with observation of target organ response. This type of testing is helpful in identifying clinically significant allergens in patients who have a large number of positive tests. Major disadvantages of this type of testing are the limitation of one antigen per session and the risk of producing severe symptoms, particularly bronchospasm, in patients with asthma (Kowal & DuBuske, 2016).

Serum-Specific IgE Test

The serum-specific IgE test, formerly known as RAST, is an automated test performed on blood samples by a pathology laboratory. As the name suggests, it detects free antigen-specific IgE in serum as opposed to antigen-specific IgE bound to mast cells in the skin. The advantages of this test over other tests include decreased risk of systemic reaction, stability of antigens, and lack of dependence on skin reactivity modified by medications. The major disadvantages include limited allergen selection and reduced sensitivity compared with intradermal skin tests, lack of immediate results, and higher cost (Kowal & DuBuske, 2017).

ALLERGIC DISORDERS

There are two types of IgE-mediated allergic reactions: atopic and nonatopic disorders. Although the underlying immunologic reactions of the two types of disorders are the same, the predisposing factors and manifestations are different. Atopy is defined as the genetic predisposition to mount an IgE response to inhaled or ingested innocuous proteins. Atopic diseases consist of asthma, allergic rhinitis, and atopic dermatitis. All share a common pathogenesis, mediated by IgE, and are frequently present together in the same individual and in families. The nonatopic disorders lack the genetic component and organ specificity of the atopic disorders. Latex allergy (see later discussion) can present as an IgE-mediated anaphylaxis, type I reaction, or a type IV hypersensitivity referred to as contact dermatitis (Stokes & Casale, 2019).

Unfolding Patient Stories: Jennifer Hoffman • Part 2

Recall from Chapter 20 Jennifer Hoffman, who came to the clinic with continued symptoms of asthma. The nurse confirmed that she was following the asthma action plan; however, Jennifer now returns to the clinic with worsening symptoms. What assessment findings would indicate to the nurse that Jennifer is having a hypersensitivity reaction to an allergen(s)? What questions can assist the nurse in identifying the causative agent(s)? What interventions should be implemented when allergen(s) are identified?

Care for Jennifer and other patients in a realistic virtual environment: ***vSim*** *for Nursing* (**thepoint.lww.com/vSimMedicalSurgical**). Practice documenting these patients' care in DocuCare (**thepoint.lww.com/DocuCareEHR**).

Anaphylaxis

Anaphylaxis is a clinical response to an immediate (type I hypersensitivity) immunologic reaction between a specific antigen and an antibody. The reaction results from a rapid release of IgE-mediated chemicals, which can induce a severe, life-threatening reaction (Actor, 2019).

Pathophysiology

Anaphylaxis is a type I IgE allergic reaction to an antigen, a foreign substance that has entered the body. It is caused by the cross-links of an allergen with allergen-specific IgE antibodies found on the surface membrane of mast cells and basophils, leading to cellular degranulation. The subsequent release of histamine and other bioactive mediators causes activation of platelets, eosinophils, and neutrophils. Histamine, prostaglandins, and inflammatory leukotrienes are potent vasoactive mediators that are implicated in the vascular permeability changes, flushing, **urticaria** (hives), angioedema, hypotension, and bronchoconstriction that characterize anaphylaxis. Smooth muscle spasm, bronchospasm, mucosal edema and inflammation, and increased capillary permeability result. Symptoms of anaphylaxis are sudden in onset and progress in severity over minutes to hours (Kemp, 2018).

Closely resembling anaphylaxis is an anaphylactoid reaction, which is caused by the release of mast cell and basophil mediators triggered by non–immunoglobulin E (IgE)-mediated events. This nonallergenic anaphylaxis reaction may occur with medications, food, exercise, or cytotoxic antibody transfusions. The reaction may be local or systemic. Local reactions usually

involve urticaria and angioedema at the site of the antigen exposure. Although possibly severe, nonallergenic anaphylaxis reactions are rarely fatal. Systemic reactions occur within about 30 minutes after exposure and involve cardiovascular, respiratory, gastrointestinal, and integumentary organ systems. For the most part, the treatment of nonallergenic anaphylaxis reaction is identical to that of anaphylaxis (Campbell & Kelso, 2018).

Common causes of anaphylaxis are listed in Chart 33-2. Antibiotics and radiocontrast agents cause the most serious anaphylactic reactions. Penicillin is the most common medication to cause anaphylaxis. Approximately 10% of the population report having an allergy to penicillin. However, less than 5% have clinically significant IgE or T cell–mediated penicillin allergy (Shenoy, Macy, Rowe, et al., 2019).

Chart 33-2

Common Causes of Anaphylaxis

Foods

Peanuts, tree nuts (e.g., walnuts, pecans, cashews, almonds), shellfish (e.g., shrimp, lobster, crab), fish, milk, eggs, soy, wheat

Medications

Antibiotics, especially penicillin and sulfa antibiotics, allopurinol, radiocontrast agents, anesthetic agents (lidocaine, procaine), vaccines, hormones (insulin, vasopressin, adrenocorticotropic hormone), aspirin, nonsteroidal anti-inflammatory drugs

Other Pharmaceutical/Biologic Agents

Animal serums (tetanus antitoxin, snake venom antitoxin, rabies antitoxin), antigens used in skin testing

Insect Stings

Bees, wasps, hornets, yellow jackets, ants (including fire ants)

Latex

Medical and nonmedical products containing latex

Clinical Manifestations

Anaphylactic reactions produce a clinical syndrome that affects multiple organ systems. Reactions may be categorized as mild, moderate, or severe. The time from the exposure to the antigen to the onset of symptoms is a good indicator of the severity of the reaction—the faster the onset, the more severe the

reaction. The severity of previous reactions does not determine the severity of subsequent reactions, which could be the same or more or less severe. The severity depends on the degree of allergy and the dose of allergen exposure (Actor, 2019).

Mild systemic reactions consist of peripheral tingling and a sensation of warmth, possibly accompanied by a sensation of fullness in the mouth and throat. Nasal congestion, periorbital swelling, pruritus, sneezing, and tearing of the eyes can also be expected. The onset of symptoms begins within the first 2 hours after the exposure.

Moderate systemic reactions may include flushing, warmth, anxiety, and itching in addition to any of the milder symptoms. More serious reactions include bronchospasm and edema of the airways or larynx with dyspnea, cough, and wheezing. The onset of symptoms is the same as for a mild reaction (Kemp, 2018).

Severe systemic reactions have an abrupt onset with the same signs and symptoms described previously. These symptoms progress rapidly to bronchospasm, laryngeal edema, severe dyspnea, cyanosis, and hypotension. Dysphagia (difficulty swallowing), abdominal cramping, vomiting, diarrhea, and seizures can also occur. Cardiac arrest and coma may follow. Severe reactions are also referred to as anaphylactic shock (Marshall et al., 2018) (see Chapter 11).

Prevention

Strict avoidance of potential allergens is an important preventive measure for the patient at risk for anaphylaxis. Those at risk for anaphylaxis from insect stings should avoid areas populated by insects and should use appropriate clothing, insect repellent, and caution to avoid further stings.

If avoidance of exposure to allergens is impossible, an autoinjector system for epinephrine will be prescribed. The patient should be instructed to carry and administer epinephrine to prevent an anaphylactic reaction in the event of exposure to the allergen. People who are sensitive to insect bites and stings, those who have experienced food or medication reactions, and those who have experienced idiopathic or exercise-induced anaphylactic reactions should always carry an emergency kit that contains epinephrine. Autoinjection devices are commercially available for first aid and deliver premeasured doses of epinephrine (Comerford & Durkin, 2020). The autoinjector system requires no preparation, and the self-administration technique is not complicated. The patient must be given an opportunity to demonstrate the correct technique for use; a training device can be used for educating about the correct technique. Verbal and written information about the emergency kit, as well as strategies to avoid exposure to threatening allergens, must also be provided (Campbell & Kelso, 2018).

Screening for allergies before a medication is prescribed or first administered is an important preventive measure. A careful history of any sensitivity to suspected antigens must be obtained before administering any medication, particularly in parenteral form, because this route is associated with the most severe anaphylaxis. Nurses caring for patients in any setting (hospital, home, outpatient diagnostic testing sites, long-term care facilities) must assess patients' risks for anaphylactic reactions. Patients are asked about previous exposure to contrast agents used for diagnostic tests and any allergic reactions, as well as reactions to any medications, foods, insect stings, and latex. People who are predisposed to anaphylaxis should wear medical identification such as a bracelet or necklace, which identifies allergies to medications, food, and other substances.

People who are allergic to insect venom may require venom immunotherapy, which is used as a control measure and not a cure. The most common serious allergic reactions to insect stings are from the Hymenoptera family, which includes bees, ants, wasps, and yellow jackets (Warrell, 2019). Venom immunotherapy is an effective treatment for people with systemic reactions to an insect sting. It reduces the systemic reaction, reduces the risk of future large local reactions, and improves quality of life (Larsen, Broge, & Jacobi, 2016).

Patients with diabetes who are allergic to insulin and those who are allergic to penicillin may require desensitization. Desensitization is based on controlled anaphylaxis, with a gradual release of mediators. Patients who undergo desensitization are cautioned to avoid lapses in therapy, because this may lead to the reappearance of the allergic reaction when the use of the medication is resumed (Castells & Solensky, 2017).

Medical Management

Management depends on the severity of the reaction. Initially, respiratory and cardiovascular functions are evaluated. If the patient is in cardiac arrest, cardiopulmonary resuscitation (CPR) is instituted (Campbell & Kelso, 2018). Supplemental oxygen is provided during CPR or if the patient is cyanotic, dyspneic, or wheezing. Epinephrine, in a 1:1000 dilution, is given subcutaneously in the upper extremity or thigh and may be followed by a continuous intravenous infusion. Most adverse events associated with administration of epinephrine (i.e., adrenaline) occur when the dose is excessive or is given intravenously. Patients at risk for adverse effects include older patients and those with hypertension, arteriopathies, or known ischemic heart disease.

Antihistamines and corticosteroids should not be given in place of epinephrine. However, they may also be given as adjunct therapy (Campbell & Kelso, 2018).

Intravenous fluids (e.g., normal saline solution), volume expanders, and vasopressor agents are given to maintain blood pressure and normal hemodynamic status. In patients with episodes of bronchospasm or a history of bronchial asthma or chronic obstructive pulmonary disease, aminophylline and corticosteroids may also be given to improve airway patency and function. See Chapter 11 for management of anaphylactic shock.

Patients who have experienced anaphylactic reactions and received epinephrine should be transported to the local emergency department (ED) for observation and monitoring because of the risk for a "rebound" or delayed reaction 4 to 8 hours after the initial allergic reaction. However, the observation time should be individualized based on the severity of the anaphylaxis. Longer periods of observation should be considered for patients who ingested the allergen, required more than one dose of epinephrine, had hypotension or pharyngeal edema, or have a history of asthma (Lieberman, 2018).

Nursing Management

If a patient is experiencing an allergic response, the nurse assesses the patient for signs and symptoms of anaphylaxis. Airway, breathing pattern, and vital signs are assessed. The patient is observed for signs of increasing edema and respiratory distress. Prompt notification of the rapid response team, the provider, or both is required. Rapid initiation of emergency measures (e.g., intubation, administration of emergency medications, insertion of intravenous lines, fluid administration, and oxygen administration) is important to reduce the severity of the reaction and to restore cardiovascular function. The nurse documents the interventions used and the patient's vital signs and response to treatment (Campbell & Kelso, 2018).

The patient who has recovered from anaphylaxis needs to be educated about what occurred, how to avoid future exposure to antigens, and how to administer emergency medications to treat anaphylaxis. The nurse assesses the health literacy level of the patient and determines the best method of providing discharge instructions (Wilkin, 2020). See the Nursing Research Profile in Chart 33-3.

Patients who have experienced an anaphylactic reaction should receive a prescription for an autoinjectable epinephrine device. The nurse educates the patient and family in their use and has the patient and family return demonstrate correct administration (Moore, Kemp, & Kemp, 2015) (see Chart 33-4).

Chart 33-3 NURSING RESEARCH PROFILE

Using Video Discharge Instructions

Wilkin, Z. L. (2020). Effects of video discharge instructions on patient understanding. *Advanced Emergency Nursing Journal*, *42*(1), 71–78.

Purpose

Patients have difficulty understanding and retaining education at the time of discharge, particularly if instructions are given only in the form of printed materials. The purpose of this study was to evaluate the effects of using video discharge instructions on patient understanding of the education provided upon discharge from an emergency department (ED).

Design

This was a prospective, randomized, controlled trial that used a convenience sample of patients admitted to the ED. Participants were randomized to receive either standard discharge procedures, or standard discharge procedures plus video discharge instructions. Ten minutes after receiving one of the education methods, participants were tested with a 5-question multiple choice test.

Findings

Participants included 60 adults with a mean age of 37 years, and with a medical diagnosis of either upper respiratory infection, pharyngitis, or gastroenteritis. Thirty participants received the video discharge instructions, while the other 30 received the standard discharge procedure. There was a significant difference in knowledge level, with those receiving the video instructions having a higher level of knowledge (4.53 vs. 4, $p = 0.009$) on the multiple choice test.

Nursing Implications

This study provides evidence that video discharge instructions have the potential to increase the knowledge level of patients receiving discharge education. Nurses who work in busy settings, such as EDs, should consider developing supplemental materials to augment standard written discharge instructions to help increase patients' understanding and retention of important information.

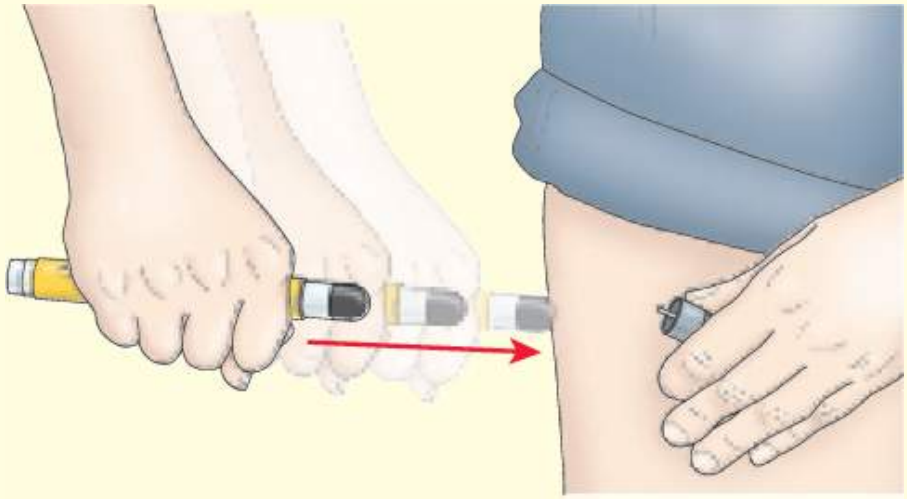
Chart 33-4 PATIENT EDUCATION

Self-Administration of Epinephrine

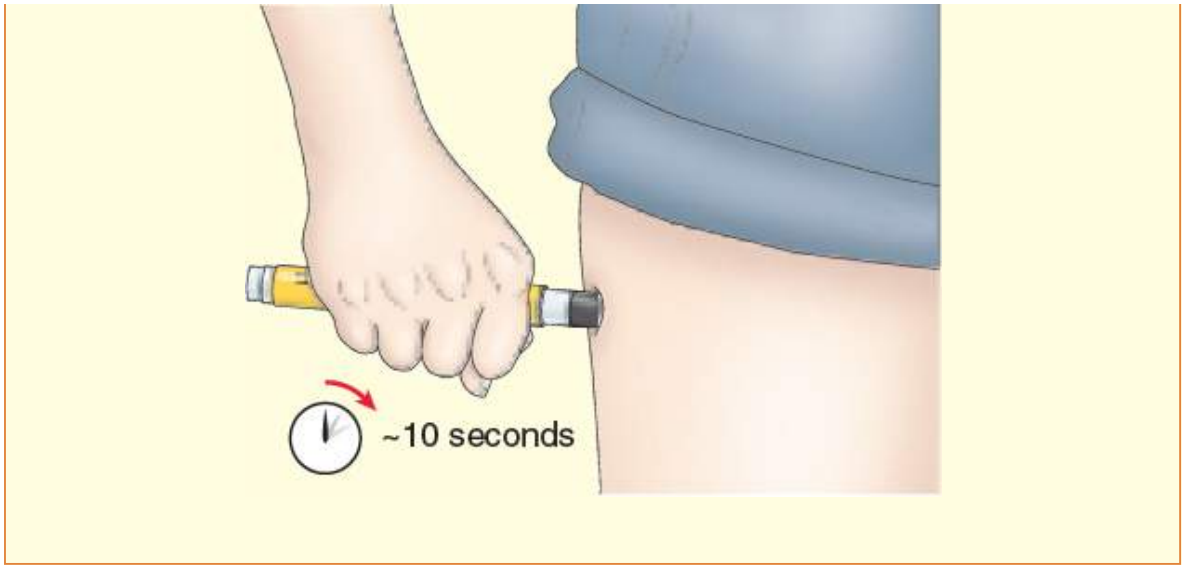
The nurse instructs the patient to:

1. After removing the autoinjector from its carrying tube, grasp the unit with the orange tip (injecting end) pointing downward. Form a fist around the unit with the orange tip down; with your other hand, remove the blue safety release cap.

2. Hold the black tip near outer thigh. Swing and jab firmly into the outer thigh until a click is heard with the device perpendicular (90-degree angle) to the thigh. Do NOT inject into buttocks.



3. Hold firmly against the thigh for approximately 10 seconds. Remove the unit from the thigh, and gently massage the injection area for 10 seconds. Call 911 and seek immediate medical attention. Carefully place the used autoinjector unit, needle-end first, into the device storage tube without bending the needle. Screw on the storage tube completely, and take it with you to the hospital emergency room.



Allergic Rhinitis

Allergic rhinitis (hay fever, seasonal allergic rhinitis) is the most common form of respiratory allergy, which is mediated by an immediate (type I hypersensitivity) immunologic reaction. In the United States approximately 20 million adults have allergic rhinitis (CDC, 2017). Early diagnosis and adequate treatment are essential to reduce complications and relieve symptoms.

Because allergic rhinitis is induced by airborne pollens or molds, it is characterized by the following seasonal occurrences (deShazo & Kemp, 2018a):

- Early spring—tree pollen
- Early summer—grass pollen
- Early fall—weed pollen (ragweed)

Each year, attacks begin and end at about the same time. Airborne mold spores require warm, damp weather. Although there is no rigid seasonal pattern, these spores appear in early spring, are rampant during the summer, then taper off and disappear by the first frost in areas that experience dramatic seasonal temperature variation. In temperate areas that do not experience freezing temperatures, these allergens, especially mold, can persist throughout the year.

Pathophysiology

Allergic rhinitis is caused by an allergen-specific IgE-mediated immunologic response. Sensitization most commonly begins by inhalation of antigen. IgE antibodies are stimulated and bind to mast cells in the respiratory mucosa, basophils in the peripheral blood, and eosinophils in the nasal and respiratory mucosa. Eosinophilia in the tissues is the key characteristic of allergic rhinitis.

When IgE antibodies bind to mast cells there is histamine release. Histamine is the major mediator of allergic reactions in the nasal mucosa. Inflammation, tissue edema, vasodilation, and increased capillary permeability occur (deShazo & Kemp, 2017).

Clinical Manifestations

Symptoms include sneezing, rhinorrhea, nasal itching, conjunctivitis, and nasal obstruction. Postnasal drip, cough, itching of the eyes, and fatigue are often present. If symptoms are severe, allergic rhinitis may interfere with sleep, leisure, school, work, and overall quality of life. Allergic rhinitis is commonly associated with chronic sinusitis, atopic dermatitis (eczema), and asthma. Infraorbital edema and dilation of peripheral vessels (due to histamine) can cause darkening under the eyes, sometimes referred to as "allergic shiners." A horizontal nasal crease can develop from constant rubbing of the nose; commonly referred to as the "allergic salute." The nasal mucosa can exhibit a grayish hue. Clear rhinorrhea, tonsillar hyperplasia, and postnasal rhinorrhea may be visible on examination of the throat. Tympanic membranes can be retracted or serous fluid may accumulate in the middle ear. Some patients can suffer oral allergy syndrome (OAS) with itching and irritation of the hard and soft palate. Allergic rhinitis and sinusitis can trigger migraine headache in some patients (deShazo & Kemp, 2018a).

Assessment and Diagnostic Findings

Diagnosis of seasonal allergic rhinitis is mainly based on history and physical examination. Blood or laboratory testing is usually unnecessary. Diagnostic testing can be done with immediate hypersensitivity skin testing (skin prick testing). In sensitive patients, testing with select diagnostic solutions of tree, grass, or weed pollen, mold, house dust mites, and animal allergens results in a wheal-and-flare reaction at the skin test site within 20 minutes. IgE immunoassay can provide similar information to skin prick test. Nasal cytology can be performed to differentiate rhinitis due to allergy from that due to infection, although it is relatively nonspecific and insensitive (deShazo & Kemp, 2018a).

Medical Management

The goal of therapy is to provide relief from symptoms. Therapy may include one or all of the following interventions: avoidance therapy, pharmacologic therapy, and immunotherapy. Verbal instructions must be reinforced by written information. Knowledge of general concepts regarding assessment and therapy

in allergic diseases is important so that the patient can learn to manage certain conditions as well as prevent severe reactions and illnesses.

Avoidance Therapy

In avoidance therapy, every attempt is made to remove the allergens that act as precipitating factors. Simple measures and environmental controls are often effective in decreasing symptoms. Examples include the use of air conditioners, air cleaners, humidifiers, and dehumidifiers; removal of dust-catching furnishings, carpets, and window coverings; removal of pets from the home or bedroom; the use of pillow and mattress covers that are impermeable to dust mites; and a smoke-free environment (Platts-Mills, 2019). Additional measures include changing clothing when coming in from outside, showering to wash allergens from hair and skin, and using an over-the-counter nasal irrigation device or saline nasal spray to reduce allergens in the nasal passages Because multiple allergens are often implicated, multiple measures to avoid exposure to allergens are often necessary. High-efficiency particulate air (HEPA) purifiers and vacuum cleaner filters may also be used to reduce allergens in the environment (Platts-Mills, 2019). Multiple avoidance strategies tailored to a person's risk factors can reduce the severity of symptoms, the number of work or school days missed because of symptoms, and the number of unscheduled health care visits for treatment. In many cases, it is impossible to avoid exposure to all environmental allergens, so pharmacologic therapy or immunotherapy is needed.

Pharmacologic Therapy

Many antihistamines, corticosteroid nasal sprays, adrenergic agents, mast cell stabilizers, nasal decongestant sprays, and corticosteroids are pharmacologic agents used in allergic rhinitis.

Antihistamines

First-generation antihistamines, which are readily absorbed, are most effective when administered orally at the first occurrence of symptoms because they prevent the development of new symptoms. Diphenhydramine is a common first-generation antihistamine available in over-the-counter (OTC) medications. Others include chlorpheniramine and hydroxyzine. First-generation antihistamines bind to histamine 1 receptors and can effectively relieve symptoms of hay fever, vasomotor rhinitis, urticaria (hives), and mild asthma. However, first-generation antihistamines cross the blood–brain barrier and cause significant sedation which impairs cognitive function and psychomotor performance. First-generation antihistamines can also have anticholinergic effects such as dry mouth, blurry vision, urinary hesitancy, and confusion. Due to their anticholinergic effects, first-generation antihistamines

should be avoided in older adults (Fick, Semla, Steinman, et al., 2019). First-generation antihistamines have a limited role in the treatment of allergy due to their adverse effects (deShazo & Kemp, 2018b).

Second-generation (nonsedating H_1-receptor antagonists) are antihistamines that do not cross the blood–brain barrier to the same extent as first-generation antihistamines. They mainly bind to peripheral rather than central nervous system H_1 receptors, causing less sedation. Examples of these OTC medications are loratadine, cetirizine, and fexofenadine (Sanchez-Borges & Ansotegui, 2019). Contraindications, major side effects, nursing implications, and patient education for select H_1 antihistamines can be found in Table 33-2.

If H_1 antihistamines are not completely effective, H_2 antihistamines such as famotidine, which blocks the H_2 receptors found in the stomach, vascular smooth muscle, and elsewhere, can be added to the drug regimen. It is given twice a day with the same total dose as for gastroesophageal reflux. H_2 antihistamines do not relieve urticaria on their own, but can augment the effect of H_1 antihistamines (Randall & Hawkins, 2018).

Antihistamines may also be combined with decongestants to reduce the nasal congestion associated with allergies. Most combination products are available as OTC medications; examples are loratadine/pseudoephedrine and cetirizine/pseudoephedrine. Decongestants can cause an increase in blood pressure; therefore, patients with a history of hypertension should be cautioned about long-term use of any medication that contains decongestants (Randall & Hawkins, 2018). Decongestants are contraindicated in patients receiving monoamine oxidase inhibitor therapy and should be used with caution in patients with closed-angle glaucoma, cardiovascular or cerebrovascular disease, hyperthyroidism, or bladder neck obstruction.

Antihistamine nasal sprays azelastine and olopatadine are available by prescription. They not only reduce inflammation and decrease nasal congestion, but also have rapid onset of action and can be used "on demand" (deShazo & Kemp, 2018b).

Corticosteroid Nasal Spray

Corticosteroid nasal sprays are recognized as the most effective pharmacotherapy for allergic rhinitis. These anti-inflammatory agents work directly on the nasal mucosa but take a few hours to work. The patient should understand that maximal therapeutic effectiveness of these agents can take 1 to 2 weeks. They are recommended as the best single therapy for patients with mild to moderate or moderate to severe symptoms (Berger & Melizer, 2015).

Corticosteroid nasal sprays are derived from hydrocortisone and are divided into first-generation and second-generation agents. Beclomethasone, flunisolide, triamcinolone, and budesonide are first-generation agents, whereas

flucatisone, mometasone, and ciclesonide are second-generation agents (deShazo & Kemp, 2018b).

Corticosteroid nasal spray therapy should begin with the maximal dose for patient age. Once patient symptoms are adequately controlled, the dose can be reduced at 1-week intervals to the lowest effective dose that controls symptoms. Patients with severe symptoms usually need daily use of the nasal spray. Some patients may find relief of symptoms with use of the nasal spray every other day or as needed. Newer second-generation corticosteroid spray preparations act rapidly (within 3 to 12 hours), and as-needed use appears to be effective. This kind of treatment may be adequate in patients with episodic symptoms (deShazo & Kemp, 2018b).

Adverse effects of corticosteroid nasal sprays are mild and include drying of the nasal mucosa and burning and itching sensations caused by the vehicle used to administer the medication. Beclomethasone, budesonide, flunisolide, and triamcinolone are deactivated rapidly after absorption, so they do not achieve significant blood levels. Inhaled corticosteroids do not affect the immune system to the same degree as systemic corticosteroids (i.e., oral corticosteroids). Because corticosteroids are inhaled into the upper respiratory tract, tuberculosis or untreated bacterial infections of the lungs may become apparent and progress. Whenever possible, patients with tuberculosis or other bacterial infections of the lungs should avoid corticosteroid nasal sprays (deShazo & Kemp, 2018b).

The combination of an antihistamine and a corticosteroid nasal spray may be helpful for patients who do not obtain sufficient relief with one agent. A combination spray containing azelastine and fluticasone is available (deShazo & Kemp, 2018b).

Adrenergic Agents

Alpha-adrenergic agonist (also called sympathomimetic) medications, such as pseudoephedrine, can be used as decongestants in allergies. These agents activate alpha-adrenergic receptor sites on the smooth muscle causing vasoconstriction of the nasal mucosal blood vessels, reducing local blood flow, fluid exudation, and mucosal edema. Oral alpha-adrenergic medications have a systemic effect and are not recommended as first-line treatment of allergic rhinitis (Laccourreye, et al., 2015). Oral alpha-adrenergic agents are also available in combination with antihistamines (e.g., diphenhydramine and pseudoephredine fexofenadine and pseudoephedrine). Alpha-adrenergic topical nasal spray (e.g., oxymetazoline) is also available. Alpha-adrenergic agonist ophthalmic drops, such as tetrahydrozoline, are commonly used for allergic conjunctivitis as they vasoconstrict the blood vessels of the eye.

There are many potential side effects of oral alpha-adrenergic agonists. These include hypertension, arrhythmias, palpitations, central nervous system stimulation, irritability, tremor, and tachyphylaxis. Oral adrenergic agents are

not first-line agents in allergy and have potential for cardiovascular and neurological adverse effects (deShazo & Kemp, 2018b). The topical preparations (i.e., drops and sprays) of alpha-adrenergic agonists cause fewer side effects than oral medications; however, the use of drops and sprays should be limited to a few days to avoid rebound congestion, also referred to as rhinitis medicamentosa.

The Combat Methamphetamine Epidemic Act of 2005 banned OTC sales of medications that contain the ingredients pseudoephedrine, ephedrine, or phenylpropanolamine as these can be used to make methamphetamine, a highly addictive stimulant. Laws to enforce this act vary state by state. There is a legal age requirement to purchase these drugs and pharmacists must limit and keep records of the amount purchased. Some states require a prescription (U.S. Food and Drug Administration [FDA], 2017).

TABLE 33-2 Select H_1 Antihistamines

H_1 Antihistamine	Contraindications	Major Side Effects	Nursing Implications and Patient Education
First-Generation H_1 Antihistamines (Sedating)			
Diphenhydramine	Allergy to any antihistamines Third trimester of pregnancy Lactation Use cautiously with narrow-angle glaucoma, asthma, stenosing peptic ulcer, benign prostatic hyperplasia (BPH) or bladder neck obstruction, first and second trimester of pregnancy, older patients, hypertension	Drowsiness, confusion, dizziness, dry mouth, nausea, vomiting, photosensitivity, urinary retention	Administer with food if gastrointestinal (GI) upset occurs. Caution patients to avoid alcohol, driving, or engaging in any hazardous activities until central nervous system (CNS) response to medication is stabilized. Suggest sucking on sugarless lozenges or ice chips for relief of dry mouth. Encourage the use of sunscreen and hat while outdoors. Assess for urinary retention; monitor urinary output.
Chlorpheniramine	Allergy to any antihistamines Third trimester of pregnancy Lactation Use cautiously with narrow-angle glaucoma, asthma, stenosing peptic ulcer, BPH or bladder neck obstruction, first and second trimesters of pregnancy, older patients, hypertension	Drowsiness, sedation, and dizziness, although less than other sedating agents; confusion, dry mouth, nausea, vomiting, urinary retention, epigastric distress, thickening of bronchial secretions	Caution patients to avoid alcohol, driving, or engaging in any hazardous activities until CNS response to medication is stabilized. Suggest sucking on sugarless lozenges or ice chips for relief of dry mouth. Recommend the use of a humidifier.
Hydroxyzine	Allergy to hydroxyzine or cetirizine, pregnancy, lactation, hypertension	Drowsiness; dry mouth; involuntary motor activity, including	Caution patients to avoid alcohol, driving, or engaging in any hazardous activities until CNS response to medication is stabilized. Suggest sucking

		tremor and seizures	on sugarless lozenges or ice chips for relief of dry mouth. Instruct patients to report tremors.
Second-Generation H_1 Antihistamines (Nonsedating)			
Cetirizine	Allergy to any antihistamines Narrow-angle glaucoma Asthma Stenosing peptic ulcer BPH or bladder neck obstruction Lactation Hypertension	Dry nasal mucosa, thickening of bronchial secretions	Can be taken without regard to meals. Instruct patients to use caution if driving or performing tasks that require alertness. Recommend the use of a humidifier.
Desloratadine	Allergy to loratadine Lactation Use cautiously with renal or hepatic impairment, pregnancy, hypertension	Somnolence, nervousness, dizziness, fatigue, dry mouth	Can be taken without regard to meals. Suggest sucking on sugarless lozenges or ice chips for relief of dry mouth. Recommend the use of a humidifier.
Loratadine	Allergy to any antihistamines Narrow-angle glaucoma Asthma Stenosing peptic ulcer BPH or bladder neck obstruction Hypertension	Headache, nervousness, dizziness, depression, edema, increased appetite	Instruct patients to take on empty stomach (1 h before or 2 h after meals or food). Instruct patients to avoid alcohol and to use caution if driving or performing tasks that require alertness. Suggest sucking on sugarless lozenges or ice chips for relief of dry mouth. Recommend the use of a humidifier.
Fexofenadine	Allergy to any antihistamines Pregnancy Lactation Use cautiously with hepatic or renal impairment, older patients, hypertension	Fatigue, drowsiness, GI upset	Should not be given within 15 min of ingestion of antacids. Instruct patients to use caution if driving or performing tasks that require alertness. Recommend the use of a humidifier.
Levocetirizine	Hypersensitivity to	Drowsiness, GI	Can be taken without regard

	any antihistamines End-stage kidney disease Hemodialysis Use cautiously with pregnancy, lactation, older patients	disturbance, headache	to meals. Instruct patients to use caution if driving or performing tasks that require alertness. Recommend the use of a humidifier.

Adapted from Comerford, K. C., & Durkin, M. T. (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer.

Mast Cell Stabilizers

Intranasal cromolyn sodium is a spray that acts by stabilizing the mast cell membrane, thus reducing the release of histamine and other mediators of the allergic response. In addition, it inhibits macrophages, eosinophils, monocytes, and platelets involved in the immune response. Cromolyn interrupts the physiologic response to nasal antigens, and it is used prophylactically (before the exposure to allergens) to prevent the onset of symptoms and to treat symptoms once they occur. It is also used therapeutically in chronic allergic rhinitis. This spray is as effective as antihistamines but is less effective than corticosteroid nasal sprays in the treatment of seasonal allergic rhinitis. It is best to use this agent 30 minutes prior to exposure to allergen. Frequent use is necessary to obtain an effect (1 to 2 nasal sprays 4 times per day). The patient must be informed that the beneficial effects of the medication may take a week or longer to manifest. The medication is of no benefit in the treatment of nonallergic rhinitis. Adverse effects (e.g., sneezing, local stinging and burning sensations) are usually mild (deShazo & Kemp, 2018b).

Nasal Decongestant Sprays

Nasal decongestant sprays include phenylephrine, oxymetazoline, and naphazoline. These agents vasoconstrict blood vessels in the nasal mucosa by blocking alpha-adrenergic receptors. Nasal decongestant sprays are not recommended as monotherapy. After using these agents for 3 to 7 days, reduced sensitivity of alpha-adrenergic receptors develops which can cause worsening nasal congestion. This effect of worsening nasal congestion often causes patients to overuse these agents with less and less therapeutic effect. This is termed rhinitis medicamentosa and can lead to increased need for the agent and eventual dependency (Wahid & Shermetaro, 2019).

The combination of a topical nasal decongestant and topical corticosteroid may effectively treat symptoms without causing rhinitis medicamentosa. Nasal decongestants are helpful when used just before air travel in patients who have difficulties with middle ear or sinus equilibration with flying or in patients who have problems with altitude changes (deShazo & Kemp, 2018b).

Corticosteroids

Oral and parenteral corticosteroids can be used when conventional therapy has failed and symptoms are severe and of short duration. They can control symptoms of allergic reactions such as hay fever, medication-induced allergies, and allergic reactions to insect stings. However, corticosteroids have a delayed onset of action and cannot be used for immediate relief of allergic symptoms. The agents are not effective as singular treatment for severe allergic reactions such as anaphylaxis (deShazo & Kemp, 2018b). Oral corticosteroids in the lowest dose to control symptoms for the shortest period of time may be prescribed if other agents fail. However, corticosteroids are usually avoided because of their side effects.

Quality and Safety Nursing Alert

Patients who receive high-dose or long-term corticosteroid therapy must be cautioned not to stop taking the medication suddenly. Doses are tapered when discontinuing this medication to avoid adrenal insufficiency.

The patient should be cautioned about side effects, which include fluid retention, weight gain, hypertension, gastric irritation, glucose intolerance, osteoporosis, immunosuppression, and adrenal suppression. Further discussion of corticosteroids is provided in Chapter 45, Table 45-3.

Leukotriene Receptor Antagonists

Leukotrienes are inflammatory mediators that cause bronchospasm, vascular permeability, and activation of leukocytes. They are three to four times more potent than histamine in perpetuating inflammation in the upper respiratory tract (Castells, 2017). Leukotriene receptor antagonists (LTRAs), such as zafirlukast and montelukast, block the synthesis or action of leukotrienes and prevent the signs and symptoms associated with asthma (see Table 33-3). LTRAs are also used to counteract allergic rhinitis.

Montelukast efficacy has been compared to a second-generation antihistamine agent. In combination with a second-generation antihistamine such as loratadine, montelukast has shown to be more effective than montelukast alone. Adverse effects of montelukast include neuropsychiatric changes such as anxiety, depression, and insomnia. This agent may be not appropriate for patients with preexisting mood disorders (Badri & Takov, 2019).

Leukotriene receptor antagonists are for long-term use, and patients should be advised to take their medication daily. LTRAs are not effective as "rescue" medications. Patients take appropriate "rescue" medications for symptom

exacerbation but continue to take the LTRA on a daily basis. Studies report that using an LTRA in conjunction with an inhaled corticosteroid is effective for mild persistent asthma (Chauchan, Jeyaraman, Singh Mann, et al., 2017).

Allergen Immunotherapy

Allergen immunotherapy (AIT) is primarily used to treat IgE-mediated diseases by injections of allergen extracts. Immunotherapy, also referred to as allergy vaccine therapy, involves the administration of gradually increasing quantities of specific allergens to the patient until a dose is reached that is effective in reducing disease severity from natural exposure. This is an effective treatment for 80% to 90% of certain allergens such as grass and pollen. This type of therapy provides an adjunct to symptomatic pharmacologic therapy and can be used when avoidance of allergens is not possible. Specific immunotherapy has been used in the treatment of allergic disorders for many years. Goals of immunotherapy include reducing the level of circulating IgE, increasing the level of blocking antibody IgG, and reducing mediator cell sensitivity. Immunotherapy has been most effective for ragweed pollen, grass, tree pollen, cat dander, and house dust mite allergens (Akdis, 2018). Indications and contraindications for immunotherapy are presented in Chart 33-5.

TABLE 33-3 Leukotriene Receptor Antagonists

Leukotriene Receptor Antagonist	Available Formulations	Frequency of Dosing
Zafirlukast	Tablets: 10 mg; 20 mg	Taken twice a day
Montelukast	Tablets: 10 mg Chewable tablets: 4 mg; 5 mg Granules: 4 mg/packet	Taken once a day in PM
Zileuton	Tablets: 600 mg extended release	Taken twice a day within 1 h after morning and evening meals

Chart 33-5

IMMUNOTHERAPY: Indications and Contraindications

Indications

- Allergic rhinitis, conjunctivitis, or allergic asthma
- History of a systemic reaction to Hymenoptera and specific immunoglobulin E antibodies to Hymenoptera venom
- Desire to avoid the long-term use, potential adverse effects, or costs of medications
- Lack of control of symptoms by avoidance measures or the use of medications

Contraindications

- The use of beta-blocker or angiotensin-converting enzyme inhibitor therapy, which may mask early signs of anaphylaxis
- Presence of significant pulmonary or cardiac disease or organ failure
- Inability of the patient to recognize or report signs and symptoms of a systemic reaction
- Nonadherence of the patient to other therapeutic regimens and nonlikelihood that the patient will adhere to the immunization schedule (often weekly for an indefinite period)
- Inability to monitor the patient for at least 30 minutes after administration of immunotherapy
- Absence of equipment or adequate personnel to respond to allergic reaction if one occurs

Correlation of a positive skin test with a positive allergy history is an indication for immunotherapy if the allergen cannot be avoided. The benefit of immunotherapy has been fairly well established in instances of allergic rhinitis and bronchial asthma that are clearly due to sensitivity to one of the common pollens, molds, or household dust. Unlike antiallergy medication, allergen immunotherapy has the potential to alter the allergic disease course after 3 to 5 years of therapy. Because it may prevent the progression or development of asthma or multiple or additional allergies, it is also considered to be a potential preventive measure. The patient must understand what to expect and the importance of continuing therapy for several years before immunotherapy is accomplished. When skin tests are performed, the results are correlated with symptoms; treatment is based on the patient's needs rather than on the results of skin tests (Klimek, Pfaar, Bousquet, et al., 2017).

There are three methods of immunotherapy: subcutaneous immunotherapy (SCIT), sublingual immunotherapy (SLIT), and epicutaneous immunotherapy (EPIT).

Subcutaneous Immunotherapy

The most common method of treatment is SCIT, which consists of the serial injection of one or more antigens that are selected in each particular case on the basis of skin testing. This method provides a simple and efficient technique for targeting IgE antibodies to specific antigens. Specific treatment consists of injecting extracts of the allergens that cause symptoms in a particular patient. Injections begin with very small amounts and are gradually increased, usually at weekly intervals, until a maximum tolerated dose is attained. Although severe systemic reactions are rare, the risk of systemic and potentially fatal anaphylaxis exists. It tends to occur most frequently at the induction or "up-dosing" phase. Therefore, the patient must be monitored after administration of immunotherapy. Because of the risk of anaphylaxis, injections should not be given by a lay person or by the patient. The patient must remain in the office or clinic for at least 30 minutes after the injection and is observed for possible systemic symptoms. If a large, local swelling develops at the injection site, the next dose should not be increased, because this may be a warning sign of a possible systemic reaction (James & Bernstein, 2017).

Maintenance booster injections are given at 2- to 4-week intervals, frequently for a period of several years, before the maximum benefit is achieved, although some patients will note early improvement in their symptoms. Long-term benefit seems to be related to the cumulative dose of vaccine given over time (Nelson, 2018).

Quality and Safety Nursing Alert

Because the injection of an allergen may induce systemic reactions, such injections are given only in a setting where epinephrine is immediately available (i.e., primary provider's office, clinic).

Sublingual Immunotherapy

SLIT has been reported to have a 30% to 40% reduction in reactions and rescue medication usage in seasonal allergic rhinitis. Administration of SLIT includes a buildup phase that is followed by a treatment plan of three times per week with a rapid dissolving tablet or liquid containing allergen extracts. Recent studies show comparable efficacy of SLIT with SCIT (Chaaban, Mansi, Tripple, et al., 2019; Durham & Penagos, 2016). Systemic side effects are rare but have been reported in patients who also report systemic reactions with SCIT. Side effects include irritation, minor swelling or itching inside the mouth, and stomach upset and nausea.

Epicutaneous Immunotherapy

EPIT is an investigational alternative allergen immunotherapy with delivery of the allergen to the epidermis. Because the epidermis is less vascular, it is theorized that there is reduced risk of systemic allergic side effect. Epicutaneous allergen patches are applied to the upper inner arm or interscapular region of the back. Doses are lower than those used in SCIT or SLIT. The allergen is soluble and absorbed into the skin. Adverse reactions include localized erythema, pruritus, and urticaria at the site of allergen patch. Studies of EPIT have shown modest results compared to placebo, and there has been a higher rate of treatment-related mild to moderate anaphylactic reactions. Long-term studies of EPIT are currently in progress for peanut allergies (Nowak-Wegrzyn, 2019).

Immunotherapy should not be initiated during pregnancy; for patients who have been receiving immunotherapy before pregnancy, the dosage should not be increased during pregnancy.

Therapeutic failure is evident when a patient does not experience a decrease of symptoms within 12 to 24 months, fails to develop increased tolerance to known allergens, and cannot decrease the use of medications to reduce symptoms. Potential causes of treatment failure include misdiagnosis of allergies, inadequate doses of allergen, newly developed allergies, and inadequate environmental controls (Akdis, 2018).

NURSING PROCESS

The Patient with Allergic Rhinitis

Assessment

The examination and history of the patient reveal sneezing, often in paroxysms; thin and watery nasal discharge; itching eyes and nose; lacrimation; and occasionally headache. The health history includes a personal or family history of allergy. The allergy assessment identifies the nature of antigens, seasonal changes in symptoms, and medication history. The nurse also obtains subjective data about how the patient feels just before symptoms become obvious, such as the occurrence of pruritus, breathing problems, and tingling sensations. In addition to these symptoms, hoarseness, wheezing, hives, rash, erythema, and edema are noted. Any relationship between emotional problems or stress and the triggering of allergy symptoms is assessed (Kakli & Riley, 2016).

Diagnosis

Nursing Diagnoses

Based on the assessment data, major nursing diagnoses may include:

- Impaired breathing associated with allergic reaction
- Lack of knowledge about allergy and the recommended modifications in lifestyle and self-care practices
- Difficulty coping with chronicity of condition and need for environmental modifications

Collaborative Problems/Potential Complications

Potential complications may include the following:

- Anaphylaxis
- Impaired breathing
- Nonadherence to the therapeutic regimen

Planning and Goals

The goals for the patient may include restoration of a breathing pattern that provides adequate ventilation, increased knowledge about the causes and control of allergic symptoms, improved coping with alterations and modifications, and absence of complications.

Nursing Interventions

Improving Breathing Pattern

The patient is instructed and assisted to modify the environment to reduce the severity of allergic symptoms or to prevent their occurrence. The patient is also instructed to reduce exposure to people with upper respiratory tract

infections. Adherence to medication schedules and other treatment regimens is encouraged and reinforced.

Promoting Understanding of Allergy and Allergy Control

Instruction includes strategies to minimize exposure to allergens and explanation about desensitization procedures and correct use of medications. The nurse informs and reminds the patient of the importance of keeping appointments for desensitization procedures, because dosages are usually adjusted on a weekly basis, and missed appointments may interfere with the dosage adjustment (Pitsios & Dietis, 2019).

Patients need to understand the difference between rescue medications for allergy exacerbation and seasonal flares (e.g., antihistamines) and medications used for allergy control throughout the year (e.g., inhaled corticosteroids, leukotriene modifiers). Patients also need to understand that medications for allergy exacerbation and seasonal flares should be used only when the allergy is apparent. Continued use of these medications when not required can result in tolerance; consequently, the medications will be ineffective when needed (Pitsios & Dietis, 2019; Scadding, 2017).

Coping with a Chronic Disorder

Although allergic reactions are infrequently life-threatening, they require vigilance to avoid allergens and modification of the lifestyle or environment to prevent recurrence of symptoms. Allergic symptoms are often present year-round and create discomfort and inconvenience for the patient. Although patients may not feel ill during allergy seasons, they often do not feel well, either. The need to be alert for possible allergens in the environment may be tiresome, placing a burden on the patient's ability to lead a normal life. Stress related to these difficulties may in turn increase the frequency or severity of symptoms. To assist the patient in adjusting to these modifications, the nurse must have an appreciation of the difficulties encountered by the patient. The patient is encouraged to verbalize feelings and concerns in a supportive environment and to identify strategies to deal with them effectively (Scadding, 2017).

Monitoring and Managing Potential Complications

Anaphylaxis and Impaired Breathing. Respiratory and cardiovascular functioning can be significantly altered during allergic reactions by the reaction itself or by the medications used to treat reactions. Anaphylaxis is an acute, systemic reaction that causes vasodilation and bronchiole constriction which can lead to hypotensive shock and asphyxiation. The respiratory status is evaluated by monitoring the respiratory rate and pattern and by assessing for breathing difficulties or abnormal lung sounds. The pulse rate and rhythm and blood pressure are monitored to assess cardiovascular status regularly or any time the patient reports symptoms such as itching or difficulty breathing. In the event of signs and symptoms

suggestive of anaphylaxis, emergency medications and equipment must be available for immediate use. People with severe allergic reactions may be advised to carry an autoinjectable epinephrine device (Song & Lieberman, 2019). See Chapter 11 for treatment of anaphylactic shock.

Nonadherence to the Therapeutic Regimen. Knowledge about the treatment regimen does not ensure adherence. Having the patient identify potential barriers and explore acceptable solutions for effective management of the condition (e.g., installing tile floors rather than carpet, not gardening in the spring) can increase adherence to the treatment regimen (Pitsios & Dietis, 2019).

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care. The patient is instructed about strategies to minimize exposure to allergens, the actions and adverse effects of medications, and the correct use of medications. The patient should know the name, dose, frequency, actions, and side effects of all medications taken.

Instruction about strategies to control allergic symptoms is based on the needs of the patient as determined by the results of tests, the severity of symptoms, and the motivation of the patient and family to deal with the condition (Pitsios & Dietis, 2019). Suggestions for patients who are sensitive to dust and mold in the home are given in Chart 33-6.

If the patient is to undergo allergen immunotherapy (AIT), the nurse reinforces the primary provider's explanation regarding the purpose and procedure. Instructions are given regarding the series of injections, which usually are given initially every week and then at 2- to 4-week intervals. These instructions include remaining in the primary provider's office or the clinic for at least 30 minutes after the injection, so that emergency treatment can be given if the patient has a reaction; avoiding rubbing or scratching the injection site; and continuing with the series for the period of time required. In addition, the patient and family are instructed about emergency treatment of severe allergic symptoms (James & Bernstein, 2017).

Because antihistamines may produce drowsiness, the patient is cautioned about this and other side effects applicable to the medication. Operating machinery, driving a car, and performing activities that require intense concentration should be postponed. The patient is also informed about the dangers of drinking alcohol when taking antihistamines, because they tend to exaggerate the effects of alcohol.

The patient must be aware of the effects caused by overuse of the sympathomimetic agents in nose drops or sprays, because rhinitis medicamentosa may result. After topical application of the medication, a rebound period occurs in which the nasal mucous membranes become more edematous and congested than they were before the medication was used.

Such a reaction encourages the use of more medication, and a cyclic pattern results. The topical agent must be discontinued immediately and completely to correct this problem (Wahid & Shermetaro, 2019).

Continuing and Transitional Care. Follow-up telephone calls to the patient are often reassuring to the patient and family and provide an opportunity for the nurse to answer any questions. The patient is reminded to keep follow-up appointments and informed about the importance of continuing with treatment. The importance of participating in health promotion activities and health screening is also emphasized.

Evaluation

Expected patient outcomes may include:

1. Exhibits a breathing pattern that provides adequate ventilation
    a. Demonstrates lungs clear on auscultation
    b. Exhibits absence of adventitious breath sounds (crackles, rhonchi, wheezing)
    c. Has a normal respiratory rate and pattern
    d. Reports no complaints of respiratory distress (shortness of breath, difficulty on inspiration or expiration)

Chart 33-6 HOME CARE CHECKLIST

Allergy Management

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of environmental allergens (e.g., dust, molds, perfumes, foods) on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- State changes in home environment necessary to minimize exposure to allergens.
  - Removing drapes, curtains, and venetian blinds and replacing them with pull shades; covering the mattress with a hypoallergenic cover that can be zipped; and removing rugs and replacing them with wood flooring or linoleum.
  - Reducing dust in the house as a whole by using steam or hot water for heating and using high-efficiency particulate air (HEPA) purifiers or air-conditioning.
  - Washing the floor and dusting and vacuuming daily, using clean filters, wearing a mask whenever cleaning is being done.
  - Replacing stuffed furniture with wood pieces that can easily be dusted.
  - Avoiding the use of tufted bedspreads, stuffed toys, and feather pillows and replacing them with washable cotton material.
  - Avoiding the use of any clothing that causes itching.
- Verbalize ways to reduce exposure to pollens or molds by identifying seasons of the year when pollen counts are high; wearing a mask at times of increased exposure (windy days and when grass is being cut); and avoiding contact with weeds, dry leaves, and freshly cut grass.
- State rationale for seeking air-conditioned areas at the height of the allergy season.
- State rationale for avoiding sprays and perfumes.
- State rationale for the use of hypoallergenic cosmetics.
- State rationale for taking prescribed medications as prescribed.
- Identify specific foods that may cause allergic symptoms and develop a list of foods to avoid (e.g., fish, nuts, eggs, chocolate).
- Verbalize ways to cope with stress successfully, plans for regular exercise, and rationale for obtaining adequate rest.
- State how to reach primary provider with questions or complications.
- State time and date of follow-up appointments, testing.
- Identify the need for health promotion, disease prevention, and screening activities.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

2. Demonstrates knowledge about allergy and strategies to control symptoms
   a. Identifies causative allergens, if known
   b. States methods of avoiding allergens and controlling indoor and outdoor precipitating factors
   c. Removes from the environment items that retain dust
   d. Wears a dampened mask if dust or mold may be a problem
   e. Avoids smoke-filled rooms and dust-filled or freshly sprayed areas
   f. Uses air-conditioning for a major part of the day when allergens are high
   g. Takes antihistamines as prescribed; participates in allergen immunotherapy program, if applicable
   h. Describes name, purpose, side effects, and method of administration of prescribed medications
   i. Identifies when to seek immediate medical attention for severe allergic responses
   j. Describes activities that are possible, including ways to participate in activities without activating the allergies
3. Adapts to the inconveniences of an allergy
   a. Relates the emotional aspects of the allergic response
   b. Demonstrates the use of measures to cope positively with allergy
4. Demonstrates absence of complications
   a. Exhibits vital signs within normal limits
   b. Reports no symptoms or episodes of anaphylaxis (urticaria, itching, peripheral tingling, fullness in the mouth and throat, flushing, difficulty swallowing, coughing, wheezing, or difficulty breathing)
   c. Demonstrates correct procedure to self-administer emergency medications to treat severe allergic reaction
   d. Correctly states medication names, dose and frequency of administration, and medication actions
   e. Correctly identifies side effects and untoward signs and symptoms to report to primary provider
   f. Discusses acceptable lifestyle changes and solutions for identified potential barriers to adherence to treatment and medication regimen

Contact Dermatitis

Contact dermatitis is an inflammatory reaction of the skin due to contact with an exogenous substance. There are two basic types of contact dermatitis: irritant contact dermatitis and allergic contact dermatitis (see Table 33-4). Irritant contact dermatitis is an inflammatory response of the skin to direct chemical damage that releases mediators predominantly from epidermal cells. Allergic contact dermatitis is a delayed (type 4) hypersensitivity reaction to exogenous contact antigens that involves activation of T cells (Litchman, Nair, & Atwater, 2019). Eighty percent of contact dermatitis is irritant type and 20% is allergic type (Fornacier & Noor, 2018). Most cases are caused by excessive exposure to or additive effects of irritants (e.g., soaps, detergents, metals, organic solvents, cosmetics). Skin sensitivity may develop after brief or prolonged periods of exposure, and the clinical picture may appear hours or weeks after the sensitized skin has been exposed.

Clinical Manifestations

Symptoms of acute contact dermatitis include itching, burning, erythema, skin lesions (vesicles and bullae), and oozing (Goldner & Fransway, 2018). The reaction is limited to the site of contact. Chronic contact dermatitis symptoms can include scaling, lichenification, thickening of the skin, and pigmentary changes. Secondary invasion by bacteria may develop in skin that is abraded by rubbing or scratching. Usually, there are no systemic symptoms unless the eruption is widespread.

Assessment and Diagnostic Findings

Determining allergens responsible requires a history, physical examination, and patch testing.

Assessment includes the date of onset and any identifiable relationship to work environment and skin care products. The location of the lesions, distribution of the dermatitis, absence of other etiologies, and the history of exposure aid in determining the condition (Goldner & Fransway, 2018). Patch testing and environmental history of exposure to contact allergens are required to verify the diagnosis. Patch testing is the standard test for identification of culprit allergens in persons with allergic contact dermatitis. The patch test most commonly used is the thin-layer rapid use epicutaneous (TRUE) test. An extended screening panel (North American screening series) has increased sensitivity. Researchers reported an extended screening panel identified an additional 10.8% of patients with positive tests that were negative to TRUE test allergens (Sundquist, Lang, & Pasha, 2019).

TABLE 33-4 Types, Testing, and Treatment of Contact Dermatitis

Type	Etiology	Clinical Presentation	Diagnostic Testing	Treatment
Allergic	Results from contact of skin and allergenic substance; has a sensitization period of 10–14 days	Vasodilation and perivascular infiltrates on the dermis Intracellular edema Usually seen on dorsal aspects of hand	Patch testing (contraindicated in acute, widespread dermatitis)	Avoidance of offending material Aluminum acetate (Burow Solution, Domeboro Powder) or cool water compress Systemic corticosteroids (prednisone) for 7–10 days Topical corticosteroids for mild cases Oral antihistamines to relieve pruritus
Irritant	Results from contact with a substance that chemically or physically damages the skin on a nonimmunologic basis; occurs after first exposure to irritant or repeated exposures to milder irritants over an extended time	Dryness lasting days to months Vesiculation, fissures, cracks Hands and lower arms most common areas	Clinical picture Appropriate negative patch tests	Identification and removal of source of irritation Application of hydrophilic cream or petrolatum to soothe and protect Topical corticosteroids and compresses for weeping lesions Antibiotics for infection and oral antihistamines for pruritus

Adapted from Comerford, K. C., & Durkin, M. T. (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer.

Atopic Dermatitis

Atopic dermatitis (commonly called eczema) is a chronic, inflammatory allergic skin disorder that is triggered by environmental factors in individuals who are genetically susceptible. This disorder affects 7% of adults in the United States (Weston & Howe, 2019). More than half of patients are also affected by asthma, allergic rhinitis, and food allergies.

Atopic dermatitis is a type I immediate hypersensitivity disorder involving IgE antibodies that causes dry, pruritic, hypersensitive skin. It often begins with small red pruritic papules that stimulate intense itching, leaving erythematous, excoriated areas of skin. This often triggers an "itch-scratch cycle" where rubbing or scratching the skin causes further irritation, redness, and skin breakdown. Skin thickening from chronic scratching (lichenification) and fissuring may develop over time. In many patients, lesions in different stages may be present at the same time (Weston & Howe, 2019). Atopic dermatitis in adults often occurs at the hands, wrists, elbows, knees, ankles, face, and neck.

Atopic dermatitis is due to a "leaky" skin barrier that allows water to leave the skin dried out and hypersensitive. Exposure of the hypersensitive skin to soaps, detergent, house dust mites, pollen, animal dander, and some bacteria break down the skin barrier (Weston & Howe, 2019).

Defective filaggrin (FLG) genes at chromosome 1q21.3 are common in persons with the disorder. Filaggrin is a protein produced by keratinocytes in the skin that is encoded by the FLG gene (Løset, Brown, Saunes, et al., 2019). Currently, there is ongoing investigation into the etiology of atopic dermatitis, including other genes involved in processing of filaggrin.

Nurses should be aware that atopic dermatitis is often linked to a process called the **atopic march** that refers to the natural history of allergic diseases as they begin in infancy and through childhood. Atopic march begins with atopic dermatitis and progresses to IgE-mediated food allergy, asthma, and allergic

rhinitis. It is the result of interactions between susceptibility genes, the environment, defective function of the skin barrier, and immunologic responses (AAAAI, 2019a; Hill & Spergel, 2018).

The diagnosis of atopic dermatitis is based on the health history, morphology and distribution of skin lesions, and associated clinical signs. Laboratory testing, patch testing, and skin biopsy may be necessary if there is a need to rule out other skin conditions.

Medical Management

Treatment of patients with atopic dermatitis involves avoidance of irritative agents, use of anti-inflammatory topical agents, and moisturization of the skin. Patients should avoid potential triggers of atopic dermatitis, which include excessive bathing without subsequent moisturization, low humidity environments, animal dander, dust mites, xerosis (dry skin), overheating of skin, and exposure to solvents and detergents. Individuals are commonly hypersensitive to fragrances, perfumes, and contact allergens such as nickel.

Topical corticosteroids are the mainstay of treatment of atopic dermatitis. If mild OTC corticosteroids are not adequate, more potent corticosteroids such as fluocinoline 0.025%, triamcinolone, 0.1%, or betamethasone, 0.05% are prescribed. These agents should not be used on the face as they can cause skin atrophy. Topical calcineurin inhibitors, which are nonsteroidal immunomodulating agents (e.g., tacrolimus, pimecrolimus), are best for the facial area. Treatment of severe flare-ups of chronic disease can be treated with a short course of systemic corticosteroids (Weston & Howe, 2019).

Dupilumab is an interleukin (IL)-4 and IL-13 receptor-alpha antagonist that was approved by the FDA for the treatment of patients aged 12 years and older with moderate to severe atopic dermatitis not adequately controlled with topical prescription therapies (Spergel & Lio, 2019).

Colonization with *Staphylococcus aureus* occurs more frequently in individuals with atopic dermatitis than in the general population, and *S. aureus* is a common cause of secondary infection in these patients. The presence of purulence or honey-colored crusts suggests *S. aureus* infection. Antibiotic treatment is needed to eradicate infection (Spergel & Lio, 2019).

Nursing Management

Patients who experience atopic dermatitis and their families require assistance and support from the nurse to cope with the disorder. The symptoms are often disturbing to the patient and disruptive to the family. The appearance of the skin may affect the patient's self-esteem and their willingness to interact with others. Instructions and counseling about strategies to incorporate preventive measures and treatments into the lifestyle of the family may be helpful.

Skin hydration is a key component of treatment as atopic skin is low in moisture. Thick cream moisturizers and emollients that contain glycerol or urea should be used as these will keep the skin hydrated. A hydrating bath with mild soap followed by immediate emollient application is recommended, or a shower of short duration (Spergel & Lio, 2019).

Itching can be decreased by wearing cotton fabrics, washing clothes with a mild detergent, and humidifying dry heat in winter. Antihistamines such as diphenhydramine may be used as treatment, but since they are sedating, the patient can be advised that it is best to use them at bedtime.

The patient and family need to be aware of signs of secondary infection and of the need to seek treatment if infection occurs. The nurse also educates the patient and family about the side effects of medications used in treatment.

Drug Hypersensitivity

Drug hypersensitivity is the leading cause of fatal anaphylaxis, comprising 43% of deaths from anaphylaxis. All routes of administration are potentially fatal, but drugs given parenterally incur the greatest risk. Cutaneous rashes are among the most common reactions to medications and occur in approximately 2% to 3% of hospitalized patients (Habif, 2016).

A drug hypersensitivity reaction is defined by the time of appearance, possible mode of action (mechanism of immune stimulation), and resulting pathophysiology. According to the World Allergy Organization, immunologic drug reactions can be divided into immediate reactions (i.e., onset within 1 hour of exposure) and delayed reactions (onset after 1 hour), based on the timing of the appearance of symptoms (Tanno, Torres, Castells, et al., 2018).

IgE-mediated immediate type 1 hypersensitivity reactions to a drug occur within 1 hour of administration of the agent. Delayed hypersensitivity reactions occur after 1 hour; most occur after 6 hours or days of treatment. These reactions can also occur after the course of medication is finished. These reactions may be caused by several different mechanisms, but they are not IgE mediated. Types II, III, and IV immunologic reactions are all considered delayed reactions (Pichler, 2019).

A disorder known as drug rash with eosinophilia and systemic symptoms (DRESS) can occur after weeks of continuous treatment. Also known as "drug-induced hypersensitivity syndrome" (DiHS), it is characterized by fever, rash, and multiorgan involvement, and may or may not be associated with eosinophilia and lymphocytosis. Hepatitis and myocarditis can be part of DRESS. These reactions can persist for weeks to months, even after the medication is stopped (Mockenhaupt, 2019). Anticonvulsant agents (e.g., lamotrigine, phenytoin, phenobarbital) and allopurinol are the most frequently reported causes of DRESS (Mockenhaupt, 2019).

Anaphylaxis is the most severe presentation of an IgE-mediated drug reaction. Medications administered IV may cause symptoms in seconds to minutes, while the same drug administered orally may cause symptoms in 3 to 30 minutes if taken on an empty stomach, and in 10 to 60 minutes if taken with food. The agents that most commonly exhibit this type of reaction include the following (Pichler, 2019):

- Beta-lactam drugs (e.g., penicillins and cephalosporins)
- Neuromuscular blocking agents (e.g., pancuronium)
- Quinolones (e.g., ciprofloxacin)
- Platinum-containing chemotherapeutic agents (e.g., carboplatin)
- Foreign proteins such as monoclonal antibodies (e.g., rituximab)

Type II cytotoxic reactions involve antibody-mediated cell destruction. Type II reactions may arise when drugs bind to surfaces of certain cell types and act as antigens. Clinical manifestations include hemolytic anemia, thrombocytopenia, or neutropenia, since these are the cell types that are most often affected. The drugs most commonly implicated in hemolytic anemia are cephalosporins, penicillins, nonsteroidal anti-inflammatory drugs (NSAIDs), and quinine and quinidine. Drugs implicated in thrombocytopenia include heparin, abciximab, quinine and quinidine, sulfonamides, vancomycin, gold compounds, beta-lactam antibiotics, carbamazepine, and NSAIDs. Severe neutropenia due to type II drug reactions presents days to weeks after beginning the medication. Clinical manifestations include symptoms of infection, such as fever, stomatitis, pharyngitis, pneumonia, or sepsis. Propylthiouracil, amodiaquine, and flecainide can cause these reactions (Pichler, 2019).

Type III reactions are mediated by antigen–antibody complexes that deposit on basement membranes and usually present as serum sickness, vasculitis, or drug fever. Signs and symptoms take 1 or more weeks to develop after drug exposure, since significant quantities of antibody are needed to generate symptoms related to antigen–antibody complexes. These are uncommon reactions but are seen with antitoxins for rabies, botulism, and venoms, tetanus, hepatitis, and diphtheria vaccines (Pichler, 2019).

Type IV reactions involve activated T cells, which take time to develop. Type IV reactions usually take at least 48 to 72 hours and sometimes days to weeks to develop following exposure to the drug. Type IV reactions can vary from a nonurticarial, maculopapular rash (drug fever) to Stevens–Johnson syndrome and toxic epidermal necrolysis (see Chapter 56), or drug rash with eosinophilia and systemic symptoms, or DRESS/DiHS. Type IV reactions can appear after weeks of drug treatment (Pichler, 2019).

Medications are the most common agent responsible for approximately 90% of all drug rashes. Commonly prescribed medications (e.g., antibiotics, sulfonamides) are implicated in most cases (Samel & Chu, 2019).

Drug fever, which usually causes fever and rash, is associated with azathioprine, sulfasalazine, minocycline, trimethoprim-sulfamethoxazole, sirolimus, and tacrolimus (McDonald & Sexton, 2019). Contact dermatitis skin reactions can result from topical anesthetics such as benzocaine, topical antibiotics such as neomycin or bacitracin, and topic corticosteroids.

Symmetrical drug-related intertriginous and flexural exanthem (SDRIFE), formerly called baboon syndrome, is a distinctive drug eruption that typically develops within a few hours to days of drug exposure and presents with demarcated, V-shaped erythema in the gluteal/perianal or inguinal/perigenital areas, often with involvement of at least one other flexural area, such as the axillae, elbows, or knees. Aminopenicillins are a common trigger of SDRIFE (Bircher, 2018).

Acute generalized exanthematous pustulosis (AGEP) is a rare type of reaction characterized by superficial pustules, usually appearing within 24 hours after the administration of the culprit drug. Antimicrobial drugs (amoxicillin), antimalarials, and calcium channel blockers are the most frequently reported triggers of AGEP (Cho & Chu, 2017).

Stevens–Johnson syndrome and toxic epidermal necrolysis are severe reactions commonly triggered by medications. The disorder can evolve into extensive epidermal necrosis and become life-threatening. Mucous membranes are affected in over 90% of patients, usually at two or more distinct sites (ocular, oral, and genital). In some patients, an exanthematous eruption can be the heralding sign of Stevens–Johnson syndrome and toxic epidermal necrolysis. Fever, often exceeding 39°C (102.2°F), and influenzalike symptoms precede development of mucocutaneous lesions and erythematous macules with purpuric centers that evolve into blisters and bullae. Photophobia, conjunctival itching or burning, and pain on swallowing may be due to mucosal involvement. Malaise, myalgia, and arthralgia are present in most patients. The following agents are most commonly implicated in Stevens–Johnson syndrome and toxic epidermal necrolysis (High, 2019):

- Allopurinol
- Aromatic antiepileptic drugs and lamotrigine
- Antibacterial sulfonamides (including sulfasalazine)
- Nevirapine
- Oxicam NSAIDs

Some conventional and targeted anticancer drugs have been associated with these syndromes including thalidomide, capecitabine, afatinib, vemurafenib, tamoxifen, and immune checkpoint inhibitors ipilimumab, pembrolizumab, and nivolumab. Radiation treatment in combination with antiepileptic drugs (e.g., phenytoin, phenobarbital, carbamazepine) can trigger Stevens–Johnson syndrome and toxic epidermal necrolysis (High, 2019).

Pharmacogenetic studies suggest that there is a genetic predisposition to drug allergy. In some populations, individuals with HLA-B*1502, HLA-B*5801, or HLA-B*5701 have an increased risk of developing Stevens–Johnson syndrome and toxic epidermal necrolysis to aromatic anticonvulsants such as carbamazepine, allopurinol, cotrimoxazole, and abacavir, respectively (Bircher, 2018).

Pseudoallergic Drug Reactions

Pseudoallergic drug reactions are adverse drug reactions with signs and symptoms that mimic immunologic drug allergies, but no immunologic mechanisms are occurring. They are referred to as nonimmunologic hypersensitivity reactions or anaphylactoid reactions. It is unclear how certain drugs elicit pseudoallergic reactions. However, degranulation of mast cells occurs. Some affected patients have underlying dermographism which indicates an "instability" of their mast cells. In dermographism, when pressure is applied to the skin, the skin reddens for a prolonged time in the same pattern as the pressure was applied. The following drugs may cause a pseudoallergic drug reaction (Pichler, 2019):

- Radiocontrast agents
- Opioids (e.g., morphine and meperidine)
- NSAIDs (e.g., ibuprofen) and aspirin
- Vancomycin
- Local anesthetic agents (e.g., lidocaine, benzocaine)
- Chemotherapeutic agents (e.g., platinum-based drugs)

The patient should be educated about avoidance and provided with a written list of the generic and brand names of the causative agents to avoid in the future (Pichler, 2019).

Urticaria and Angioedema

Urticaria (hives) is a type I hypersensitive allergic reaction of the skin that is characterized by the sudden appearance of intensely pruritic pink or red discrete papules that progress to wheals of variable size. Urticarial lesions coalesce and evolve into large erythematous plaques (AAAAI, 2019b). This is a common condition with up to 20% of people having at least one episode of hives during their lifetime. Urticaria is most commonly instigated by infections, allergic reactions to food, insect stings, and medications (Asero, Tedeschi, Marzano, et al., 2017).

Acute urticaria evolves over a time span of minutes to hours and disappears by 24 hours; lesions can be in different stages over this time. Urticaria is

considered acute if it has been present for less than 6 weeks. However, if urticaria occurs frequently and reoccurs daily for longer than 6 weeks, the condition is called chronic urticaria. In urticaria, mast cells and basophils within the skin are activated and release histamine and inflammatory mediators that cause vasodilation (AAAAI, 2019b).

Common causes of urticaria include allergic reactions to medications or contact allergens, foods, insect stings and bites; reactions to medications that cause nonallergic mast cell activation (e.g., opioids); latex allergy; transfusions; and NSAIDs. Physical urticarial syndromes are forms of chronic urticaria that are triggered by specific physical and environmental factors, such as cold exposure, sudden changes in body temperature, pressure or vibration against the skin, exercise, exposure to sunlight, or other stimuli (Asero, 2017). Serum sickness, a type III hypersensitivity reaction, commonly due to medication, can also cause urticaria. Serum sickness classically causes rash, fever, and polyarthralgias or polyarthritis, which begin 1 to 2 weeks after the first exposure to the responsible agent and resolve within a few weeks of discontinuation (Wener, 2018).

The diagnosis of urticaria can usually be made by health history and physical examination. Laboratory testing is usually not necessary.

Management of the condition includes eliminating the causative agent; avoiding the use of NSAIDs; and minimizing potential aggravators, including heat, stress, alcohol, and tight clothes. Treatment with second-generation H_1 antihistamine agents (e.g., cetirizine, fexofenadine, loratadine) is the mainstay of treatment. These agents are better tolerated as they have less sedating effects than first-generation H_1 antihistamines (e.g., diphenhydramine, chlorpheniramine, hydroxyzine). Doses of second-generation antihistamines may be increased as high as four times the standard dose (Khan, 2019a). Oral corticosteroids given in a decreasing dose schedule may be prescribed to relieve severe symptoms for a few days. About 50% of cases of chronic spontaneous urticaria will respond to treatment with antihistamines, as discussed above. For those patients who do not improve with antihistamines, 65% might respond to prescribed omalizumab. Omalizumab, a monoclonal antibody that acts against IgE antibodies, is injected under the skin every 2 to 4 weeks by a primary provider. Therapeutic effects can be seen within 3 to 6 months (AAAAI, 2019b; Stokes & Casale, 2018).

Angioedema is an allergic reaction that involves the infiltration of fluid in subcutaneous tissue and mucous membranes resulting in diffuse swelling. It is manifested by nonpruritic, brawny, widespread, nonpitting edema. Urticaria and angioedema often occur together (AAAAI, 2019b; Habif, 2016).

The regions most often involved in angioedema are the lips, eyelids, cheeks, hands, feet, genitalia, and tongue; the mucous membranes of the larynx, bronchi, and gastrointestinal tract may also be affected, particularly in the hereditary type (see discussion in the following section). On occasion, this

reaction covers the entire back or large area of the body. Swellings may appear suddenly, in a few seconds or minutes, or slowly over 1 or 2 hours. It usually resolves within 24 hours. Angioedema is usually a benign and transient condition, although it can be life-threatening when severe angioedema of the larynx, upper airway, or tongue results in airway obstruction (Zuraw, 2019).

Two types of angioedema can be distinguished: mast cell–mediated, also called histaminergic angioedema, and bradykinin-mediated angioedema. Allergic reactions to foods, latex, certain drugs, or insect stings are common examples of mast cell–mediated angioedema. Histamine is the main inflammatory mediator and signs and symptoms include urticaria, flushing, generalized pruritus, bronchospasm, throat tightness, and/or hypotension. Patients may be experiencing anaphylaxis and should be treated immediately with epinephrine. Mast cell–mediated angioedema usually begins within minutes of exposure to the allergen, builds over a few hours, and resolves in 24 to 48 hours (Zuraw, 2019).

Alternatively, bradykinin-induced angioedema does not involve histamine and is not associated with urticaria, bronchospasm, or other symptoms of allergic reactions. Bradykinin is a potent vasodilator which also increases vasopermeability (Cicardi & Zuraw, 2018a). The fluid infiltration of the tissues usually develops over 24 to 36 hours and resolves within 2 to 4 days. The relationship between the trigger and the onset of symptoms is often not apparent. Angiotensin-converting enzyme inhibitors (e.g., captopril) are common causes of bradykinin-induced angioedema; swelling may appear within a week of starting the medication or after years of use (Zuraw, 2019).

Second-generation H_1 antihistamines and corticosteroids are the mainstay of treatment for mast cell–mediated angioedema. If angioedema is part of an anaphylactic reaction, intramuscular epinephrine is an important part of treatment (Guyer & Banerji, 2019).

Treatment of bradykinin-induced angioedema involves avoidance of drug, icatibant, C1 inhibitor concentrate, ecallantide, and possibly administration of fresh-frozen plasma. Antihistamines are ineffective (Cicardi & Zuraw, 2018b). Icatibant is a synthetic bradykinin beta-2-receptor antagonist. C1 inhibitor concentrate and exallantide inhibit kallikrein which is a protease involved in bradykinin production. Fresh-frozen plasma contains angiotensin-converting enzyme, and the administration of plasma is thought to degrade high levels of bradykinin (Guyer & Banerji, 2019).

Hereditary Angioedema

Hereditary angioedema (HAE) is a rare, potentially life-threatening, autosomal dominant genetic disorder. It is a bradykinin-mediated type of angioedema that is due to a lack of C1 inhibitor activity, a specific protein that takes part in

kinin generation. Kinins are inflammatory mediators; bradykinin is one of these. C1INH usually plays a role in limiting bradykinin production, so when C1INH is deficient or dysfunctional, bradykinin production is relatively unchecked (AAAAI, 2019c).

There are two different types of HAE; HAE type I is due to C1 inhibitor (C1INH) deficiency, and type II is caused by C1INH dysfunction (Cicardi & Zuraw, 2018a).

Clinical Manifestations

HAE is commonly categorized as laryngeal, gastrointestinal, or cutaneous. Swelling of the skin is usually diffuse, nonpruritic, and not accompanied by urticaria. Attacks of swelling in patients with HAE generally involve the extremities, abdomen, genitourinary tract, face, oropharynx, or larynx and follow a stereotypical pattern in which the swelling worsens over 24 hours, peaks, and then slowly resolves over the following 48 hours. Gastrointestinal edema may cause abdominal pain severe enough to be incapacitating. Typically, attacks last 2 to 4 days and resolve without intervention; however, attacks can occasionally affect the subcutaneous and submucosal tissues in the region of the upper airway and can be associated with respiratory obstruction and asphyxiation (Cicardi & Zuraw, 2018a).

Medical Management

Attacks usually subside within 2 to 4 days, but during this time the patient should be observed carefully for signs of laryngeal obstruction, which may necessitate tracheostomy as a lifesaving measure. Epinephrine, antihistamines, and corticosteroids are commonly administered in an attempt to relieve HAE; however, these are often ineffective. A trial of high doses of second-generation H_1 antihistamines for 1 month may be effective in some patients. If this proves unsuccessful, C1INH concentrate, derived from human plasma, recombinant human C1INH (rhC1INH, conestat alfa), icatibant, a synthetic bradykinin beta-2-receptor antagonist and ecallantide, a recombinant plasma kallikrein inhibitor are agents that are available (Cicardi & Zuraw, 2018b). Nurses need to be prepared to use different emergency approaches in the treatment of HAE and to have lifesaving equipment readily available.

Cold Urticaria

Cold urticaria is a type of physical urticaria. Physical urticarias are inducible urticarias that are stimulated by environmental triggers. Cold urticaria is the development of wheals (hives) or angioedema due to exposure to cold. Mast

cells release histamine and inflammatory mediators are stimulated in response to skin contact with cold objects, cold fluids, or cold air. It is an IgE-mediated atopic immune reaction. Cold urticaria most commonly affects young adults as a self-limited disorder that occurs over a period of 5 to 6 years.

Clinical Manifestations

The patient feels a burning or pruritic sensation and the skin is erythematous due to activation of sensory nerves and vasodilation of arterioles. Most commonly it is a localized reaction in areas exposed to cold. However, extensive cold contact, such as swimming in cold water, may result in systemic reactions, ranging from generalized urticaria to anaphylaxis, with symptoms involving the respiratory, gastrointestinal, and/or cardiovascular systems. Oropharyngeal angioedema, which can cause suffocation and severe hypotension, has been observed in some persons with the disorder (Maurer, 2019).

Medical Management

Cold urticaria is diagnosed by cold stimulation testing. An ice cube within a thin plastic bag of cold water is applied to the volar aspect of the forearm for 1 to 5 minutes. A positive test results in development of urticaria at the site. The test is considered positive if the test site shows a palpable and clearly visible wheal-and-flare skin reaction upon rewarming. All patients with any form of cold urticaria should carry an autoinjectable epinephrine device for emergency use because hives can progress to anaphylaxis. Pretreatment with an antihistamine prior to predictable cold exposure is recommended, because clinical experience suggests that antihistamine pretreatment can prevent skin reactions and systemic reactions (Maurer, 2019). Patients with cold urticaria refractory to antihistamines can be treated with immunomodulator agents, such as omalizumab, certain antibiotics, leukotriene receptor antagonists, or cold desensitization therapy (Khan, 2019b).

Nursing Management

Prevention involves avoidance of cold stimuli. Patient education is needed about what environmental conditions can stimulate a reaction. For instance, patients should be instructed to expose a small section of the body to the water of a swimming pool prior to submerging the body in water. A wet suit can be used during swimming. Patients should understand that cold foods and beverages can stimulate oropharyngeal angioedema or anaphylaxis and should be avoided. Patients anticipating surgery may develop a reaction to the cold air within operating rooms and are instructed to alert surgical personnel that they

have cold uriticaria and should be kept warm during any procedures. Cold intravenous solutions can also provoke a reaction (Singleton & Halverstam, 2016).

Food Allergy

Food allergy is an adverse reaction to certain foods due to immunologic mechanisms. Food allergies are categorized as either IgE-mediated or non–IgE-mediated allergies. IgE-mediated food allergy, a type I hypersensitivity reaction, occurs in about 5% of adults. IgE-mediated food allergy is more common and better understood than non–IgE-mediated food allergy (Commins, 2019). Recent studies show that within the population there are many with the misconception that they have a food allergy (19%) compared to persons with true immune-mediated food allergy (10%) (Gupta, Warren, & Smith, 2019).

Almost any food can cause an IgE-mediated allergic reaction. Allergic reactions can range from cutaneous urticaria to anaphylaxis. Fish and shellfish (e.g., lobster, shrimp, crab, clams, fin fish) as well as peanuts and tree nuts (e.g., cashew, walnut) are the two food groups that cause the majority of adult food allergies (Gupta et al., 2019). Other common foods causing allergy include cow's milk, eggs, soy, and wheat. Allergens are proteins and there is a danger that cross-reactivity can occur in foods containing similar proteins (AAAAI, 2018).

OAS, or pollen-food allergy syndrome (PFAS or PFS), is the most common form of IgE-mediated food allergy in adults. OAS often occurs in persons who are also allergic to pollen that causes seasonal allergic rhinitis. Raw fruits and vegetables often cause OAS but cooked fruit and vegetables do not (Burks, 2019).

Non–IgE-mediated food allergies present as more subacute and/or chronic symptoms that are typically isolated to the gastrointestinal tract and/or skin.

Clinical Manifestations

Acute urticaria and angioedema (swelling of the mouth, face, lips, tongue, and throat) are the most common clinical manifestations of food allergy. The reaction develops within minutes to hours after eating the offending food. The clinical symptoms may include wheezing, cough, laryngeal edema, and gastrointestinal symptoms (abdominal pain, nausea, cramps, vomiting, and diarrhea). Tree nuts and peanuts can cause the most severe allergic reactions evolving into anaphylaxis.

Assessment and Diagnostic Findings

Diagnosis of food allergy requires clinical history, physical examination, trial elimination diets, diet diaries, skin prick testing (SPT), and allergen-specific serum IgE immunoassay. A patch test is used if non–IgE-mediated food allergy is suspected. However, the standard is clinician-supervised oral food challenges to confirm or rule out the diagnosis. SPT is used to identify the source of symptoms and assists in identifying specific foods as causative agents. The patient is injected with a minute quantity of food antigen under the skin. Then the patient and primary provider wait to observe if hives and erythema arise within the 15 minute period. If the allergen triggers mast cells to release histamine, a localized wheal will be raised in the skin. A positive skin prick test for IgE-mediated food allergy is diagnosed when a wheal of 3 mm in diameter is raised within 15 minutes. A different kind of test, referred to as a 48-hour atopy patch test, is used for non–IgE-mediated food allergy. This is a topical application of food allergen that is applied to the small surface area of skin. This is a delayed reaction that requires 48 hours of observation (Andreae & Schreffler, 2019).

Medical Management

Therapy for food hypersensitivity includes avoidance of the food responsible for the hypersensitivity. Pharmacologic therapy is necessary for patients who cannot avoid exposure to offending foods and for patients with multiple food sensitivities not responsive to avoidance measures. Medication therapy involves the use of H_1 blockers, antihistamines, adrenergic agents, corticosteroids, and cromolyn sodium. All patients with food allergies, especially seafood and nuts, should have an autoinjectable epinephrine device prescribed. Another essential aspect of management is educating patients and family members about how to recognize and manage the early stages of an acute anaphylactic reaction.

Oral immunotherapy (OIT), or tolerance induction, is an increasingly used treatment. The patient ingests very small amounts of the allergen in increasing dosages over several months. OIT is not a curative treatment. The goal of OIT is to increase the threshold that triggers a reaction. OIT can be used to achieve desensitization or sustained unresponsiveness to a food allergen (AAAAI, 2018).

Initially, OIT has to be administered in a clinical setting equipped for treatment of potential anaphylaxis. Patients are generally started on a very small daily dose of the food (e.g., 3 to 6 mg of food protein) and advanced periodically (usually every 2 weeks) to a maintenance dose (e.g., 300 mg or, depending on the food and goals, 1 to 2 g of food protein daily) over several months (Nowak-Wegrzyn, 2019).

Peanut, egg, and milk OIT have been shown to desensitize approximately 60% to 80% of patients studied. OIT has not cured food allergy in these

individuals; it has raised the patient's tolerance of the offending food. Most children outgrow their allergies to cow's milk, egg, soy and wheat, even if they have a history of a severe reaction. However, peanut, tree nuts, fish, and shellfish allergies tend to persist through adulthood (AAAAI, 2018).

Chart 33-7 HOME CARE CHECKLIST

Managing Food Allergies

At the completion of education, the patient and/or caregiver will be able to:

- State the impact of food allergies on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.
- Verbalize understanding of the need to maintain an allergen-free diet.
- Demonstrate reading of food labels to identify hidden allergens in food.
- Identify ways to manage an allergen-free diet when eating away from home.
- State the need to wear medical identification bracelet or necklace.
- List symptoms of food allergy.
- Demonstrate emergency administration of epinephrine.
- State the importance of replacing epinephrine when outdated.
- State the importance of prompt treatment of allergic reactions and health care follow-up.
- State how to reach primary provider with questions or complications.
- State time and date of follow-up appointments, testing.
- Verbalize ways to cope with stress successfully, plans for regular exercise, and rationale for obtaining adequate rest.
- Identify the need for health promotion, disease prevention, and screening activities.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Nursing Management

In addition to participating in management of the allergic reaction, the nurse focuses on preventing future exposure of the patient to the food allergen. The nurse should educate the patient about the signs of anaphylaxis and devise an action plan with the patient. If a severe allergic or anaphylactic reaction to food allergens has occurred, the nurse must instruct the patient and family about avoidance strategies to prevent its recurrence (see Chart 33-7). All patient allergies, including food allergies, should be noted on patient medical

records, as dietary restrictions would be necessary in the case of hospitalization. Also, there may be risk of cross-reactivity with some medications containing similar substances. The patient also needs to understand how to select and specify preparation of restaurant food (Sicherer, 2019).

Latex Allergy

Latex allergy—the allergic reaction to the proteins in the saplike fluid of a rubber tree—has been implicated in rhinitis, conjunctivitis, contact dermatitis, urticaria, asthma, and anaphylaxis. The prevalence is estimated at 4% to 7% of the population, but this has been steadily declining because of the use of nonpowdered latex and latex-free gloves (Hamilton, 2017a).

The sap of the rubber tree (*Hevea brasiliensis*) contains 250 different polypeptides that can react with IgE. The polypeptides and proteins in natural rubber latex (Hevea proteins) or the various chemicals that are used in the manufacturing process are thought to be the source of the allergic reactions.

Those at risk include health care workers, patients who have undergone multiple surgeries, people working in factories that manufacture latex products, and patients with spina bifida. Patients with spina bifida are at risk because they have had multiple surgeries, multiple urinary catheterization procedures, and other treatments involving use of latex products (Hamilton, 2017a). Because food handlers, hairdressers, automobile mechanics, and police may wear latex gloves and use latex products, they are also at risk for latex allergy. Increasingly, however, nonlatex gloves are being used in various occupational settings. Risk factors include occupational exposure to latex and atopic tendency in the affected person. Patients are at risk for anaphylactic reactions as a result of contact with latex during medical treatments, particularly surgical procedures (AAAAI, 2019d).

Persons with latex allergy are also prone to cross-reactions to pollen and some fruits; such as kiwis, bananas, pineapples, mangoes, passion fruit, avocados, and chestnuts (Hamilton, 2017a).

Routes of exposure to latex products can be cutaneous, percutaneous, mucosal, parenteral, or aerosol. The most frequent source of exposure is cutaneous, which usually involves the wearing of natural latex gloves. The powder used to facilitate putting on latex gloves can become a carrier of latex proteins from the gloves; when the gloves are put on or removed, the particles become airborne and can be inhaled or settle on skin, mucous membranes, or clothing (AAAAI, 2019d). Mucosal exposure can occur from the use of latex condoms, catheters, airways, and nipples. Parenteral exposure can occur from intravenous lines or hemodialysis equipment. In addition to latex-derived medical devices, many household items also contain latex. Examples of

medical and household items containing latex and a list of alternative products are found in Table 33-5. It is estimated that more than 40,000 medical devices and nonmedical products contain latex (AAAAI, 2019d).

Clinical Manifestations

Many different types of reactions to latex are possible (see Table 33-6). Irritant contact dermatitis, a nonimmunologic response, may be caused by mechanical skin irritation or an alkaline pH associated with latex gloves. Common symptoms of irritant dermatitis include erythema and pruritus.

Delayed hypersensitivity to latex, a type IV reaction mediated by T cells, is localized to the area of exposure and is characterized by symptoms of contact dermatitis. These include vesicular skin lesions, papules, pruritus, edema, erythema, and crusting and thickening of the skin. These symptoms usually appear on the back of the hands 1 to 4 days postcontact. It is the most common allergic reaction to latex. Although usually not life-threatening, delayed hypersensitivity reactions often require major changes in the patient's home and work environment to avoid further exposure (AAAAI, 2019d).

TABLE 33-5 Select Products Containing Natural Rubber Latex and Latex-Free Alternatives

Products Containing Latex	Examples of Latex-Safe Alternatives[a]
Hospital Environment	
Ace bandage (brown)	Ace bandage, white all cotton
Adhesive bandages, Band-Aid dressing, Telfa	Cotton pads and plastic or silk tape, Active Strips (3M), DuoDERM
Anesthesia equipment	Neoprene anesthesia kit (King)
Blood pressure cuff, tubing, and bladder	Clean Cuff, single-use nylon or vinyl blood pressure cuffs or wrap with stockinette or apply over clothing
Catheters	All-silicone or vinyl catheters
Catheter leg bag straps	Velcro straps
Crutch axillary pads and hand grips, tips	Cover with cloth, tape
ECG pads	Baxter, Red Dot 3M ECG pads
Elastic compression stockings	Kendall SCD stockings with stockinette
Gloves	Derma Prene, neoprene, polymer, or vinyl gloves
IV catheters	Jelco, Deseret IV catheters
IV rubber injection ports	Cover Y-sites and ports; do not puncture. Use three-way stopcocks on plastic tubing
Levin tube	Salem sump tube
Medication vials	Remove rubber stopper
Penrose drains	Jackson-Pratt, Zimmer Hemovac drains
Prepackaged enema kits	Therevac, Fleet Ready-to-Use
Pulse oximeters	Noninoximeters
Resuscitation bags	Laerdal, Puritan Bennett, *certain* Ambu
Stethoscope tubing	PVC tubing; cover with latex-free stockinette
Suction tubing	PVC (Davol, Laerdal)
Syringes—single use (Monoject, BD)	Terumo syringes, Abbott PCA Abboject
Tapes	Dermicel, Micropore
Theraband	New Thera-band Exercisers, plastic tubing
Thermometer probes	Diatek probe covers
Tourniquets	X-Tourn straps (Avcor)
Home Environment	
Balloons	Mylar balloons
Condoms, diaphragms	Polyurethane products, Durex Avanti and Reality products (female condom)
Diapers, incontinence pads	Huggies, Always, *some* Attends

Feminine hygiene pads	Kimberly-Clark products
Wheelchair cushions	ROHO cushions, Sof Care bed/chair cushions

[a]Confirmation is essential to verify that all items are latex free before using, especially if risk of latex allergy is present.

ECG, electrocardiogram; IV, intravenous; PVC, polyvinyl chloride.

Adapted from Centers for Disease Control and Prevention (CDC). (2014). Latex allergy: A prevention guide. Retrieved on 12/2/2019 at: www.cdc.gov/niosh/docs/98-113/default.html; Mayo Foundation for Medical Education and Research. (2019). Diseases and conditions: Latex allergy. Retrieved on 12/2/2019 at: www.mayoclinic.org/diseases-conditions/latex-allergy/basics/definition/CON-20024233

Latex allergy can also be an immediate hypersensitivity, type I allergic reaction, mediated by IgE. Localized itching, erythema, or local urticaria within 10 to 15 minutes after exposure to latex are often the initial symptoms (Hamilton, 2017a). Symptoms commonly include rhinitis, conjunctivitis, and nasal congestion. An asthma attack can be triggered. Severe anaphylaxis can occur, which includes generalized urticaria, angioedema, bronchospasm, and hypotension minutes after dermal or mucosal exposure to latex.

Assessment and Diagnostic Findings

The diagnosis of latex allergy is based on the history, physical examination, and diagnostic test results. Sensitization is detected by skin testing; serum-specific IgE, EIA, or ELISA; or the level of Hevea latex-specific IgE antibody in the serum. Testing for the chemicals found in the rubber production that makes latex is performed using the patch test. Skin patch testing is the preferred method for patients with contact allergies. The TRUE test and other skin tests should be performed only by primary providers who have expertise in their administration and interpretation and who have the necessary equipment available to treat local or systemic allergic reactions to the reagent (Hamilton, 2017a).

Medical Management

The best prevention strategy for latex allergy is the avoidance of latex-based products. A new, natural derivative from the desert plant guayule is now being used as a replacement for latex in many products. The predominant nonsterile, nonlatex examination gloves used in medical institutions today are made of nitrile, neoprene, vinyl, or synthetic polyisoprene rubber that is extracted from oil. Nonlatex condoms are available for contraception but these do not prevent transmission of HIV or other sexually transmitted infections (STIs). Persons allergic to latex should be cautioned to not blow up latex balloons or be in

enclosed spaces where these are used, as these balloons are still used as decorations (AAAAI, 2019d).

Patients at risk for an anaphylactic reaction to latex should be instructed to carry auto-injectable epinephrine in case of a reaction (Hamilton, 2017b).

Patients should report their allergy prior to any medical, dental, gynecologic, or surgical procedure and request a latex-safe environment (Hamilton, 2017b).

TABLE 33-6 Types of Reactions to Latex

Type of Reaction	Cause	Signs/Symptoms	Treatment
Irritant contact dermatitis	Damage to skin because of irritation and loss of epidermoid skin layer; not an allergic reaction. Can be caused by excessive use of soaps and cleansers, repeated handwashing, inadequate hand drying, mechanical irritation (e.g., sweating, rubbing inside powdered gloves), exposure to chemicals added during the manufacturing of gloves, and alkaline pH of powdered gloves. Reaction may occur with first exposure, is usually benign, and is not life-threatening.	*Acute:* Redness, edema, burning, discomfort, itching *Chronic:* Dry, thickened, cracked skin	Referral for diagnostic testing Avoidance of exposure to irritant Thorough washing and drying of hands Use of powder-free gloves with more frequent changes of gloves Changing glove types Use of water- or silicone-based moisturizing creams, lotions, or topical barrier agents Avoidance of oil- or petroleum-based skin agents with latex products, because they cause breakdown of the latex product
Allergic contact dermatitis	Delayed hypersensitivity (type IV) reaction. Usually affects only area in contact with latex; reaction is usually to chemical additives used in the manufacturing process rather than to latex itself. Cause of reaction is T-cell–mediated sensitization to additives of latex. Reaction is not life-threatening and is far more common than a type I reaction.	Pruritus, erythema, swelling, crusty thickened skin, blisters, other skin lesions	Referral for diagnosis (patch tests) and treatment Thorough washing and drying of hands Use of water- or silicone-based moisturizing creams,

	Slow onset; occurs 18–24 h after exposure. Resolves within 3–4 days after exposure. More severe reactions may occur with subsequent exposures.		lotions, or topical barrier agents Avoidance of oil- or petroleum-based products unless they are latex compatible Avoidance of identified causative agent, because continued exposure to latex products in presence of breaks in skin may contribute to latex protein sensitization
Latex allergy	Type I IgE-mediated immediate hypersensitivity to plant proteins in natural rubber latex. In sensitized people, antilatex IgE antibody stimulates mast cell proliferation and basophil histamine release. Exposure can be through contact with the skin, mucous membranes, or internal tissues, or through inhalation of traces of powder from latex gloves. Severe reactions usually occur shortly after parenteral or mucous membrane exposure. People with any type I reaction to latex are at high risk for anaphylaxis. Local swelling, redness, edema, itching, and systemic reactions, including anaphylaxis, occur within minutes after exposure.	Rhinitis, flushing, conjunctivitis, urticaria, laryngeal edema, bronchospasm, asthma, severe vasodilation angioedema, anaphylaxis, cardiovascular collapse, death	Immediate treatment of reaction with epinephrine, fluids, vasopressors, and corticosteroids, and airway and ventilator support, with close monitoring for recurrence for the next 12–14 h Prompt referral for diagnostic evaluation Treatment and diagnostic evaluation in latex-free environment Assessment of all patients for symptoms of latex allergy

	Educating patients and family members about the disorder and the importance of preventing future reactions by avoiding latex (e.g., wearing medical identification, carrying and autoinjector of epinephrine)

IgE, immunoglobulin E.

Adapted from American Academy of Allergy, Asthma, and Immunology (AAAAI). (2019d). Latex Allergy. Retrieved on 7/7/2019 at: www.aaaai.org/conditions-and-treatments/library/allergy-library/latex-allergy

Nursing Management

The nurse can assume a pivotal role in the management of latex allergies in both patients and staff. All patients should be asked about latex allergy. Every time an invasive procedure must be performed, the nurse should consider the possibility of latex allergies. Nurses working in operating rooms, intensive care units, short procedure units, and EDs need to pay particular attention to latex allergy (Hamilton, 2017b). See Chapter 14, Figure 14-2, for a sample latex allergy assessment form.

Although the type I reaction is the most significant of the reactions to latex, care must be taken in the presence of irritant contact dermatitis and delayed hypersensitivity reaction to avoid further exposure of the person to latex. Patients with latex allergy are advised to notify their health care providers and to wear medical identification. Patients must become knowledgeable about what products contain latex and what products are safe, nonlatex alternatives. They must also become knowledgeable about signs and symptoms of latex allergy and emergency treatment and self-injection of epinephrine in case of allergic reaction (Hamilton, 2017b).

CRITICAL THINKING EXERCISES

1 ipc You are the nurse working in an outpatient walk-in clinic. A 28-year-old patient is newly diagnosed with allergic rhinitis. What nursing and interprofessional assessments are indicated? What interventions, including patient education, will you implement? What interprofessional referrals would be appropriate?

2 ebp A 44-year-old presents to the emergency department (ED) complaining of dyspnea after eating at a new restaurant. The patient states that this has happened two other times in the past and seems to be worse each time. What is the evidence for management of this patient? Describe the strength of the evidence and criteria used to assess its strength.

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*Asterisk indicates nursing research.

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Mayo Foundation for Medical Education and Research, www.mayoclinic.org
National Institute of Allergy and Infectious Diseases, www.niaid.nih.gov
Occupational Safety and Health Administration (OSHA), www.osha.gov

34 Assessment and Management of Patients with Inflammatory Rheumatic Disorders

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Explain the pathophysiology of inflammatory rheumatic diseases and describe the assessment and diagnostic findings seen in patients with these disorders.
2. Use the nursing process as a framework for care of the patient with an inflammatory rheumatic disorder.
3. Devise an education plan for the patient with newly diagnosed inflammatory rheumatic disease.
4. Identify modifications in interventions to accommodate changes in patients' functional ability that may occur with disease progression.

NURSING CONCEPTS

Assessment
Cellular Regulation
Comfort
Immunity
Infection
Inflammation

GLOSSARY

arthritis: inflammation of a joint
cytokines: cell signaling proteins that are vital to regulation of hematopoiesis, apoptosis, and immune responses
exacerbation: period when disease symptoms occur or increase
pannus: proliferation of newly formed synovial tissue infiltrated with inflammatory cells
remission: period when disease symptoms are reduced or absent
rheumatic diseases: numerous disorders affecting skeletal muscles, bones, cartilage, ligaments, tendons, and joints
rheumatoid arthritis: a systemic autoimmune disease with symmetric arthritic manifestations and multiple extra-articular features
subchondral bone: bony plate that supports the articular cartilage
tophi: accumulation of crystalline deposits in articular surfaces, bones, soft tissue, and cartilage

The **rheumatic diseases** encompass autoimmune, degenerative, inflammatory, and systemic conditions that affect the joints, muscles, and soft tissues of the body. Rheumatic diseases most commonly manifest the clinical features of **arthritis** (inflammation of a joint) and pain. There are more than 100 types of rheumatic diseases. The problems caused by rheumatic diseases include limitations in mobility and activities of daily living, pain, fatigue, altered self-image, and sleep disturbances, as well as systemic effects that can lead to organ failure and death. An understanding of inflammatory rheumatic diseases and their effects on a patient's function and well-being is essential to developing an appropriate plan of nursing care.

Rheumatic Diseases

Rheumatic disease processes affect males and females of all ages and ethnic groups. Some disorders are more likely to occur at a particular time of life or

to affect one gender more often than the other. In general, women are two to nine times more commonly affected by rheumatic diseases than men (Norris, 2019). Arthritis and other rheumatic diseases and the physical limitations that occur with them are becoming more prominent and a larger public health issue, which can be attributed to the increased number of older adults in the United States.

The onset of these conditions may be acute or insidious, with a course possibly marked by periods of **remission** (a period when disease symptoms are reduced or absent) and **exacerbation** (a period when symptoms occur or increase). Treatment can be simple, aimed at localized relief, or it can be complex, directed toward relief of systemic effects. Permanent changes and disability may result from these disorders.

Nurses need to understand the classification of rheumatic diseases. One system is to classify disease as either monoarticular (affecting a single joint) or polyarticular (affecting multiple joints). Another system is to classify the disease as either inflammatory or noninflammatory. This chapter focuses on inflammatory rheumatic diseases, while noninflammatory rheumatic diseases (i.e., osteoarthritis) are covered in Chapter 36. Conditions that may secondarily affect the musculoskeletal structure are also considered in disease classification.

Pathophysiology

Each of the inflammatory rheumatic diseases exhibits unique pathophysiologic features. Three distinct characteristics of pathophysiology include inflammation, autoimmunity, and degeneration.

Inflammation

Inflammation is a complex physiologic process mediated by the immune system that occurs in response to harmful stimuli like damaged cells or antigens, which may include pathogens (e.g., viruses, bacteria). Inflammation is meant to protect the body from insult by removing the triggering antigen or event. In response to a triggering episode, the antigen stimulus activates the body's immune system to form antibodies like monocytes and T lymphocytes (also referred to as T cells). Next, the immunoglobulin antibodies form immune complexes with antigens. Phagocytosis of the immune complexes is initiated, generating an inflammatory reaction (joint effusion, pain, and edema) (see Fig. 34-1). Phagocytosis produces chemicals such as leukotrienes and prostaglandins. Leukotrienes contribute to the inflammatory process by attracting other white blood cells to the area. Prostaglandins act as modifiers to inflammation. In some cases, they increase inflammation; in other cases, they decrease it. Leukotrienes and prostaglandins produce enzymes such as collagenase that break down collagen, which is a vital part of a normal joint.

The release of these enzymes in the joint causes edema and proliferation of synovial membrane. In patients with chronic inflammation, the immune response can deviate from normal. Instead of resolution of swelling and joint pain once the triggering event has subsided, **pannus** (proliferation of newly formed synovial tissue infiltrated with inflammatory cells) formation occurs. Destruction of the joint's cartilage and erosion of bone soon follow (Norris, 2019).

The immunologic inflammatory process begins when antigens are presented to T lymphocytes, leading to a proliferation of T and B cells. B cells (also referred to as plasma cells) are a source of antibody-forming cells. In response to specific antigens, plasma cells produce and release antibodies. Antibodies combine with corresponding antigens to form pairs, or immune complexes. The immune complexes build up and are deposited in synovial tissue or other organs in the body, triggering the inflammatory reaction that can ultimately damage the involved tissue (Norris, 2019).

Autoimmunity

A hallmark of inflammatory rheumatic diseases is autoimmunity, where the body mistakenly recognizes its own tissue as a foreign antigen. Autoimmunity leads to destruction of tissue via the same inflammatory process as discussed earlier, along with chronic and long-standing pain. Although focused in the joints, inflammation and autoimmunity also involve other areas. The blood vessels (vasculitis and arteritis), lungs, heart, and kidneys may be affected by the autoimmunity and inflammation. See Chapter 32 for more information on autoimmune disease. A large group of genes, called *human leukocyte antigen* (HLA) genes, has been linked to the immune response and the development of multiple rheumatic diseases (Norris, 2019).

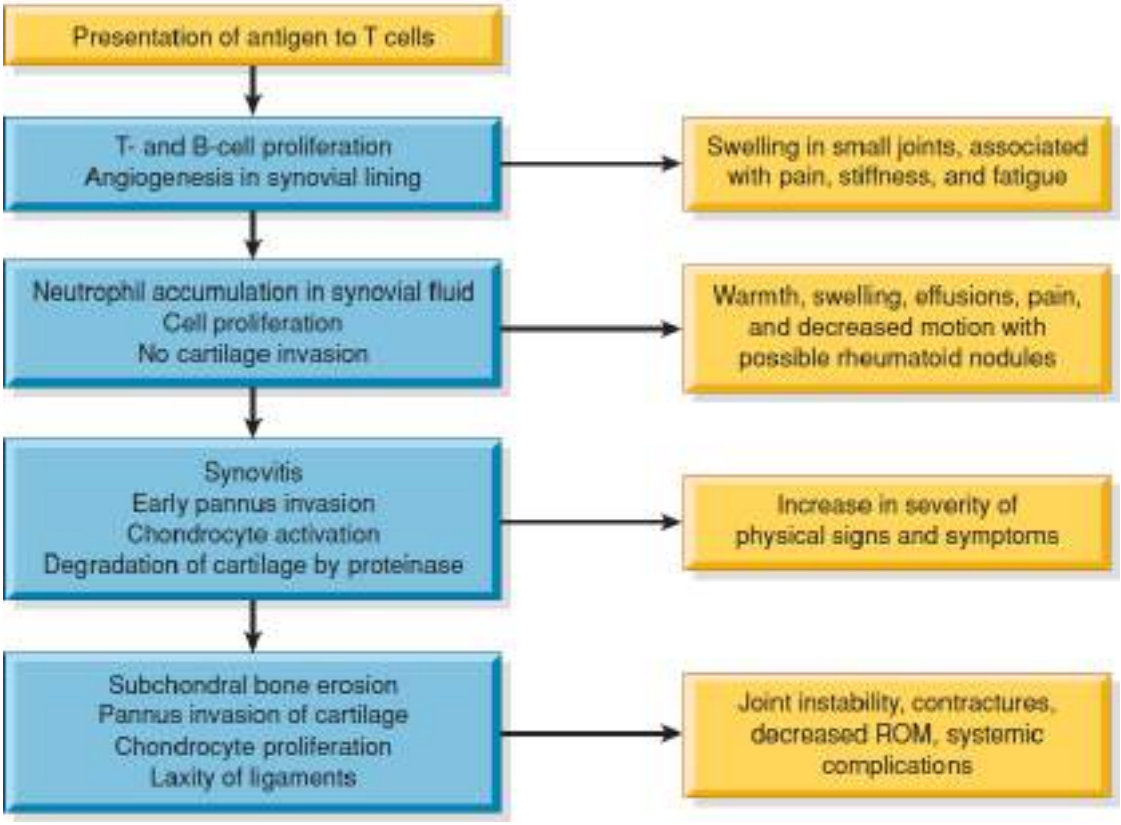

Figure 34-1 • Pathophysiology and associated physical signs of rheumatoid arthritis. ROM, range of motion.

Degeneration

In degenerative rheumatic diseases, inflammation also occurs, but as a secondary process. Although the cause of degeneration of the articular cartilage is poorly understood, the process is known to be metabolically active and therefore is more accurately called *degradation.* One theory of degradation is that genetic or hormonal influences, mechanical factors, and prior joint damage cause cartilage failure. Degradation of cartilage ensues, and increased mechanical stress on bone ends causes stiffening of bone tissue. Another theory is that bone stiffening occurs and results in increased mechanical stress on cartilage, which in turn initiates the processes of degradation. See Chapter 35 for more information on the structure and function of the articular system.

Clinical Manifestations

The most common symptom in the rheumatic diseases is pain. Other common symptoms include joint swelling, limited movement, stiffness, weakness, and fatigue.

Assessment and Diagnostic Findings

Assessment begins with a general health history, which includes the onset of symptoms and how they evolved, family history, past health history, and any other contributing factors. Because many of the rheumatic diseases are chronic conditions, the health history should also include information about the patient's perception of the problem, previous treatments and their effectiveness, the patient's support systems, and the patient's current knowledge base and the source of that information. A complete health history is followed by a complete physical assessment (see Chapter 4).

Assessment for rheumatic diseases combines the physical examination with a functional assessment (Eliopoulos, 2021). Inspection of the patient's general appearance occurs during the initial contact. Gait, posture, and general musculoskeletal size and structure are observed. Gross deformities and abnormalities in movement are noted. The symmetry, size, and contour of other connective tissues, such as the skin and adipose tissue, are also noted and recorded (Weber & Kelley, 2019). Chart 34-1 outlines the important areas for consideration during the physical assessment. The functional assessment is a combination of history (what the patient reports that they can and cannot do) and examination (observation of activities, in which the patient demonstrates what they can and cannot do, such as dressing and getting in and out of a chair). Observation also includes the adaptations and adjustments the patient may have made (sometimes without awareness)—for example, with shoulder or elbow involvement, the person may bend over to reach a fork rather than raising the fork to the mouth.

Laboratory Studies

In Table 34-1 common laboratory studies are listed with their corresponding normal ranges and significance. Many of the tests require special laboratory techniques and may not be performed in every health care facility. The primary provider determines which tests are necessary based on symptoms, stage of disease, cost, and likely benefit. In some instances, tests are used to monitor the course of the disease.

Other Diagnostic Studies

Imaging studies commonly used for patients with rheumatic diseases include x-ray studies, computed tomography (CT) scans, magnetic resonance imaging (MRI) scans, and arthrography. See Chapter 35 for further information about these and other diagnostic studies.

Medical Management

The chronic nature of rheumatic conditions requires cooperation between the patient and the provider. Patient education regarding the disease process and treatment options is imperative to enable patients to make informed decisions regarding their care. Management of rheumatic diseases is based on a shared decision process between the provider and patient that takes into account the patient's values, preferences, and comorbidities (Singh, Saag, Bridges, et al., 2016).

Pharmacologic Therapy

Medications are used with the rheumatic diseases to manage symptoms, to control inflammation, and, in some instances, to modify the disease. Useful medications include the salicylates, nonsteroidal anti-inflammatory drugs (NSAIDs), and both biologic and nonbiologic disease-modifying antirheumatic drugs (DMARDs). As their name suggests, DMARDs have the ability to suppress the autoimmune response; alter disease progression; and stop or decrease further tissue damage on the joints, cartilage, and organs. DMARDs have been found to halt the progression of bone loss and destruction and can induce remission (Singh et al., 2016). Nonbiologic DMARDs are thought to reduce proinflammatory **cytokines** (cell signaling proteins vital to regulation of hematopoiesis, apoptosis, and immune responses) and increase anti-inflammatory cytokines. Biologic DMARDs, in contrast, have been specifically engineered to target a certain cell or molecule within the immune system to treat the specific rheumatic condition. Specific biologic DMARDs target tumor necrosis factor alpha (TNF-α), B cells, T cells, interleukin 1 (IL-1), and interleukin 6 (IL-6). Table 34-2 reviews select medications.

Controlling the inflammation related to the disease process helps manage pain, but this is often a delayed response. Nonopioid medications are often used for pain management, especially early in the treatment program, until other measures can be instituted.

Nonpharmacologic Pain Management

Nonpharmacologic methods of pain management are important. Heat applications are helpful in relieving pain, stiffness, and muscle spasm (Kapale, Vardharajulu, & Warude, 2017). Superficial heat may be applied in the form of warm tub baths or showers and warm moist compresses. Paraffin baths (dips), which offer concentrated heat, are helpful to patients with wrist and small-joint involvement. Maximum benefit is achieved within 20 minutes after application. More frequent use for shorter lengths of time is most beneficial. Therapeutic exercises can be carried out more comfortably and effectively after heat has been applied (Kapale et al., 2017).

Chart 34-1 ASSESSMENT

Assessing for Rheumatic Disorders

In addition to the head-to-toe assessment or systems review, the following are important areas of consideration to be noted when performing the complete physical assessment of a patient with a known or suspected rheumatic disorder.

Manifestation	Significance
Skin (inquire and inspect)	
Rash, lesions	Associated with systemic lupus erythematosus (SLE) vasculitis, adverse effect of medication
Increased bruising	Associated with several rheumatic diseases and adverse effect of medication
Erythema	Sign of inflammation
Thinning	Adverse effect of medication
Warmth	Sign of inflammation
Photosensitivity	Associated with SLE, dermatomyositis, adverse effect of medication
Hair (inquire and inspect)	
Alopecia or thinning	Associated with rheumatic diseases or adverse effect of medication
Eye (inquire and inspect)	
Dryness, grittiness	Associated with Sjögren's syndrome (commonly occurring with rheumatoid arthritis [RA] and SLE)
Decreased acuity or blindness	Associated with temporal arteritis, medication complications
Cataracts	Adverse effect of medication
Decreased peripheral vision	Adverse effect of medication
Conjunctivitis, uveitis	Associated with ankylosing spondylitis and Reiter's syndrome
Ear (inquire)	
Tinnitus	Adverse effect of medication
Decreased acuity	Adverse effect of medication
Mouth (inquire and inspect)	
Buccal, sublingual lesions	Associated with vasculitis, dermatomyositis, adverse effect of medication
Altered sense of taste	Adverse effect of medication
Dryness	Associated with Sjögren's syndrome
Dysphagia	Associated with myositis
Difficulty chewing	Associated with decreased range of motion of jaw
Chest (inspect and inquire)	
Pleuritic pain	Associated with RA and SLE
Decreased chest expansion	Associated with ankylosing spondylitis
Activity intolerance (dyspnea)	Associated with pulmonary hypertension in scleroderma
Cardiovascular system (inquire, inspect, palpate)	

Blanching of fingers on exposure to cold	Associated with Raynaud's phenomenon
Peripheral pulses	Deficit may indicate vascular involvement or edema associated with medication effect or rheumatic diseases, especially SLE or scleroderma
Abdomen (inquire and palpate)	
Altered bowel habits	Associated with scleroderma, spondylosis, ulcerative colitis, decreased physical mobility, medication effect
Nausea, vomiting, bloating, and pain	Adverse effect of medication
Weight change (measure)	Associated with RA (decreased), adverse effect of medication (increased or decreased)
Genitalia (inquire and inspect)	
Dryness, itching	Associated with Sjögren's syndrome
Abnormal menses	Adverse effect of medication
Altered sexual performance	Fear of pain (or of pain caused by partner) and limitation of motion may affect sexual mobility
Hygiene	Poor hygiene may be related to limitations in activities of daily living
Urethritis, dysuria	Associated with ankylosing spondylitis and Reiter's syndrome
Lesions	Associated with vasculitis
Neurologic (inquire and inspect)	
Paresthesias of extremities; abnormal reflex pattern	Nerve compressions (e.g., carpal tunnel syndrome, spinal stenosis)
Headaches	Associated with temporal arteritis, adverse effect of medication
Musculoskeletal (inspect and palpate)	
Joint redness, warmth, swelling, tenderness, deformity—location of first joint involved, pattern of progression, symmetry, acute vs. chronic nature	Signs of inflammation
Joint range of motion	Decreased range of motion may indicate severity or progression of disease
Surrounding tissue findings	
Muscle atrophy, subcutaneous nodules, popliteal cyst	Extra-articular manifestations
Muscle strength (grip)	Muscle strength decreases with increased disease activity

Adapted from Weber, J. R., & Kelley, J. H. (2019). *Health assessment in nursing* (6th ed.). Philadelphia, PA: Wolters Kluwer.

TABLE 34-1 Common Blood Studies for Rheumatic Diseases

Test	Normal Value	Significance
Serum		
Creatinine		
Metabolic waste excreted through the kidneys	*Men*: 0.6–1.2 mg/dL (71–106 mmol/L) *Women*: 0.4–1.0 mg/dL (36–90 mmol/L)	Increase may indicate kidney damage in SLE, scleroderma, and polyarteritis.
Erythrocyte Count		
Measures circulating erythrocytes	*Men:* 4,200,000–5,400,000/mm^3 ($4.2–5.4 \times 10^{12}$/L) *Women:* 3,600,000–5,000,000/mm^3 ($3.6–5.0 \times 10^{12}$/L)	Decrease can be seen in RA, SLE.
Erythrocyte Sedimentation Rate (ESR)		
Measures the rate at which RBCs settle out of unclotted blood in 1 hour	Westergren: Men under 50 yr: <15 mm/h Men over 50 yr: <20 mm/h Women under 50 yr: <20 mm/h Women over 50 yr: <30 mm/h	Increase is usually seen in inflammatory connective tissue diseases. An increase indicates rising inflammation, resulting in clustering of RBCs, which makes them heavier than normal. The higher the ESR, the greater the inflammatory activity.
Hematocrit		
Measures the size, capacity, and number of cells present in blood	*Men:* 42–52% *Women:* 36–48%	Decrease can be seen in chronic inflammation (anemia of chronic disease); also, blood loss through GI bleed.
White Blood Cell Count		
Measures circulating leukocytes	4,500–11,000 cells/mm^3	Decrease may be seen in SLE.
Uric Acid		
Measures level of uric acid in serum	*Men:* 3.4–7 mg/dL (202–416 µmol/L) *Women:* 2.4–6 mg/dL (143–357 µmol/L)	Increase is seen with gout. During acute flare, levels may be normal. After flare has subsided, levels will be elevated in gout.

Serum Immunology		
Antinuclear Antibody (ANA)		
Measures antibodies that react with a variety of nuclear antigens If antibodies are present, further testing determines the type of ANA circulating in the blood (anti-DNA, anti-RNP).	Negative Healthy adults may also have a positive ANA.	Positive test may be associated with SLE, RA, scleroderma, Raynaud's disease, Sjögren's syndrome, necrotizing arteritis. The higher the titer, the greater the inflammation. The pattern of immunofluorescence (speckled, homogeneous, or nucleolar) helps determine the diagnosis.
Anti-DNA, DNA Binding		
Titer measurement of antibody to double-stranded DNA	Negative	High titer is seen in SLE; increases in titer may indicate an increase in disease activity.
C-Reactive Protein (CRP)		
Shows presence of abnormal glycoprotein due to inflammatory process	<1 mg/dL (<10 mg/L)	A positive reading indicates active inflammation.
Immunoglobulin Electrophoresis		
Measures the values of immunoglobulins	*IgA:* 60–400 mg/dL (600–4000 mg/L) *IgG:* 700–1,500 mg/dL (7–15 g/L) *IgM:* 60–300 mg/dL (600–3000 mg/L)	Increased levels are found in people who have autoimmune disorders.
Rheumatoid Factor (RF)		
Determines the presence of abnormal antibodies seen in connective tissue disease	Negative	Positive titer >1:80 Present in 80% of those with RA Positive RF may also suggest SLE, Sjögren's syndrome, or mixed connective tissue disease. The higher the titer (number at right of colon), the greater the inflammation.
Tissue Typing		
HLA-B27 Antigen		
Measures presence of HLA antigens, which are used for tissue recognition	Negative	Found in 80–90% of those with ankylosing spondylitis and Reiter's syndrome

DNA, deoxyribonucleic acid; GI, gastrointestinal; HLA, human leukocyte antigen; IgA, immunoglobulin A; IgG, immunoglobulin G; IgM, immunoglobulin M; RA, rheumatoid arthritis; RBCs, red blood cells; RNP, ribonucleoprotein; SLE, system lupus erythematosus.

Adapted from Fischbach, F. T., & Fischbach, M. A. (2018). *A manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Wolters Kluwer.

TABLE 34-2 Select Medications Used in Rheumatic Diseases

Medication	Action, Use, and Indication	Nursing Considerations
Salicylates		
Acetylated: aspirin *Nonacetylated:* choline trilisalicylate, salsalate, sodium salicylate	*Action:* Anti-inflammatory, analgesic, antipyretic Acetylated salicylates are platelet aggregation inhibitors	Administer with food, milk, antacids or large glass of water to reduce GI effects. Assess for tinnitus, gastric intolerance, GI bleeding, and purpura. Administer enteric coated or extended release whole, do not crush.
Nonsteroidal Anti-Inflammatory Drugs (NSAIDs)		
diclofenac, diflunisal, etodolac, ibuprofen, ketoprofen, meloxicam, nabumetone, naproxen, piroxicam, sulindac *COX-2 enzyme blockers:* celecoxib	*Action:* Anti-inflammatory, analgesic, antipyretic, platelet aggregation inhibitor Anti-inflammatory effect occurs 2–4 wk after initiation All NSAIDs are useful for short-term treatment of acute gout attack NSAIDs are an alternative to salicylates for first-line therapy in several rheumatic diseases *Action:* Inhibit only COX-2 enzymes, which are produced during inflammation, and spare COX-1 enzymes, which can be protective to the stomach	Administer NSAIDs with food. Monitor for GI, CNS, cardiovascular, renal, hematologic, and dermatologic adverse effects. Avoid salicylates; use acetaminophen for additional analgesia. Watch for possible confusion in older adults. Monitoring is the same as for other NSAIDs. Increased risk of cardiovascular events, including myocardial infarction and stroke. Appropriate for older adults and patients who are at high risk for gastric ulcers.
Disease-Modifying Antirheumatic Drugs (DMARDs)		
Antimalarials: hydroxychloroquine, chloroquine	*Action:* Anti-inflammatory, inhibit lysosomal enzymes Slow acting; onset may take 2–4 mo. May be used in conjunction with other DMARD therapy. Useful in RA and SLE.	May be administered concurrently with NSAIDs. Assess for visual changes, GI upset, skin rash, headaches, photosensitivity, bleaching of hair. Emphasize need for ophthalmologic

		examinations (every 6–12 mo).
Janus Kinase (JAK) inhibitors		
tofacitinibic, baricitinic	*Action*: Enters the cell and binds to the active JAK site, inhibits autophosphorylation and JAK activation that inhibits cytokine production. May be used in combination with methotrexate or other nonbiologic DMARDs. May also be used as monotherapy.	Administer twice a day (immediate release) or once daily (extended release). Do not administer with biologic DMARDs or potent immunosuppressants. Test for latent TB before initiation of therapy. Monitor liver enzymes routinely.
sulfasalazine	*Action:* Anti-inflammatory, reduces lymphocyte response, inhibits angiogenesis Useful in RA, seronegative spondyloarthropathies	Administer concurrently with NSAIDs. Do not use in patients with allergy to sulfa medications or salicylates. Emphasize adequate fluid intake. Assess for GI upset, skin rash, headache, liver abnormalities, anemia.
Immunosuppressives: methotrexate, azathioprine, cyclophosphamide	*Action:* Nonbiologic immune suppression, affect DNA synthesis and other cellular effects Have teratogenic potential; azathioprine and cyclophosphamide reserved for more aggressive or unresponsive disease Methotrexate is generally the first-line agent for RA treatment; also useful in SLE. Methotrexate may be given orally or by intramuscular or subcutaneous injection	Assess for bone marrow suppression, GI ulcerations, skin rashes, alopecia, bladder toxicity, increased infections. Monitor CBC, liver enzymes, creatinine at 6 wk after initiation, then every 2–3 mo or accordingly. Advise patient of contraceptive measures because of teratogenicity.
cyclosporine	*Action:* Nonbiologic immune suppression by inhibiting T lymphocytes Used for severe, progressive RA, unresponsive to other DMARDs Used in combination with methotrexate	Assess slow dose titration upward until response noted or toxicity occurs. Assess for toxic effects, such as bleeding gums,

		fluid retention, hair growth, tremors. Monitor blood pressure and renal function (creatinine) every 2 wk until stable.
Immunomodulators		
Pyrimidine synthesis inhibitor: leflunomide	*Action:* Nonbiologic with antiproliferative and anti-inflammatory effects; used in moderate to severe RA May be used alone or in combination with other DMARDs	Long half-life; requires loading dose followed by daily administration. Assess for diarrhea, hair loss, skin rash, mouth sores. Monitor liver function tests. Contraindicated in pregnancy and breast-feeding. Given orally.
TNF-blocking agents: adalimumab, certolizumabpegol, etanercept, infliximab, golimumab	*Action:* Biologic response modifier that binds to TNF, a cytokine involved in inflammatory and immune responses. Used in moderate to severe RA. Can be used alone or with methotrexate or other nonbiologic DMARDs. Adalimumab is given by subcutaneous injection every 2 wk, but may be used every week if efficacy not reached. Certolizumabpegol is given by subcutaneous injection every 2 wk. Etanercept is given by subcutaneous injection weekly. Infliximab is given intravenously over 2 h or more. Medication must be refrigerated. Golimumab is given by subcutaneous injection once a month. Golimumab SQ is a second alternative that is administered intravenously every 8 wk after initial 2 loading doses	Patient should be tested for tuberculosis before beginning this medication. Educate patient about subcutaneous self-injection. Monitor for injection site reactions. Educate patient about increased risk for infection and to withhold medication if fever occurs. Notify provider if any illness or infection occurs and medication is held.
T-cell costimulation modulator: abatacept	*Action:* Blocks one of the pathways needed to fully activate T cells, decreasing inflammatory and immunologic responses. Used in moderate to severe RA	Administered IV initially, then transitions to subcutaneous dosage once weekly. Educate patient about

	unresponsive to TNF inhibitors. Used with methotrexate or DMARDs other than TNF inhibitors or anakinra.	subcutaneous self-injections given daily. Monitor for injection site reactions. Educate patient about increased risk of infection and to withhold medication if fever occurs. IV infusions are given every 4 wk over 30-min infusion.
B-cell production blocker: rituximab	*Action:* Binds to B-lymphocyte CD20 surface antigens. Used in refractory RA in patients with inadequate response to TNF antagonist. Given with methotrexate.	Rituximab is given as two 1000-mg doses via IV infusion separated by 2 wk. Given on wk 0 and 2, and then subsequent doses are infused 24 wk later or based on clinical diagnosis (commonly given every 6 mo). Premedicate with acetaminophen, antihistamine, and methylprednisolone 30 min prior to infusion of rituximab. Educate patient about increased risk of infection.
Human IL-1 receptor antagonist: anakinra	*Action:* Blocks IL-1 receptors, decreasing inflammatory and immunologic responses. Used in moderate to severe RA. Can be used alone or with methotrexate or DMARDs other than TNF-blocking agents	Given daily by subcutaneous injection. Educate patient about subcutaneous self-injections given daily. Medication must be refrigerated. Monitor for injection site reactions. Educate patient about increased risk of infection and to withhold medication if fever occurs.
Human IL-6 receptor antagonist: tocilizumab	*Action:* Binds to and inhibits IL-6 receptors, decreasing inflammatory and immunologic responses. Can be used alone or with methotrexate or in combination with other nonbiologic DMARDs	Administered IV every 4 wk. Educate patient about increased risk of infection.

Corticosteroids		
prednisone, prednisolone, hydrocortisone	*Action:* Anti-inflammatory. Used for shortest duration and at lowest dose possible to minimize adverse effects. Useful for unremitting RA, SLE, polymyalgia rheumatica, myositis, arteritis Fast acting; onset in days Intra-articular injections useful for joints unresponsive to NSAIDs	Assess for toxicity: Cataracts, GI irritation, hyperglycemia, hypertension, fractures, avascular necrosis, hirsutism, psychosis. Joints most amenable to injections include ankles, knees, hips, shoulders, and hands. Repeated injections can cause joint damage. Use caution in patients diagnosed with diabetes, due to effects causing elevation in blood sugar.

CBC, complete blood count; CNS, central nervous system; COX, cyclo-oxygenase; GI, gastrointestinal; IL-1, interleukin 1; IL-6, interleukin 6; IV, intravenous; RA, rheumatoid arthritis; SLE, systemic lupus erythematosus; TNF, tumor necrosis factor.

Adapted from Comerford, K. C., & Durkin, M. T. (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer; Mogul, A., Corsi, K., & McAuliffe, L. (2019). Baricitinic: The second FDA approved JAK inhibitor for the treatment of rheumatoid arthritis. *Annals of Pharmacotherapy*, *53*(9), 947–953.

Devices such as braces, splints, and assistive devices for ambulation (e.g., canes, crutches, walkers) ease pain by limiting movement or stress from putting weight on painful joints. Acutely inflamed joints can be rested by applying splints to limit motion. Splints also support the joint to relieve spasm. Canes and crutches can relieve stress from inflamed and painful weight-bearing joints while promoting safe ambulation. Cervical collars may be used to support the weight of the head and limit cervical motion. A metatarsal bar or special pads may be put into the patient's shoes if foot pain or deformity is present. A combination of methods may be required, because different methods often work better at different times.

Exercise and Activity

The ongoing nature of most rheumatic diseases makes it important to maintain and, when possible, improve joint mobility and overall functional status. Appropriate programs of exercise have been shown to decrease pain and improve function (Eliopoulos, 2021). Changes in gait as well as joint limitations commonly require referral for rehabilitation therapy. An individualized exercise program is crucial to improve movement. Table 34-3

summarizes the exercises appropriate for patients with rheumatic diseases. Physical and occupational therapy programs and interventions are beneficial in improving physical activity and maintaining range of motion. Such interventions may include stretching exercises, muscle conditioning, aerobic exercise, massage, acupuncture, and chiropractic and osteopathic manipulation. Other strategies for decreasing pain include muscle relaxation techniques, imagery, self-hypnosis, and distraction. A mild analgesic agent may be suggested before exercise to improve pain during exercise. A weight reduction program may be recommended to relieve stress on painful joints for patients who are overweight. Any patient who experiences acute or prolonged pain associated with exercise should report the symptoms to their primary provider for evaluation.

TABLE 34-3 Exercise to Promote Mobility

Type of Exercise	Purpose	Recommended Performance	Precautions
Range of motion	Maintain flexibility and joint motion	Active or active/self-assisted at least daily	Reduce the number of repetitions when inflammation is present
Isometric exercise	Improve muscle tone, static endurance, and strength; prepare for dynamic and weight-bearing exercises	Perform at 70% of maximal voluntary contraction daily	Monitor blood pressure; isometric exercises may increase blood pressure and decrease blood flow to muscles
Dynamic exercise	Maintain or increase dynamic strength and endurance; increase muscle power; enhance synovial blood flow; promote strength of bone and cartilage	Start with repetitions against gravity and add progressive resistance; perform 2–3 days per week	May increase biomechanical stress on unstable or misaligned joints
Aerobic exercise	Improve cardiovascular fitness and endurance	Perform 3–5 days per week for 20–30 min of moderate-intensity exercise	Progress slowly as activity tolerance and fitness improve
Pool exercise	Water supports or resists movement; warm water may provide muscle relaxation	Provide buoyant medium for performance of dynamic or aerobic exercise	Heated swimming pool; deep water to minimize joint compression; nonslip footwear for safety and comfort. Receive appropriate education in a program designed for people with arthritis

Adapted from Kapale, P., Vardharajulu, G., & Warude, T. (2017). Effect of free exercise and rheumatoid arthritis. *Indian Journal of Physiotherapy and Occupational Therapy*, *11*(3), 62–65.

The major challenge for the patient and the health care provider is the need to adjust all aspects of treatment according to the activity of the disease. Especially for the patient with an active diffuse connective tissue disease, such as rheumatoid arthritis (RA) or systemic lupus erythematosus (SLE), activity levels may vary from day to day and even within a single day.

Sleep

Short-term use of low-dose antidepressant medications, such as amitriptyline, may be prescribed to reestablish adequate sleep patterns and improve pain management (Comerford & Durkin, 2020). Patients need restful sleep so that they can cope with pain, minimize physical fatigue, and deal with the changes related to having a chronic disease. In patients with acute disease, sleep time is frequently reduced and fragmented by prolonged awakenings. Stiffness, depression, and medications may also compromise the quality of sleep and increase daytime fatigue. A sleep-inducing routine, medication, and comfort measures may help improve the quality of sleep.

Education about sleep hygiene strategies may help promote restorative sleep. These strategies include establishing a set time to sleep and a regular wake-up time, creating a quiet sleep environment with a comfortable room temperature, avoiding factors that interfere with sleep (e.g., the use of alcohol and caffeine), using relaxation exercises, and getting out of bed and engaging in another activity (e.g., reading) if unable to sleep.

Nursing Management

Much of the care of patients with arthritis involves self-management; thus, using a standardized assessment of self-management behaviors will help plan effective on-going care and treatment targets (Oh, Han, Kim, et al., 2018). The Nursing Research Profile in Chart 34-2 describes one such tool. Chart 34-3 details the nursing diagnoses, interventions, and expected outcomes for the patient with a rheumatic disorder.

Gerontologic Considerations

The various rheumatic disease conditions in the older adult pose unique challenges. These challenges relate to disability, cognitive changes, comorbid conditions, and diagnosis. Musculoskeletal problems are the most frequently reported conditions in older adults (Eliopoulos, 2021) and will be seen more frequently by health professionals in the coming years along with associated disability, especially among frail older adults.

Comorbid conditions pose a unique challenge in diagnosing rheumatic disease in older adults because they have the potential to mask or alter presenting symptoms. The frequency, pattern of onset, clinical features, severity, and effects on function of the rheumatic disease in older patients needs to be assessed. One study reported that functional disability was correlated with disease state and thus must be addressed in planning care (Omma, Celik, Bes, et al., 2018). Additional medical conditions may take precedence over the rheumatic disease, causing it to become a secondary diagnosis and concern. Decreased vision and altered balance, often present in older adults, may be problematic if rheumatic disease in the lower extremities

affects locomotion. The combination of decreased hearing and visual acuity, memory loss, and depression contributes to failure to follow the treatment regimen in older adult patients as well (Eliopoulos, 2021). Special techniques for promoting patient safety, self-management, and strategies such as memory aids for medications may be necessary.

Chart 34-2 NURSING RESEARCH PROFILE

Assessing Self-Management in Patients with Arthritis

Oh, H. S., Han, S. Y., Kim, S. H., et al. (2018). Development and validity testing of an arthritis self-management assessment tool. *Orthopaedic Nursing*, *37*(1), 24–35.

Purpose

Self-management is central to arthritis treatment; yet, no instrument existed to measure arthritis self-management ability. Therefore, the purpose of this research was to develop and test the reliability and validity of a comprehensive tool to assess self-management in patients with arthritis.

Design

A nonexperimental correlational design was used for this study. Items for inclusion on the Arthritis Self-Management Assessment Tool (ASMAT) were generated using a chronic illness management model. Content validity of the initial 42 items were reviewed by a panel of experts and decreased to 32 items. The tool was then tested with 150 patients with arthritis in an outpatient setting. Factor analysis was used to test construct validity.

Findings

The mean age of participants was 52 years and approximately 60% were male. There were 32 items generated and tested in the final version of the ASMAT. The 32 items were validated and the scale was found to have 3 subscales: that of medical management tasks (10 items), behavioral management tasks (13 items), and psycho-emotional management tasks (9 items). Confirmatory factor analysis showed construct validity for the 32 item tool. Cronbach α levels showed the overall toll and the 3 subscales to be reliable.

Nursing Implications

Nurses are in a key position to assist patients with arthritis to self-manage their care. Performing an ASMAT helps evaluate the patient's self-management abilities and the effectiveness of self-management interventions. Early identification of barriers to adoption of self-management strategies can lead to improved symptom management, independence, and improved quality of life.

Behavioral clues such as gait patterns, guarding, and joint flexion may aid the nurse in assessing the patient's pain when cognitive impairment is present. Older adults, especially men, may also neglect to communicate their pain unless elicited by the provider. Pain, in general, in this population that is not treated or undertreated may impact the quality of life for these patients, which can exacerbate all other medical conditions.

Chart 34-3 PLAN OF NURSING CARE

Care of the Patient with a Rheumatic Disorder

Nursing Diagnosis: Acute and chronic pain associated with inflammation and increased disease activity, tissue damage, fatigue, or lowered tolerance level

Goal: Improvement in comfort level; incorporation of pain management techniques into daily life

Nursing Interventions	Rationale	Expected Outcomes
1. Provide variety of comfort measures: a. Application of heat or cold b. Massage, position changes, rest c. Foam mattress, supportive pillow, splints d. Relaxation techniques, diversional activities 2. Administer anti-inflammatory, analgesic, and slow-acting antirheumatic medications as prescribed. 3. Individualize medication schedule to meet patient's need for pain management. 4. Encourage verbalization of feelings about pain and chronicity of disease. 5. Assess for subjective changes in pain.	1. Pain may respond to nonpharmacologic interventions, such as exercise, relaxation, and thermal modalities. 2. Pain of rheumatic disease responds to monotherapy or combination medication regimens. 3. Previous pain experiences and management strategies may be different from those needed for persistent pain. 4. Verbalization promotes coping. 5. The impact of pain on an individual's life often leads to misconceptions about pain and pain management techniques. The individual's description of pain is a more reliable indicator than objective measurements	• Identifies factors that exacerbate or influence pain response • Identifies and uses pain management strategies • Verbalizes decrease in pain • Reports signs and symptoms of side effects in timely manner to prevent additional problems • Verbalizes that pain is characteristic of rheumatic disease • Establishes realistic pain relief goals • Identifies changes in quality or intensity of pain

	such as change in vital signs, body movement, and facial expression.	
NURSING DIAGNOSIS: Fatigue associated with increased disease activity, pain, inadequate sleep/rest, deconditioning, inadequate nutrition, emotional stress, anxiety, and depressive symptoms **Goal:** Incorporates as part of daily activities strategies necessary to modify fatigue		
Nursing Interventions	**Rationale**	**Expected Outcomes**
1. Provide education about fatigue. a. Describe relationship of disease activity to fatigue. b. Describe comfort measures while providing them. c. Develop and encourage a sleep routine (warm bath and relaxation techniques that promote sleep). d. Explain importance of rest for relieving systematic, articular, and emotional stress. e. Explain how to use energy conservation techniques (pacing, delegating, setting priorities). f. Identify physical and emotional factors that can cause fatigue.	1. The patient's understanding of fatigue will affect their actions. a. The amount of fatigue is directly related to the activity of the disease. b. Relief of discomfort can relieve fatigue. c. Effective bedtime routine promotes restorative sleep. d. Different kinds of rest are needed to relieve fatigue and are based on patient's need and response. e. A variety of measures can be used to conserve energy.	• Self-evaluates and monitors fatigue pattern • Verbalizes the relationship of fatigue to disease activity • Uses comfort measures as appropriate • Practices effective sleep hygiene and routine • Makes use of various assistive devices (splints, canes) and strategies (bed rest, relaxation techniques) to ease different kinds of fatigue • Incorporates time management

2. Facilitate development of appropriate activity/rest schedule. 3. Encourage adherence to the treatment program. 4. Refer to and encourage a conditioning program. 5. Encourage adequate nutrition, including source of iron from food and supplements.	f. Awareness of the various causes of fatigue provides the basis for measures to modify the fatigue. 2. Alternating rest and activity conserves energy while allowing most productivity. 3. Overall control of disease activity can decrease the amount of fatigue. 4. Deconditioning resulting from lack of mobility, understanding, and disease activity contributes to fatigue. 5. A nutritious diet can help counteract fatigue.	strategies in daily activities • Uses appropriate measures to prevent physical and emotional fatigue • Has an established plan to ensure well-paced, therapeutic activity schedule • Adheres to therapeutic program • Follows a planned conditioning program • Consumes a nutritious diet consisting of the five major groups and recommended daily allowance of vitamins and minerals

Nursing Diagnosis: Impaired mobility associated with decreased range of motion, muscle weakness, pain on movement, limited endurance, lack of or improper use of ambulatory devices

Goal: Attains and maintains optimal functional mobility

Nursing Interventions	Rationale	Expected Outcomes
1. Encourage verbalization	1. Mobility is not necessarily	• Identifies factors that

regarding limitations in mobility. 2. Assess need for occupational or physical therapy consultation. a. Emphasize range of motion of affected joints. b. Promote the use of assistive ambulatory devices. c. Explain the use of safe footwear. d. Use individual appropriate positioning/posture. 3. Assist to identify environmental barriers. 4. Encourage independence in mobility and assist as needed. a. Allow ample time for activity. b. Provide rest period after activity. c. Reinforce principles of pacing and work simplification. 5. Initiate referral to community health agency.	related to deformity. Pain, stiffness, and fatigue may temporarily limit mobility. The degree of mobility is not synonymous with the degree of independence. Decreased mobility may influence a person's self-concept and lead to social isolation. 2. Therapeutic exercises, proper footwear, and assistive equipment may improve mobility. Correct posture and positioning are necessary for maintaining optimal mobility. 3. Furniture and architectural adaptations may enhance mobility. 4. Changes in mobility may lead to a decrease in personal safety. 5. The degree of mobility may be slow to improve or may not improve with intervention.	interfere with mobility • Describes and uses measures to prevent loss of motion • Identifies environmental (home, school, work, community) barriers to optimal mobility • Uses appropriate techniques, assistive equipment, or both to aid mobility • Identifies community resources available to assist in managing decreased mobility
Nursing Diagnosis: Able to perform self care associated with contractures, fatigue, or loss of motion		

Goal: Performs self-care activities independently or with the use of resources

Nursing Interventions	Rationale	Expected Outcomes
1. Assist patient to identify self-care deficits and factors that interfere with ability to perform self-care activities. 2. Develop a plan based on the patient's perceptions and priorities on how to establish and achieve goals to meet self-care needs, incorporating energy conservation, and work simplification concepts. a. Provide appropriate assistive devices. b. Reinforce correct and safe use of assistive devices. c. Allow patient to control timing of self-care activities. d. Explore with the patient different ways to perform difficult tasks or ways to enlist the help of someone else. 3. Consult with community health care agencies when individuals have attained a maximum level of self-care yet still have some	1. The ability to perform self-care activities is influenced by the disease activity and the accompanying pain, stiffness, fatigue, muscle weakness, loss of motion, and depression. 2. Assistive devices may enhance self-care abilities. Effective planning for changes must include the patient, who must accept and adopt the plan. 3. Individuals differ in ability and willingness to perform self-care activities. Changes in ability to care for self may lead to a decrease in personal safety.	• Identifies factors that interfere with the ability to perform self-care activities • Identifies alternative methods for meeting self-care needs • Uses alternative methods for meeting self-care needs • Identifies and uses other health care resources for meeting self-care needs

deficits, especially regarding safety.

Nursing Diagnosis: Disturbed body image associated with physical and psychological changes and dependency imposed by chronic illness
Goal: Adapts to physical and psychological changes imposed by the rheumatic disease

Nursing Interventions	Rationale	Expected Outcomes
1. Help patient identify elements of control over disease symptoms and treatment. 2. Encourage patient's verbalization of feelings, perceptions, and fears. a. Help to assess present situation and identify problems.	1. The individual's self-concept may be altered by the disease or its treatment. 2. The individual's coping strategies reflect the strength of their self-concept.	• Verbalizes an awareness that changes taking place in self-concept are normal responses to rheumatic disease and other chronic illnesses • Identifies strategies to cope with altered self-concept

Nursing Diagnosis: Difficulty coping associated with actual or perceived lifestyle or role changes

Goal: Use of effective coping behaviors for dealing with actual or perceived limitations and role changes

Nursing Interventions	Rationale	Expected Outcomes
1. Identify areas of life affected by disease. Answer questions and dispel possible myths. a. Assist to identify past coping mechanisms. b. Assist to identify effective coping mechanisms. 2. Develop plan for managing symptoms and enlisting support of family and friends to promote daily function.	1. The effects of disease may be more or less manageable once identified and explored reasonably. 2. By taking action and involving others appropriately, patient develops or draws on coping skills and community support.	• Names functions and roles affected and not affected by disease process • Describes therapeutic regimen and states actions to take to improve, change, or accept a particular situation, function, or role

Collaborative Problems: Complications secondary to effects of medications

Goal: Absence or resolution of complications

Nursing Interventions	Rationale	Expected Outcomes
1. Perform periodic clinical assessment and laboratory evaluation.	1. Skillful assessment helps detect early symptoms of side effects of medications.	• Adheres to monitoring procedures and experiences minimal side effects

Provide 2. education about correct self-administration, potential side effects, and importance of monitoring. 3. Counsel regarding methods to reduce side effects and manage symptoms. 4. Administer medications in modified doses as prescribed if complications occur.	2. The patient needs accurate information about medications and potential side effects to avoid or manage them. 3. Appropriate identification and early intervention may minimize complications. 4. Modifications may help minimize side effects or other complications.	Takes medication as • prescribed and lists potential side effects • Identifies strategies to reduce or manage side effects • Reports that side effects or complications have subsided

Pharmacologic therapy (including analgesic agents), exercise, postural assistance, modification of activities of daily living, and psychological support are useful components of a self-management program for the older adult (Oh et al., 2018).

Identifying the effects of the rheumatic disease on the patient's lifestyle, independence, and psychological status is important and can improve the quality of life for older adults. Depressed mood is routinely found in those suffering from chronic joint disease. The body image and self-esteem of the older adult with rheumatic disease, combined with underlying depression, may interfere with the use of assistive devices such as canes. The use of adaptive equipment such as long-handled reachers or tongs may be viewed by the older adult as evidence of aging rather than as a means of increasing independence.

Because most rheumatic diseases involve pain, especially with joints, some older adults may consider their symptoms as inevitable consequences of aging. In fact, many older adults expect and accept the immobility and self-care problems related to the rheumatic diseases and do not seek help, thinking that nothing can be done.

The older adult usually has a lifelong pattern of dealing with the stresses of daily life. Depending on the success of that pattern, the older adult can often maintain a positive attitude and self-esteem when faced with a rheumatic disease, especially if support is available. Previous stress management strategies are assessed. If these strategies have been effective, the patient is

encouraged and supported in their use. If they were ineffective, the nurse assists the patient in identifying alternative strategies, encourages the use of new strategies, and assesses their effectiveness.

Pharmacologic treatment of rheumatic disease in older patients is more difficult than in younger patients. If therapeutic medications have an effect on the senses (hearing, cognition), this effect is intensified in the older adult. The cumulative effect of medications, in general, is accentuated because of the physiologic changes of aging. For example, decreased renal function in the older adult alters the metabolism of certain medications, such as NSAIDs. Older adults are more prone to side effects associated with the use of multiple-drug therapy.

Partly because of the more frequent contact of older adults with health care providers for a variety of health issues, overtreatment or inappropriate treatment is possible. Complaints of pain may be met with a prescription for analgesic agents rather than instructions for rest, the use of an assistive device, and local comfort measures such as heat or cold. Acetaminophen may be appropriate and worth trying before other medications that pose a greater chance of side effects. NSAIDs can be used; however, long-term use of NSAIDs can increase the risks of peptic ulcers, hemorrhage, and cardiovascular toxicity (Comerford & Durkin, 2020).

Intra-articular corticosteroid injections, with their usually rapid relief of symptoms, may be requested by the patient who is unaware of the consequences of too-frequent use of this treatment. In addition, exercise programs may not be instituted or may be ineffective because the patient expects results to occur quickly or fails to appreciate the effectiveness of a program of exercise. In fact, strength training is encouraged in the older adult with chronic diseases.

Diffuse Connective Tissue Diseases

Diffuse connective tissue disease refers to a group of systemic disorders that are chronic in nature and are characterized by diffuse inflammation and degeneration in the connective tissues. These disorders share similar clinical features and may affect some of the same organs. The characteristic clinical course is one of exacerbations and remissions. Although diffuse connective tissue diseases have unknown causes, they are thought to be the result of immunologic abnormalities. They include RA, SLE, Sjögren's syndrome, scleroderma, polymyositis, polymyalgia rheumatica (PMR), and giant cell arteritis (GCA).

Rheumatoid Arthritis

Rheumatoid arthritis is an autoimmune disease of unknown origin that affects 1% to 2% of the population worldwide, with females having a three times greater incidence than males. It may occur at any age but the onset commonly occurs between the third and sixth decade of life. The incidence of RA increases after the sixth decade of life (Norris, 2019). RA that occurs after the age of 65 is referred to as elderly onset RA (Norris, 2019). Additional risks that have been identified include family history, environmental influences such as diet or geographic location, nulliparity, as well as the modifiable factors of smoking and obesity (Mogul, Corsi, & McAuliffe, 2019).

Pathophysiology

The exact mechanism of action for the etiology of RA is unknown. Evidence points to a genetic predisposition and the development of immunologically mediated joint inflammation (Eliopoulos, 2021; Norris, 2019). An autoimmune reaction (see Fig. 34-1) occurs in the synovial tissue. RA synovium breaks down collagen, causing edema, proliferation of the synovial membrane, and ultimately pannus formation. Pannus destroys cartilage and erodes the bone. The consequence is the loss of articular surfaces and joint motion. Muscle fibers undergo degenerative changes. Tendon and ligament elasticity and contractile power are lost.

The RA inflammatory process has also been implicated in other disease processes (i.e., arteriosclerosis). It is hypothesized that the RA disease process somehow interferes with the production of high-density lipoprotein cholesterol, which is the form of cholesterol responsible for decreasing cellular lipids and, therefore, is considered antiatherosclerotic.

The nervous system is also affected by the RA inflammatory process. The synovial inflammation can compress the adjacent nerve, causing neuropathies and paresthesias. Axonal degeneration and neuronal demyelination are also possible due to the infiltration of polymorphonuclear leukocytes, eosinophils, and mononuclear cells, causing necrotizing or occlusive vasculitis (Norris, 2019).

Clinical Manifestations

The American College of Rheumatology and the European League Against Rheumatism have collaborated and established criteria for classifying RA. These criteria are based on a point system where a total score of 6 or greater is required for the diagnosis of RA. The scoring system is based on joint involvement (number of joints affected), serology (low positive or high positive rheumatoid factor [RF] or anti-citrullinated peptide antibody [ACPA]), abnormal results of the acute phase reactants (erythrocyte sedimentation rate [ESR] or C-reactive protein [CRP]), and duration of symptoms greater than 6

weeks. Patients diagnosed with RA who are excluded from these diagnostic criteria include: (1) patients who have one joint with synovitis that is not related to any other clinical disease and who also score at least 6 to 10 points on the scale, and (2) patients diagnosed with bony erosions on x-ray (Aletaha, Neogi, Silman, et al., 2010; Molano-Gonzalez, Olivares-Matinez, Anaya, et al., 2019).

The initial clinical manifestations of RA include symmetric joint pain and morning joint stiffness lasting longer than 1 hour. Over the course of the disease, clinical manifestations of RA vary, usually reflecting the stage and severity of the disease. Symmetric joint pain, swelling, warmth, erythema, and lack of function are classic symptoms. Palpation of the joints reveals spongy or boggy tissue. Often, fluid can be aspirated from the inflamed joint. Characteristically, the pattern of joint involvement begins in the small joints of the hands, wrists, and feet (Omma et al., 2018). As the disease progresses, the knees, shoulders, hips, elbows, ankles, cervical spine, and temporomandibular joints may be affected. The onset of symptoms is usually acute. Symptoms are usually bilateral and symmetric.

In the early stages of disease, even before the presentation of bony changes, limitation in function can occur when there is active inflammation in the joints. Joints that are hot, swollen, and painful are not easily moved. The patient tends to guard or protect these joints by immobilizing them. Immobilization for extended periods can lead to contractures, creating soft tissue deformity.

Deformities of the hands (e.g., ulnar deviation and swan neck deformity) and feet are common in RA (see Chapter 35, Fig. 35-6). The deformity may be caused by misalignment resulting from swelling, progressive joint destruction, or the subluxation (partial dislocation) that occurs when one bone slips over another and eliminates the joint space. Deformities of RA differ from those seen with osteoarthritis (OA), such as Heberden's and Bouchard's nodes (see Chapter 36).

RA is a systemic disease with multiple extra-articular features. Most common are fever, weight loss, fatigue, anemia, lymph node enlargement, and Raynaud's phenomenon (cold- and stress-induced vasospasm causing episodes of digital blanching or cyanosis). Rheumatoid nodules are common in patients with more advanced RA. These nodules are usually nontender and movable in the subcutaneous tissue. They usually appear over bony prominences such as the elbow, are varied in size, and can disappear spontaneously or progress to ulceration (Weber & Kelley, 2019; Young, 2019). Nodules occur only in people who have rheumatoid factor. Other extra-articular features include arteritis, neuropathy, pericarditis, splenomegaly, and Sjögren's syndrome (dry eyes and dry mucous membranes).

Assessment and Diagnostic Findings

Several assessment findings are associated with RA: rheumatoid nodules, joint inflammation detected on palpation, and certain laboratory findings. The history and physical examination focus on manifestations, such as bilateral and symmetric stiffness, tenderness, swelling, and temperature changes in the joints (Weber & Kelley, 2019). The patient is also assessed for extra-articular changes; these often include weight loss, sensory changes, lymph node enlargement, and fatigue. Symptoms and examination findings are often recorded using a disease activity score, a variety of which are in use, to evaluate disease activity, help guide treatment decisions, and monitor treatment efficacy (Mahmood, van Tuyl, Schoonmade, et al., 2019).

Rheumatoid factor is present in many patients with RA, but its presence alone is not diagnostic of RA, and its absence does not rule out the diagnosis. Antibodies to cyclic citrullinated peptide (anti-CCP) have a specificity of approximately 95% at detecting RA (Norris, 2019). The ESR and CRP tend to be significantly elevated in the acute phases of RA and are therefore useful in monitoring active disease and disease progression. The complete blood count (CBC) should be assessed to establish a baseline count especially prior to starting medications (Fischbach & Fischbach, 2018). Patients may exhibit anemia, and platelets may be elevated due to the inflammatory process. A tuberculin (TB) skin test should be done prior to the initiation of certain medications to rule out tuberculosis. In the event the patient has latent TB and has never been treated, the infection can be reactivated. The patient should also be assessed for hepatitis B and hepatitis C, which could impact treatment strategies if positive. If the client tests positive for hepatitis, the infection should be treated prior to starting medication. Liver and kidney monitoring are recommended for most DMARD therapy because it can cause elevation of the liver enzymes and can also affect kidney function.

X-ray, ultrasound, or both of the hands, wrists, and feet can be useful in establishing a baseline for joint evaluation, and assessing the joints for erosions and synovitis. Joint damage may occur within the first 6 to 12 months of diagnosis and should be followed as indicated. Plain x-ray is the most common radiographic study used to track disease progression as it is inexpensive, reliable, and reproducible (Mahmood et al., 2019). MRI can also be useful to detect small erosions that may not be visible on x-ray or ultrasound.

Medical Management

The goal of treatment at all phases of the RA disease process is to decrease joint pain and swelling, achieve clinical remission, decrease the likelihood of joint deformity, and minimize disability. Initial treatment delays have been implicated in greater long-term joint deformity. Aggressive and early treatment

regimens are warranted. The use of a targeted pharmacologic treatment strategy is recommended to decrease RA disease activity (Singh et al., 2016).

Early Rheumatoid Arthritis

Once the diagnosis of RA is made, treatment should begin with either a nonbiologic or biologic DMARD. The goal of using DMARD therapy is preventing inflammation and joint damage.

Recommended treatment guidelines include beginning with the nonbiologic DMARDs (methotrexate is the preferred agent but leflunomide, sulfasalazine, or hydroxychloroquine are also used) biologics, or tofacitinibic within 3 months of disease onset. Care should be used with each of these medications by performing routine blood testing for liver and kidney function, along with monitoring the CBC for anemia. Dosage may need to be modified for patients with renal impairment (Comerford & Durkin, 2020).

Another treatment approach for RA is the use of biologic DMARDs. These agents have been specifically engineered to target the most prominent proinflammatory mediators in RA—TNF-α, B cells, T cells, IL-1, and IL-6 (see Table 34-2). Biologic DMARDs are the first targeted therapy for RA. Clinical evidence suggests that biologic DMARDs work more quickly and show a greater delay in radiologic disease progression when compared to nonbiologic DMARDs. The biologic DMARDs are more expensive and have fewer years of usage with the RA population. Therefore, they tend to be reserved for patients with persistent moderate to severe RA who have not responded adequately to synthetic DMARDs (Singh et al., 2016).

After initiating treatment with a DMARD, patients generally report a beneficial effect within 6 weeks and tolerate the medication relatively well. However, some patients may take longer to see improvement. Corticosteroids are recommended as a "bridge" in the early treatment but are not recommended for long-term therapy due to side effects (Singh et al., 2016).

A newer class of drugs, the Janus Kinase (JAK) inhibitors, bind to the active JAK enzyme sites, inhibiting autophosphorylation and thus inhibiting cytokine production and decreasing the immune response (Mogul et al., 2019). JAK inhibitors are used in combination with methotrexate or other nonbiologic DMARDs. They may also be used as monotherapy (Mogul et al., 2019; Singh et al., 2016).

NSAIDs and specifically the cyclo-oxygenase 2 (COX-2) enzyme blockers are used for pain and inflammation relief. NSAIDs, such as ibuprofen and naproxen, are commonly prescribed because of their low cost and analgesic properties. They must be used with caution, however, in long-term chronic diseases because of the possibility of gastric ulcers. Several COX-2 enzyme blockers have been approved for treatment of RA. Cyclo-oxygenase is an enzyme that is involved in the inflammatory process. COX-2 medications block the enzyme involved in inflammation (COX-2) while leaving intact the

enzyme involved in protecting the stomach lining (COX-1). As a result, COX-2 enzyme blockers are less likely to cause gastric irritation and ulceration than other NSAIDs; however, they are associated with increased risk of cardiovascular disease and must be used with caution (Comerford & Durkin, 2020). The nurse should be aware that NSAIDs do not prevent erosions or alter disease progression and, consequently, are medications useful only for symptom relief (Singh et al., 2016).

Additional analgesia may be prescribed for periods of extreme pain. Opioid analgesic agents are avoided because of the potential for continuing need for pain relief. Nonpharmacologic pain management techniques (e.g., relaxation techniques, heat and cold applications) are taught.

Established Rheumatoid Arthritis

In patients with established RA, a formal program with occupational and physical therapy is prescribed to educate the patient about principles of pacing activities, work simplification, range of motion, and muscle-strengthening exercises. The patient is encouraged to participate actively in the management program. The medication program is reevaluated periodically, and appropriate changes are made if disease progression is occurring despite pharmacologic treatment. Additional agents may be added to enhance the disease-modifying effect of methotrexate. Combination therapy using one nonbiologic DMARD and one biologic DMARD is common (Singh et al., 2016).

For more established RA, reconstructive surgery and corticosteroids are often used. Reconstructive surgery is indicated when pain cannot be relieved by conservative measures and the threat of loss of independence is eminent. Surgical procedures include synovectomy (excision of the synovial membrane), tenorrhaphy (suturing of a tendon), arthrodesis (surgical fusion of the joint), surgical repair, and replacement of the joint. Surgery is not performed during exacerbations.

Systemic corticosteroids are used when the patient has unremitting inflammation and pain or needs a “bridging” medication while waiting for the slower DMARDs (e.g., methotrexate) to begin taking effect. Low-dose corticosteroid therapy is prescribed for the shortest time necessary to minimize side effects (Singh et al., 2016). Single large joints that are severely inflamed and fail to respond promptly to the measures outlined previously may be treated by local injection of a corticosteroid.

Topical analgesic agents such as capsaicin and methylsalicylate are often prescribed. Topical diclofenac sodium gel may help with joint pain in the hands and knees (Comerford & Durkin, 2020).

For most patients with RA, the emotional and possible financial burden of the disease can lead to depressive symptoms and sleep deprivation. The patient may require the short-term use of low-dose antidepressant medications, such as amitriptyline, paroxetine, or sertraline, to reestablish an adequate sleep

pattern and manage depressive symptoms. Patients may benefit from referrals for talk therapy or group support.

Obesity Considerations

The prevalence of obesity is increasing in the general population and in patients with RA. One large study reported that the prevalence of obesity, diagnosed with a body mass index (BMI) of greater than or equal to 30 kg/m^2, was approximately 20% at diagnosis and increased each year (Nikiphorou, Norton, Young, et al., 2018). Furthermore, the presence of obesity adversely affected disease progression, function, and quality of life in patients with RA followed for 10 to 25 years (Nikiphorou et al., 2018). Management of obesity in the patient with RA is essential.

Certain medications (i.e., oral corticosteroids) used in RA treatment stimulate the appetite and, when combined with decreased activity, may lead to weight gain. In fact, one study reported that approximately half the increase in BMI within the first year of diagnosis with RA could be attributed to steroid use (Nikiphorou et al., 2018).

A dietician can counsel the patient about better food choices. Food selection should include the five major groups (grains, vegetables, fruits, dairy, and protein), with emphasis on foods high in vitamins, protein, and iron for tissue building and repair. Patients who are overweight or have obesity need to be counseled about eating a healthy, calorie-restricted diet.

Nursing Management

Nursing care of the patient with RA follows the basic plan of care presented earlier (see Chart 34-3). The most common issues for the patient with RA include pain, sleep disturbance, fatigue, altered mood, and limited mobility. The patient with newly diagnosed RA needs information about the disease to make daily self-management decisions and cope with having a chronic disease. Consultation with a dietician for assessment and assistance with appropriate food choices may be helpful.

Monitoring and Managing Potential Complications

Patients commonly have comorbid conditions such as cardiovascular disease that can lead to complications. It has been estimated that the primary cause of death for up to 40% of patients diagnosed with RA is cardiovascular disease. The cause of cardiovascular disease in these patients is thought to be due to elevated lipid values, chronic inflammation, dysfunction of the endothelium, and/or abnormal homocysteine levels (Norris, 2019).

Medications used for treating RA may cause serious and adverse effects. The primary provider bases the prescribed medication regimen on clinical findings and past medical history, and then, with the help of the nurse, monitors for side effects using periodic clinical assessments and laboratory testing. The nurse, who can be available for consultation between visits with the primary provider, works to help the patient recognize and deal with these side effects (see Table 34-2). Medication may need to be stopped or the dose reduced. If the patient experiences an increase in symptoms while the complication is being resolved or a new medication is being initiated, the nurse's counseling regarding symptom management may relieve potential anxiety and distress.

Promoting Home, Community-Based, and Transitional Care

Educating Patients About Self-Care

Patient education is an essential aspect in nursing care of the patient with RA to enable the patient to maintain as much independence as possible, to take medications accurately and safely, and to use adaptive devices correctly (Oh et al., 2018). Patient education focuses on self-management related to the disorder, the therapeutic regimen prescribed to treat it, and the potential side effects of medications. Patients undergoing surgery need education as well. The nurse works with the patient and family on strategies to maintain independence, function, and safety in the home (see Chart 34-4).

The patient and family are encouraged to verbalize their concerns and ask questions. Because RA commonly affects young women, major concerns may be related to the effects of the disease on childbearing potential, caring for family, or work responsibilities. The patient with a chronic illness may seek a "cure" or have questions about alternative therapies. Research indicates that acupuncture is safe and may be beneficial for patients with RA (Chou & Chu, 2018). There is not enough evidence of the effectiveness of other complementary, alternative, and integrative health therapies, and more rigorous research is needed (Chou & Chu, 2018; Katz-Talmor, Katz, Porta-Katz, et al., 2018).

The nurse educates patients using topical analgesic agents to apply sparingly, avoid areas of open skin, and avoid contact with eyes and mucous membranes. Patients should also wash their hands carefully after application and assess for local skin irritation. Pain, fatigue, and depressive symptoms can interfere with the patient's ability to learn and should be addressed before the education is initiated. Various educational strategies may then be used, depending on the patient's previous knowledge base, interest level, degree of comfort, social or cultural influences, and readiness to learn. The nurse

educates the patient about basic disease management and necessary adaptations in lifestyle. Some types of aerobic exercise and strength training should be discussed (Kapale et al., 2017). Because suppression of inflammation and autoimmune responses require the use of anti-inflammatory, disease-modifying antirheumatic, and immunosuppressive agents, the patient is taught about prescribed medications, including type, dosage, rationale, potential side effects, self-administration, and required monitoring procedures. If hospitalized, the patient is encouraged to practice new self-management skills with support from caregivers and significant others. The nurse then reinforces disease management skills during each patient contact. Barriers are assessed, and measures are taken to promote adherence to medications and the treatment program.

Chart 34-4 HOME CARE CHECKLIST

The Patient with Rheumatoid Arthritis

At the completion of education, the patient and/or caregiver will be able to:

State the impact of rheumatoid arthritis on physiologic functioning, ADLs, IADLs, roles, relationships, and spirituality.

- State changes in lifestyle (e.g., diet, activity, rest) necessary to maintain health.
- State the name, dose, side effects, frequency, and schedule for all medications.
- Demonstrate accurate and safe self-administration of medications.
- Describe and demonstrate the use of pain management techniques.
- Demonstrate ability to perform ADLs independently or with assistive devices/adaptive equipment.
- Verbalize ways to cope with stress successfully, plans for regular, safe exercise, and rationale for obtaining adequate rest. Demonstrate a relaxation technique.
- Verbalize a dietary plan that includes maintaining or losing weight while maximizing vitamins, protein, and iron for tissue building and repair
- State how to reach primary provider with questions or complications
- State time and date of follow-up appointments, testing
- Identify the need for health promotion, disease prevention, and screening activities
- Identify community resources for peer and caregiver/family information and support:
  - Identify sources of support (e.g., friends, relatives, faith community)
  - Identify the contact details for support services for patients and their caregivers/families

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Continuing and Transitional Care

Depending on the severity of the disease and the patient's resources and supports, referral for home care may be warranted. For example, the patient who is an older adult or frail, has RA that limits function significantly, and lives alone may need referral for home care.

The impact of RA on everyday life is not always evident when the patient is seen in the hospital or in an ambulatory care setting. The increased frequency with which nurses see patients in the home provides opportunities for recognizing problems and implementing interventions aimed at improving the quality of life of patients with RA.

During home visits, the nurse has the opportunity to assess the home environment and its adequacy for patient safety and management of the disorder. Adherence to the treatment program can be more easily monitored in the home setting, where physical and social barriers to adherence are more readily identified. For example, a patient who also has diabetes and requires insulin may be unable to fill the syringe accurately or unable to administer the insulin because of impaired joint mobility. Appropriate adaptive equipment needed for increased independence is often identified more readily when the nurse sees how the patient functions in the home. Any barriers to adherence are identified, and appropriate referrals are made.

For patients at risk for impaired skin integrity, the home health nurse can closely monitor skin status and also educate, provide, or supervise the patient and family in preventive skin care measures. The nurse also assesses the patient's need for assistance in the home and supervises home health aides, who may meet many of the needs of the patient with RA. Referrals to physical and occupational therapists may be made as problems are identified and limitations increase. A home health nurse may visit the home to make sure that the patient can function as independently as possible despite mobility problems and can safely manage treatments, including pharmacotherapy. The patient and family should be informed about support services such as Meals on Wheels and local Arthritis Foundation chapters.

Because many of the medications used to suppress inflammation are injectable, the nurse may administer the medication to the patient or educate about self-injection. These frequent contacts allow the nurse to reinforce other disease management techniques.

The nurse also assesses the patient's physical and psychological status, adequacy of symptom management, and adherence to the management plan. Patients should know which type of rheumatic disease they have, not just that they have "arthritis" or "arthritis of the knee." The importance of attending follow-up appointments is emphasized to the patient and family, and they should be reminded about the importance of participating in other health promotion activities and health screening.

Systemic Lupus Erythematosus

SLE is an inflammatory, autoimmune disorder that affects nearly every organ in the body. The overall incidence of SLE is estimated to be 1.8 to 7.6 per 100,000 people (Centers for Disease Control and Prevention [CDC], 2018). It occurs 4 to 12 times more frequently in women than in men and occurs more often in African Americans, Hispanics/Latino Americans, Asians, and American Indians/Alaska Natives than among White Americans (CDC, 2018). In addition to SLE, other forms of adult lupus exist, including subacute

cutaneous or discoid lupus erythematous, and drug-induced lupus (Aringer, Costenbader, Daikh, et al., 2019).

Pathophysiology

While the exact cause is not known, SLE starts with the body's immune system inaccurately recognizing one or more components of the cell's nucleus as foreign, seeing it as an antigen. The immune system starts to develop antibodies to the nuclear antigen. In particular, B cells begin to overproduce antibodies with the help of multiple cytokines such as B-lymphocyte stimulator (BLyS), which is overexpressed in SLE. The antibodies and antigens form antigen–antibody complexes and have the propensity to get trapped in the capillaries of visceral structures. The antibodies also act to destroy host cells. It is thought that those two mechanisms are responsible for the majority of the clinical manifestations of this disease process. The immunoregulatory disturbance is thought to be brought about by some combination of four distinct factors: genetic, immunologic, hormonal, and environmental (Norris, 2019).

Research into the genetic origins of SLE has thus far revealed that multiple genes are likely implicated in the development of SLE (Norris, 2019). The large majority of SLE cases, however, remain sporadic and unrelated to family medical history.

Given the high number of women with SLE compared with men, it is hypothesized that female sex hormones (estrogen) play a role in the predisposition to SLE. Estrogen may contribute to the body's response of overreacting to the body's own tissues.

Although genetics and hormones likely play a role in the predisposition of SLE, it is hypothesized that exogenous or environmental triggers are also implicated in the onset of the disease process. These triggers may include cigarette smoke, ultraviolet rays, exposure from sunlight and fluorescent light bulbs, medications (hydralazine, minocyline, or procainamide), viral infections, emotional stress, stress on the body (e.g., surgery, pregnancy), and silica dust exposure in the occupational setting (Norris, 2019).

Clinical Manifestations

SLE is an autoimmune, systemic disease that can affect any body system (Fig. 34-2). The disease process involves chronic states where symptoms are minimal or absent and acute flares where symptoms and lab results are elevated. Symptoms most often include fever, fatigue, skin rashes, as well as joint pain and swelling (Aringer et al., 2019; CDC, 2018). The mucocutaneous, musculoskeletal, renal, nervous, cardiovascular, and respiratory systems are

most commonly involved. Less commonly affected are the gastrointestinal tract and liver as well as the ocular system.

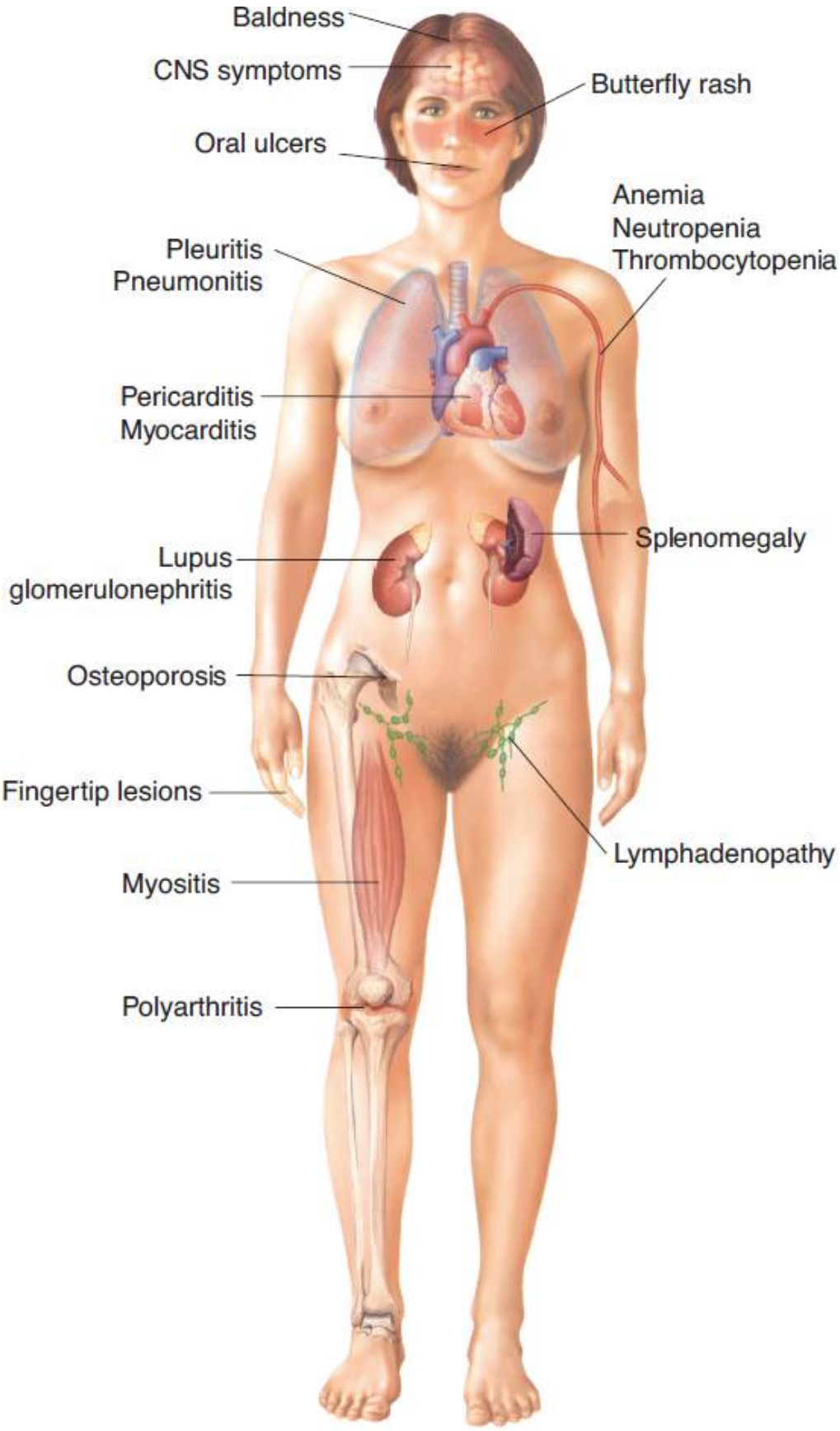

Figure 34-2 • Clinical manifestations of SLE. Reprinted with permission from Norris, T. L. (2019). *Porth's pathophysiology:*

Concepts of altered health states (10th ed., Fig. 50.5). Philadelphia, PA: Wolters Kluwer.

Some type of cutaneous system manifestation is experienced in up to 85% of patients with SLE (Norris, 2019). Several skin manifestations may occur in patients with SLE, including subacute cutaneous lupus erythematosus, which involves papulosquamous or annular polycyclic lesions, and a discoid rash, which is a chronic rash with erythematous papules or plaques and scaling and can cause scarring and pigmentation changes (Aringer et al., 2019). In some cases, the only skin involvement may be a discoid rash. In some patients with SLE, the initial skin involvement is the precursor to more systemic involvement. The lesions often worsen during **exacerbations** (flares) of the systemic disease and possibly are provoked by sunlight or artificial ultraviolet light (Norris, 2019). Oral ulcers, which may accompany skin lesions, may involve the buccal mucosa or the hard palate, occur in crops, and are often associated with exacerbations. Other cutaneous manifestations include splinter hemorrhages, alopecia, and Raynaud's phenomenon.

Joint pain and swelling occur in more than 90% of patients with SLE (Norris, 2019). Joint swelling, tenderness, and pain on movement are also common. Frequently, these are accompanied by morning stiffness.

The cardiac system is also commonly affected in SLE. Pericarditis is the most common cardiac manifestation (Norris, 2019). Patients may present with substernal chest pain that is aggravated by movement or inspiration. Symptoms can be acute and severe or last for weeks at a time. Other cardiac symptoms may involve myocarditis, hypertension, cardiac arrhythmias, and valvular incompetence.

Nephritis as a result of SLE, also referred to as lupus nephritis, occurs due to a buildup of antibodies and immune complexes that cause damage to the nephrons. Serum creatinine levels and urinalysis are used in screening for renal involvement. Early detection allows for prompt treatment so that renal damage can be prevented. Renal involvement may lead to hypertension, which also requires careful monitoring and management (see Chapter 27).

Central nervous system involvement is widespread, encompassing the entire range of neurologic disease. The varied and frequent neuropsychiatric presentations of SLE are now widely recognized and include psychosis, cognitive impairment, seizures, peripheral and cranial neuropathies, transverse myelitis, and strokes. These are generally demonstrated by subtle changes in behavior patterns or cognitive ability.

Assessment and Diagnostic Findings

Diagnosis of SLE is based on a complete history, physical examination, and blood tests. In addition to the general assessment performed for any patient

with a rheumatic disease, assessment for known or suspected SLE has special features. The skin is inspected for erythematous rashes. Cutaneous erythematous plaques with an adherent scale may be observed on the scalp, face, or neck. Areas of hyperpigmentation or depigmentation may be noted, depending on the phase and type of disease. The patient should be questioned about skin changes (because these may be transitory) and specifically about sensitivity to sunlight or artificial ultraviolet light. The scalp should be inspected for alopecia and the mouth and throat for ulcerations reflecting gastrointestinal involvement.

Cardiovascular assessment includes auscultation for pericardial friction rub, possibly associated with myocarditis and accompanying pleural effusions. The pleural effusions and infiltrations, which reflect respiratory insufficiency, are demonstrated by abnormal lung sounds. Papular, erythematous, and purpuric lesions developing on the fingertips, elbows, toes, and extensor surfaces of the forearms or lateral sides of the hand that may become necrotic suggest vascular involvement.

Joint swelling, tenderness, warmth, pain on movement, stiffness, and edema may be detected on physical examination. The joint involvement is often symmetric and similar to that found in RA.

The neurologic assessment is directed at identifying and describing any central nervous system changes. The patient and family members are asked about any behavioral changes, including manifestations of neurosis or psychosis. Signs of depression are noted, as are reports of seizures, chorea, or other central nervous system manifestations.

The antinuclear antibody (ANA) is positive in more than 95% of patients with SLE, indicating exceptional specificity (Aringer et al., 2019). Other laboratory tests include anti-DNA (antibody that develops against the patient's own DNA), anti-ds DNA (antibody against DNA that is highly specific to SLE, which helps differentiate it from drug-induced lupus), and anti-Sm (antibody against Sm, which is a specific protein found in the nucleus). Other blood work includes the CBC, which may reveal anemia, thrombocytopenia, leukocytosis, or leukopenia.

Medical Management

SLE can be life-threatening, but advances in its treatment have led to improved survival and reduced morbidity. Acute disease requires interventions directed at controlling increased disease activity or exacerbations that can involve any organ system. Disease activity is a composite of clinical and laboratory features that reflect active inflammation secondary to SLE. Management of the more chronic condition involves periodic monitoring and recognition of meaningful clinical changes requiring adjustments in therapy.

The goals of treatment include preventing progressive loss of organ function, reducing the likelihood of acute disease, minimizing disease-related disability, and preventing complications from therapy. Management of SLE involves regular monitoring to assess disease activity and therapeutic effectiveness.

Pharmacologic Therapy

The mainstay of SLE treatment is based on pain management and nonspecific immunosuppression. Therapy includes monoclonal antibodies, corticosteroids, antimalarial agents, NSAIDs, and immunosuppressive agents. Each of these medications has potentially serious side effects, including organ damage.

Belimumab is a monoclonal antibody that specifically recognizes and binds to BLyS. BLyS acts to stimulate B cells to produce antibodies against the body's own nuclei, which is an integral part of the disease process in SLE. Belimumab acts to render BLyS inactive, preventing it from binding to B-cell surfaces and stimulating B-cell activity. This action then halts the production of unnecessary antibodies and decreases disease activity in SLE. Live vaccines are contraindicated for 30 days before taking this medication (Comerford & Durkin, 2020). Rituximaub is an additional monoclonal antibody used in the treatment of SLE for its immune modulating effects (MacIsaac, Siddiqui, Jamula, et al., 2018).

Corticosteroids are another medication used topically for cutaneous manifestations, in low oral doses for minor disease activity, and in high doses for major disease activity. Intravenous (IV) administration of corticosteroids is an alternative to traditional high-dose oral administration. One of the most important risk factors associated with the use of corticosteroids in SLE is osteoporosis and fractures (Comerford & Durkin, 2020).

An antimalarial medication, hydroxychloroquine, is effective for managing cutaneous, musculoskeletal, and mild systemic features of SLE (Comerford & Durkin, 2020). The NSAIDs used for minor clinical manifestations are often used in conjunction with corticosteroids in an effort to minimize corticosteroid requirements.

Immunosuppressive agents (alkylating agents and purine analogues) are used because of their effect on overall immune function. These medications are generally reserved for patients who have serious forms of SLE that have not responded to conservative therapies. Examples include cyclophosphamide, azathioprine, mycophenolic acid, and methotrexate, which are contraindicated in pregnancy and have been used most frequently in SLE nephritis (Comerford & Durkin, 2020).

Nursing Management

Nursing care of the patient with SLE is based on the fundamental plan presented earlier in the chapter (see Chart 34-3). The most common nursing diagnoses include fatigue, impaired skin integrity, body image disturbance, and lack of knowledge for self-management decisions. The disease or its treatment may produce dramatic changes in appearance and considerable distress for the patient. The changes and the unpredictable course of SLE necessitate expert assessment skills and nursing care with sensitivity to the psychological reactions of the patient. The patient may benefit from participation in support groups, which can provide disease information, daily management tips, and social support. Because sun and ultraviolet light exposure can increase disease activity or cause an exacerbation, patients should be instructed to avoid exposure or to protect themselves with sunscreen and appropriate clothing.

Because of the increased risk of involvement of multiple organ systems, patients should understand the need for routine periodic screenings as well as health promotion activities. A dietary consultation may be indicated to ensure that the patient is knowledgeable about dietary recommendations, given the increased risk of cardiovascular disease, including hypertension and atherosclerosis.

In the healthy population, smoking and using electronic nicotine delivery systems (ENDS) including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars clearly poses health risks. Smoking increases the incidence of respiratory infections, lung cancer, risk of coronary artery disease; increases blood pressure, which can worsen kidney function; inhibits liver function (which can also inhibit treatment medications from working appropriately, such as hydroxychloroquine); increases the risk for skin diseases; and increases the risk for osteoporosis. The health risks of ENDS use is under investigation. Patients diagnosed with SLE are at even higher risk of developing lung cancer and other rare cancers. Therefore, smoking cessation programs should be offered to all patients who report smoking habits (Montes, Mocarzel, Lanzieri, et al., 2016).

The nurse educates the patient about the importance of continuing prescribed medications and addresses the changes and potential side effects that are likely to occur with their use. The patient is reminded of the importance of monitoring because of the increased risk of systemic involvement, including renal and cardiovascular effects.

Because of the immunosuppression associated with systemic corticosteroid usage, the nurse must watch for signs and symptoms of infection, especially with patients who are acutely ill.

The nurse should also screen the patient for osteoporosis, because long-term use of corticosteroids increases the incidence of osteoporosis. Patients should have a bone mineral density test performed at diagnosis and prior to beginning steroid use to determine a baseline status and then every 2 years thereafter. Educating the patient regarding calcium and vitamin D supplementation daily

is encouraged, along with the benefits of weight-bearing activities to support bone health.

Primary Sjögren's Syndrome

Primary Sjögren's syndrome is a rare systemic autoimmune disease that predominantly affects middle-aged women (Cornec, Devauchelle-Pensec, Mariette, et al., 2017).

Sjögren's syndrome often manifests in conjunction with other autoimmune diseases, most commonly autoimmune thyroid disease, RA, and SLE (MacIsaac et al., 2018; Molano-Gonzalez et al., 2019).

Pathophysiology

Primary Sjögren's is a multisystem disease characterized by lymphocytic infiltration leading to failure of the lacrimal and salivary glands (Cui, Li, Yin, et al., 2018).

Clinical Manifestations

The most common symptoms involve kerotoconjunctivitis sicca (dry eyes), xerostomia (dry mouth), pain, and fatigue (Cornec et al., 2017; Cui et al., 2018). Some patients will complain that their eyes feel "gritty," as if there is sand present. The patient's eyes will exhibit increased redness and lack of tearing. The mouth will have dry and sticky mucous membranes. The reduced saliva production may lead to difficulty swallowing.

Sjögren's syndrome can also exhibit symptoms in many other organ systems. Lesions may ulcerate and can be painful. Optic neuritis, trigeminal neuralgia, and sensory neuropathy may be present, with symptoms such as burning pain in the extremities, numbness, vertigo, arthralgia, and/or myalgia. Raynaud's phenomenon, which involves blood vessel spasms leading to decreased circulation to the toes, fingers, nose, and ears, may be reported. Patients experience symptoms of pain, fatigue, depression, and anxiety (Cui et al., 2018). Sleep disturbances are frequently reported and may be related to pain, fatigue, and depressive symptoms (Hackett, Gotts, Ellis, et al., 2017).

Assessment and Diagnostic Findings

The classification criteria for diagnosis of Sjögren's syndrome identify six distinct indices (Klippel, Stone, Crofford, et al., 2008):

- Ocular symptoms such as chronic dry eye (Kerotoconjunctivitis Sicca).

- Positive ocular tests (evaluating tear production, corneal, and conjunctival damage). Ocular testing may include Schemer tear test or Rose Bengal tests.
- Oral symptoms, dry mouth.
- Histopathology evaluation (of salivary glands). This will help differentiate the cause of dry mouth from other causes, such as infection, malignancy, stones, and sarcoidosis.
- Salivary gland involvement.

Laboratory tests include autoantibodies to ribonucleoprotein particles (Ro[SS-A] and/or La[SS-B]), which act as antigens in this disease process. Other laboratory indices are also useful in diagnosing Sjögren's syndrome. Rheumatoid factor is present in 50% to 70% of patients. ANA, circulating DNA (cDNA), anti-CCP, ACPA, and anticentromere antibody (ACA) are all potentially present in Sjögren's syndrome and in some cases may act as markers for disease activity (Molano-Gonzalez et al., 2019).

For vasculitis manifestations, a skin biopsy can yield useful information such as leukocytoclastic vasculitis found on histologic examination. If neurologic symptoms are present, nerve conduction studies, MRI, electroencephalograms, and cerebrospinal fluid testing may be used to aid in diagnosis and treatment planning.

Medical Management

There is no cure for Sjögren's syndrome, and treatment is aimed at symptom management and improving quality of life (Cornec et al., 2017; Cui et al., 2018; Hackett et al., 2017). Artificial tears, drops such as pilocarpine, and ocular ointments such as topical cyclosporine are used for dry eyes. Tears normally drain through the lacrimal puncta to the nose, which can render artificial tears ineffective. Therefore, punctum plugs may be a useful management tool. One systematic review reported that pilocarpine is highly effective in decreasing symptoms of dry mouth by increasing salivary flow (Hamad, Lodi, Porter, et al., 2018). Biotene oral rinse may also be useful for some patients. Additional suggestions include eating small frequent meals; omitting spicy, salty, and irritating food; and avoiding smoking (including ENDS), excessive alcohol use, and drugs with anticholinergic side effects. There is some evidence for the effectiveness of rituximab and interferone (Cornec et al., 2017; Hamad et al., 2018; MacIsaac et al., 2018). Patients need to be screened for depression and sleep disturbances, then appropriate referrals made when these comorbid conditions are present (Cui et al., 2018; Hackett et al., 2017).

Nursing Management

Nursing care is based on the fundamental plan of nursing care presented earlier (see Chart 34-3). The primary issues for the patient with Sjögren's syndrome are pain, fatigue, and inadequate knowledge of self-management techniques. The nurse is in the unique position to educate and reinforce the treatment regimen with the patient, especially involving the ocular treatments to avoid eye infections secondary to the dry eyes. The high prevalence of pain, fatigue, and depressive symptoms may interfere with the patient's ability to learn and engage in self-management techniques and should be addressed (Cui et al., 2018).

Scleroderma

Scleroderma is a rare autoimmune disease affecting the connective tissue of the skin, blood vessel walls, and internal organs. There are two general types: localized (affecting only the cutaneous system) or diffuse (routinely referred to as systemic sclerosis and affecting multiple organ systems). Similar to other autoimmune diseases, women are affected four times more than men, and the onset occurs typically between the ages of 25 and 50 years (Norris, 2019). Scleroderma has a variable course with remissions and exacerbations.

Pathophysiology

The pathogenesis is poorly understood. Scleroderma commonly begins with skin involvement. Mononuclear cells cluster on the skin and stimulate lymphokines to stimulate procollagen. Insoluble collagen is formed and accumulates excessively in the tissues (Norris, 2019). Initially, the inflammatory response causes edema, with a resulting taut, smooth, and shiny skin appearance. The skin then undergoes fibrotic changes, leading to loss of elasticity and movement. Eventually, the tissue degenerates and becomes nonfunctional. This chain of events, from inflammation to degeneration, also occurs in blood vessels, major organs, and body systems (Norris, 2019).

Clinical Manifestations

The skin and subcutaneous tissues become increasingly hard and rigid due to excess collagen and cannot be pinched up from the underlying structures. Wrinkles and lines are obliterated. The skin is dry because sweat secretion over the involved region is suppressed. The extremities stiffen and lose mobility. The condition spreads slowly; for years, these changes may remain localized in the hands and the feet. The face appears masklike, immobile, and expressionless, and the mouth becomes rigid; referred to as "stone facies" (Norris, 2019).

The changes within the body, although not visible directly, are vastly more important than the visible changes. The esophagus hardens, interfering with swallowing. The lungs become scarred, impeding respiration. Digestive disturbances occur because of sclerosing (hardening) of the intestinal mucosa. Vascular involvement of the kidneys leads to malignant hypertension and renal insufficiency. Cardiac disorders include pericarditis, heart block, and myocardial fibrosis (Norris, 2019).

The patient may manifest a variety of symptoms referred to as the CREST syndrome. *CREST* stands for *c*alcinosis (calcium deposits in the tissues), *R*aynaud's phenomenon, *e*sophageal dysmobility, *s*clerodactyly (scleroderma of the digits), and *t*elangiectasia (capillary dilation that forms a vascular lesion) (Norris, 2019).

Assessment and Diagnostic Findings

Assessment focuses on the sclerotic changes in the skin, contractures in the fingers, and color changes or lesions in the fingertips. Assessment of systemic involvement requires a systems review with special attention to gastrointestinal, pulmonary, renal, and cardiac symptoms. Limitations in mobility and self-care activities should be assessed, along with the impact the disease has had (or will have) on body image.

There is no one conclusive diagnostic test used to diagnose scleroderma. Generally, the patient is diagnosed with the CREST type of scleroderma if they have four of the five symptoms in the syndrome (Norris, 2019).

Medical Management

Treatment of scleroderma is mainly symptomatic and supportive. No medication regimen is effective in modifying the disease process in scleroderma, but various medications are used to treat organ system involvement. The use of angiotensin-converting enzyme inhibitors when there is kidney involvement has led to a substantial decrease in mortality from hypertensive kidney disease (Norris, 2019).

All patients require counseling, during which realistic individual goals may be determined. Support measures include strategies to decrease pain and limit disability. A moderate exercise program is encouraged to prevent joint contractures. Patients are advised to avoid extreme temperatures and to use lotion to minimize skin dryness.

Nursing Management

Nursing care of the patient with scleroderma is based on the fundamental plan of nursing care presented earlier (see Chart 34-3). The primary nursing

diagnoses are impaired skin integrity; self care deficits; impaired nutritional status; and disturbed body image. The patient with advanced disease may also have impaired gas exchange, impaired cardiac output, impaired swallowing, and constipation.

Providing meticulous skin care and preventing the effects of Raynaud's phenomenon are major nursing challenges. See Chapter 26 for further discussion of Raynaud's phenomenon.

Polymyositis

Polymyositis is a group of diseases that are termed *idiopathic inflammatory myopathies* (Klippel et al., 2008). They are rare chronic conditions, with an incidence estimated at 2 cases per 10,000 adults per year. Polymyositis is most commonly seen in women versus men (2:1) and usually seen between 40 and 50 years of age (Miller & Vleugels, 2019).

Pathophysiology

Polymyositis is classified as autoimmune because autoantibodies are present. However, these antibodies do not cause damage to muscle cells, indicating only an indirect role in tissue damage. The pathogenesis is multifactorial, including cellular and humoral immune mechanisms (Norris, 2019).

Clinical Manifestations

The onset may be very slow and insidious, with symptoms gradually worsening over weeks to months. Proximal muscle weakness is typically the first symptom. Muscle weakness is usually symmetric and diffuse. Common complaints include having difficulty rising from a chair, climbing steps, or holding up the head. Myalgia and muscle tenderness occur in 25% to 50% of patients. Dermatomyositis, a related condition, is most commonly identified by an erythematous smooth or scaly lesion found over the joint surface, which often occurs prior to symptoms of weakness in 50% to 60% of patients (Miller & Vleugels, 2019).

Assessment and Diagnostic Findings

A complete history and physical examination help exclude other muscle-related disorders. As with other diffuse connective tissue disorders, no single test confirms polymyositis. An electromyogram is performed to rule out degenerative muscle disease. A muscle biopsy may reveal inflammatory infiltrate in the tissue. Serum studies indicate increased muscle enzyme activity.

Medical Management

Corticosteroid therapy is the mainstay of medical management (Norris, 2019). IV immune globulin, plasmapheresis, lymphapheresis, and total-body irradiation have been used if there is no response to corticosteroids. The goal is to control inflammation and prevent long-term damage to muscles, joints, and internal organs (Norris, 2019). The antimalarial agent hydroxychloroquine may be effective for skin rashes. Physical therapy is initiated slowly, with range-of-motion exercises to maintain joint mobility, followed by gradual strengthening exercises (Klippel et al., 2008).

Nursing Management

Nursing care is based on the fundamental plan of nursing care presented earlier (see Chart 34-3). The primary nursing diagnoses for the patient with polymyositis are impaired mobility, fatigue, self care deficit, and lack of knowledge of self-management techniques.

Patients with polymyositis may have symptoms similar to those of other inflammatory diseases. However, proximal muscle weakness is characteristic, making activities such as combing the hair, reaching overhead, and using stairs difficult. Therefore, the use of assistive devices may be recommended, and referral to occupational or physical therapy may be warranted.

Polymyalgia Rheumatica and Giant Cell Arteritis

PMR involves stiffness of muscles and pain in the neck, shoulder, and pelvic girdle. GCA is a form of vasculitis affecting the medium-sized and large arteries of the body (Klippel et al., 2008). GCA is also sometimes referred to as temporal arteritis (Hill, Black, Nossent, et al., 2017). PMR and GCA represent a spectrum of one disease. Both primarily affect individuals older than 50 years and are associated with the same HLA haplotype genetic markers. PMR and GCA occur predominately in Caucasians and often in first-degree relatives. PMR has an annual incidence rate of 52 cases per 100,000 people older than 50 years. GCA varies by geographic location and has the highest incidence in Scandinavian countries. PMR is two to three times more common than GCA (Klippel et al., 2008).

Pathophysiology

The underlying mechanism of action involved with PMR and GCA is unknown. It is clear, however, that the immune system is abnormally activated in both disease processes with increases in circulating monocytes that produce IL-1 and IL-6. These circulating monocytes make the endothelial linings of

blood vessels more vulnerable to vasculitis (Klippel et al., 2008). Immunoglobulin deposits in the walls of inflamed temporal arteries suggest that an autoimmune process is at work.

Clinical Manifestations

PMR is characterized by severe proximal muscle discomfort with mild joint swelling. Severe aching in the neck, shoulder, and pelvic muscles is common. Stiffness is noticeable most often in the morning and after periods of inactivity. This stiffness can become so severe that patients struggle putting on a coat or combing their hair. Systemic features include low-grade fever, weight loss, malaise, anorexia, and depression. Because PMR usually occurs in people 50 years and older, it may be confused with, or dismissed as, an inevitable consequence of aging.

GCA may cause headaches, changes in vision, and jaw claudication. These symptoms should be evaluated immediately because of the potential for blindness and stroke if left untreated (Hill et al., 2017). PMR and GCA have a self-limited course, lasting several months to several years (Klippel et al., 2008).

Assessment and Diagnostic Findings

Assessment focuses on musculoskeletal tenderness, weakness, and decreased function. Careful attention should be directed toward assessing the head (for changes in vision, headaches, and jaw claudication). An MRI scan may be used in the assessment of extra-articular synovitis in patients with PMR, regardless of symptoms.

Often, diagnosis is difficult because of the lack of specificity of tests. A markedly high ESR is a screening test but is not definitive. The CRP level and platelet count also provide valuable data. In fact, simultaneous elevation in the ESR and CRP has a sensitivity of 98.6% and a specificity of 75.7% in making the diagnosis of GCA when coupled with clinical findings (Seetharaman, 2019). Diagnosis of both GCA and PMR is more likely to be made by eliminating other potential diagnoses. The dramatic and immediate response to treatment with corticosteroids is considered by some to be diagnostic.

In the case of GCA, biopsy of the temporal artery is the definitive diagnostic tool (Seetharaman, 2019). High-resolution MRI is an alternative or adjunct to the traditional temporal artery biopsy.

Medical Management

The treatment for patients with PMR (without GCA) is moderate doses of corticosteroids. Longer durations of corticosteroid treatment are required with

patients who have higher baseline inflammatory markers. Gradual tapering of the corticosteroid treatment should be monitored. NSAIDs are sometimes given in mild disease. The treatment for patients with GCA is rapid initiation of and strict adherence to a regimen of corticosteroids. This is essential to avoid the complication of blindness (Hill et al., 2017). Aspirin is an adjunctive treatment may help reduce the risk of visual loss.

Nursing Management

Nursing care of the patient with PMR is based on the fundamental plan of nursing care presented earlier (see Chart 34-3). The most common nursing diagnoses are pain and lack of knowledge of medications.

A management concern is that the patient will take the prescribed medication, frequently corticosteroids, until symptoms improve and then discontinue the medication. The decision to discontinue the medication should be based on clinical and laboratory findings and the prescription. Nursing implications are related to helping the patient prevent and monitor adverse effects of medications (e.g., infections, diabetes, gastrointestinal problems, and depression) and adjust to those side effects that cannot be prevented (e.g., increased appetite and altered body image).

Quality and Safety Nursing Alert

The nurse must emphasize to the patient the need for continued adherence to the prescribed medication regimen to avoid complications of GCA, such as blindness and stroke.

The loss of bone mass with corticosteroid use increases the risk of osteoporosis in this already at-risk population. Interventions to promote bone health, such as adequate dietary calcium and vitamin D, measurement of bone mineral density, weight-bearing exercise, smoking and ENDS cessation, and reduction of alcohol consumption if indicated, should be emphasized.

Spondyloarthropathies

The spondyloarthropathies are another category of systemic inflammatory disorders of the skeleton. The spondyloarthropathies include ankylosing spondylitis (AS), reactive arthritis (formerly known as Reiter's syndrome), and psoriatic arthritis. Spondyloarthritis is also associated with inflammatory bowel diseases such as Crohn's disease (regional enteritis) and ulcerative colitis (Norris, 2019).

These rheumatic diseases share several clinical features. The inflammation tends to occur peripherally at the sites of attachment—at tendons, joint capsules, and ligaments. Periosteal inflammation may be present. Many patients have arthritis of the sacroiliac joints. The onset tends to occur during young adulthood, with the disease affecting men more often than women. There is a strong tendency for these conditions to occur in families. Frequently, the HLA-B27 genetic marker is found. In addition, more than one of these conditions can be found simultaneously in the same person or another family member (Norris, 2019).

As with other inflammatory conditions, patients with spondyloarthropathies have an increased risk for cardiovascular disease. These findings may be related to a state of chronic systemic inflammation and an increase in traditional cardiac risk factors, such as lack of exercise due to increased pain (Norris, 2019).

Ankylosing Spondylitis

AS is a chronic inflammatory disease of the spine. It is more prevalent in males than in females and is usually diagnosed in the second or third decade of life. The disease is also more severe in males, and significant systemic involvement is likely (Norris, 2019).

AS affects the cartilaginous joints of the spine and surrounding tissues, making them rigid, decreasing mobility, and leading to kyphosis (a stooped position). This kyphosis can, in turn, lead to decreased stability and balance. Back pain is the characteristic feature. The back pain can be so severe that it may mask symptoms of a cervical fracture, which can lead to neurologic problems if left untreated. Occasionally, the large synovial joints, such as the hips, knees, or shoulders, may be involved (Norris, 2019).

AS also exhibits systemic effects as the heart and lungs become constricted in the chest cavity (Norris, 2019). Another potential complication of AS is the risk of osteoporosis, which appears to be related to the inflammatory process as well as bone turnover and low vitamin D levels. Other complications involve atrioventricular conduction defects, aortic insufficiency, and pulmonary fibrosis. As the disease progresses, ankylosis (i.e., fixation or immobility) of the entire spine may occur, leading to respiratory compromise and further complications.

Reactive Arthritis (Reiter's Syndrome)

The disease process involved in reactive arthritis is called *reactive* because the arthritis occurs after an infection, primarily gastrointestinal or genitourinary (Norris, 2019). It mostly affects young adult males and is characterized

primarily by urethritis, arthritis, and conjunctivitis. Dermatitis and ulcerations of the mouth and penis may also be present. Low back pain is common.

Psoriatic Arthritis

Psoriatic arthritis is an inflammatory arthritis associated with the skin disease psoriasis. Approximately 7% of people with psoriasis develop psoriatic arthritis (Norris, 2019). Psoriasis is the most common autoimmune disease in the United States, affecting 2% to 3% of the population. Psoriatic arthritis onset occurs between 30 and 50 years of age and affects equal numbers of men and women (Dewing, 2015). See Chapter 56 for more information on psoriasis.

Psoriatic arthritis is characterized by synovitis, polyarthritis, and spondylitis. Inflammatory back pain is a common symptom, which is differentiated from other back pain by symptoms of back pain presenting at a young age, pain improving with activity, and pain occurring at night. Radiographic evidence of asymetrical sacroilitis or spondylitis may also assist with diagnosing psoriatic arthritis (Dewing, 2015). Other sites of pain commonly seen in these patients are the Achilles tendon, plantar fascia, or tibial tuberosity areas. Pain in these areas is common from the inflammation that occurs at the entheses, where tendons and ligaments attach to the bone.

Medical Management

Medical management of spondyloarthropathies focuses on treating pain and maintaining mobility by suppressing inflammation. For the patient with AS, good body positioning and posture are essential so that if ankylosis does occur, the patient is in the most functional position. Maintaining range of motion with regular exercise and a muscle-strengthening program is especially important and has been linked with higher quality of life for patients.

Pharmacologic Management

NSAIDs are the first-line therapy for treating all spondylarthropathies. All chronic conditions (cardiac, renal, and gastrointestinal) should be taken into consideration when prescribing long-term NSAIDs. Methotrexate, sulfasalazine, and leflunomide may also be used; these drugs may help with skin and peripheral joint disease but may not prevent spinal changes. Corticosteroid injections may be used for periodic flares; however, oral and long-term use of steroids is not recommended due to the possibility of psoriatic skin flare when discontinuing use.

Disease remission is now the target for psoriatic arthritis (Mease & Coates, 2018). Anti-TNF medications that have been used effectively include etanercept, infliximab, adalimumab, golimumab, and certolizumabpegol.

Additional agents include apremilast, which is a PDE4 inhibitor, and ustekinumab, an anti-IL12/anti-IL23 agent (Mease & Coates, 2018).

Surgical Management

With advanced AS and subsequent debilitating kyphosis, an osteotomy of the spine can be done. One study showed that an average correction of 45 degrees in the cervical spine was obtained and that quality of life also improved. Surgical management may also include total joint replacement (see Chapter 36).

Nursing Management

Major nursing interventions in the spondyloarthropathies are related to symptom management and maintenance of optimal functioning. Affected patients are primarily young men. Their major concerns are often related to prognosis and job modification, especially among those who perform physical work. Patients may also express concerns about leisure and recreational activities. Focusing on physical activity and staying active and maintaining good posture will help to prevent chronic changes that may lead to deformities. It is important to address psychological changes, such as depression and emotional stress, that can occur with the diagnosis and chronic nature of the disease. If symptoms are present, the primary provider should assess for emotional stress and treat as appropriate.

Metabolic and Endocrine Diseases Associated with Rheumatic Disorders

Metabolic and endocrine diseases may be associated with rheumatic disorders. These include biochemical abnormalities (amyloidosis and scurvy), endocrine diseases (diabetes and acromegaly), immune deficiency diseases (human immune deficiency virus infection, acquired immune deficiency syndrome), and some inherited disorders (hypermobility syndromes). However, the most common conditions are the crystal-induced arthropathies, in which crystals such as monosodium urate (gout) or calcium pyrophosphate (calcium pyrophosphate dihydrate disease or pseudogout) are deposited within joints and other tissues (Norris, 2019).

Gout

Gout is the most common form of inflammatory arthritis. More than 8.3 million Americans self-report the diagnosis of gout (CDC, 2019). The prevalence is reported to be about 3.9% and appears to be on the rise. Men are

three to four times more likely to be diagnosed with gout than women. The incidence of gout increases with age, body mass index, alcohol consumption, hypertension, and diuretic use (CDC, 2019). Evidence links the consumption of fructose-rich beverages with the risk of gout for both men and women (CDC, 2019). Patients with gout have an increased risk of cardiovascular disease. Comorbid conditions such as hypertension, dyslipidemia, diabetes, osteoarthritis, kidney disease, and depression may be present in patients with gout (Lin, Zhang, & Ma, 2018; Norris, 2019).

Pathophysiology

Gout is caused by hyperuricemia (increased serum uric acid). Uric acid is a by-product of purine metabolism; purines are basic chemical compounds found in high concentrations in meat products. Urate levels are affected by diet, medications, overproduction in the body, and inadequate excretion by the kidneys. Hyperuricemia (serum concentration greater than 6.8 mg/dL) can, but does not always, cause urate crystal deposition. However, as uric acid levels increase, the risk becomes greater. The initial cause for the gout attack occurs when macrophages in the joint space phagocytize urate crystals. Through a series of immunologic steps, interleukin-1β is secreted, increasing the inflammation. This process is exacerbated by the presence of free fatty acids. Both alcohol and consumption of a large meal, especially with red meat, can lead to increases in free fatty acid concentrations; they also are implicated as triggers to acute gout attacks (Norris, 2019).

With repeated attacks, accumulations of sodium urate crystals, called tophi, are deposited in peripheral areas of the body, such as the great toe, the hands, and the ear. Renal uratelithiasis (kidney stones), with chronic kidney disease secondary to urate deposition, may develop.

Primary hyperuricemia may be caused by severe dieting or starvation, excessive intake of foods that are high in purines (shellfish, organ meats), or heredity. In secondary hyperuricemia, gout is a clinical feature secondary to any of a number of genetic or acquired processes, including conditions in which there is an increase in cell turnover (leukemia, multiple myeloma, some types of anemias, psoriasis) and an increase in cell breakdown. Altered renal tubular function, either as a major action or as an unintended side effect of certain pharmacologic agents (e.g., diuretics such as thiazides and furosemide), low-dose salicylates, or ethanol can contribute to uric acid underexcretion (Klippel et al., 2008). The finding of urate crystals in the synovial fluid of asymptomatic joints suggests that factors other than crystals may be related to the inflammatory reaction. Recovered monosodium urate crystals are coated with immunoglobulins that are mainly IgG. IgG enhances crystal phagocytosis, thereby demonstrating immunologic activity (Klippel et al., 2008).

Clinical Manifestations

Manifestations of the gout syndrome include acute gouty arthritis (recurrent attacks of severe articular and periarticular inflammation), **tophi** (crystalline deposits accumulating in articular tissue, osseous tissue, soft tissue, and cartilage), gouty nephropathy (renal impairment), and uric acid urinary calculi. Four stages of gout can be identified: asymptomatic hyperuricemia, acute gouty arthritis, intercritical gout, and chronic tophaceous gout (Neoai, Jansen, Dalbeth, et al., 2015). The subsequent development of gout is directly related to the duration and magnitude of the hyperuricemia. Therefore, the commitment to lifelong pharmacologic treatment of hyperuricemia is deferred until there is an initial attack of gout.

Acute arthritis is the most common early clinical manifestation. The metatarsophalangeal joint of the big toe is a commonly affected joint. The tarsal area, ankle, or knee may also be affected. Less commonly, the wrists, fingers, and elbows may be affected. Trauma, alcohol ingestion, dieting, medications, surgical stress, or illness may trigger the acute attack. The abrupt onset often occurs at night, awakening the patient with severe pain, redness, swelling, and warmth of the affected joint. Early attacks tend to subside spontaneously over 3 to 10 days without treatment. The attack is followed by a symptom-free period (the intercritical stage) until the next attack, which may not come for months or years. However, with time, attacks tend to occur more frequently, involve more joints, and last longer (Becker & Gaffo, 2019).

Tophi (seen in chronic tophaceous gout) are generally associated with more frequent and severe inflammatory episodes. Higher serum concentrations of uric acid are also associated with more extensive tophus formation. Tophi most commonly occur in the synovium, olecranon bursa, **subchondral bone** (bony plate that supports the articular cartilage), infrapatellar and Achilles tendons, and subcutaneous tissue on the extensor surface of the forearms and overlying joints. They have also been found in the aortic walls, heart valves, nasal and ear cartilage, eyelids, cornea, and sclera. Joint enlargement may cause a loss of joint motion. Uric acid deposits may cause renal stones and kidney damage.

Medical Management

Given that the incidence of gout increases with age, its management can be complicated by other medical conditions, medications, and age-related changes. A definitive diagnosis of gouty arthritis is established by polarized light microscopy of the synovial fluid of the involved joint. Uric acid crystals are seen within the polymorphonuclear leukocytes in the fluid during a disease flare up (CDC, 2019).

Acute attacks are managed with colchicine (oral or parenteral), an NSAID such as indomethacin, or a corticosteroid. Management of hyperuricemia,

tophi, joint destruction, and renal disorders is usually initiated after the acute inflammatory process has subsided. Once the acute attack has subsided, uric acid lowering therapy should be considered. Xanthine oxidase inhibitors, such as allopurinol and febuxostat, are the agents of choice. Given the role of IL-1 in the pathogenesis of gout, some experts suggest that there may be a role for anakinra, an IL-1 receptor antagonist in the management of acute gout (Becker & Perez-Ruiz, 2019).

Management between gout attacks needs to include lifestyle changes such as avoiding purine-rich foods, weight loss, decreasing alcohol consumption, and avoiding certain medications. Uricosuric agents, such as probenecid, may be indicated in patients with frequent acute attacks. Uricosuric medications correct hyperuricemia and dissolve deposited urate. Corticosteroids may also be used in patients who have no response to other therapy. In patients with refractory chronic gout who are not controlled with the regimens mentioned earlier, pegloticase, a newer agent, has been shown to be effective in lowering uric acid levels (Becker & Perez-Ruiz, 2019). Specific treatment is based on the serum uric acid level, 24-hour urinary uric acid excretion, and renal function (see Table 34-4).

TABLE 34-4 Common Medications Used to Treat Gout

Medication	Actions and Use	Nursing Implications
colchicine	Lowers the deposition of uric acid and interferes with leukocyte infiltration, thus reducing inflammation; does not alter serum or urine levels of uric acid; used in acute and chronic management	*Acute management:* Administer when attack begins; dosage increased until pain is relieved or diarrhea develops, then stop medication *Chronic management:* Causes gastrointestinal upset in most patients.
probenecid	Uricosuric agent; inhibits renal reabsorption of urates and increases the urinary excretion of uric acid; prevents tophi formation	Be alert for nausea and rash.
allopurinol, febuxostat	Xanthine oxidase inhibitors; interrupt the breakdown of purines before uric acid is formed; inhibit xanthinoxidase because uric acid formation is blocked	Monitor for side effects, including bone marrow depression, nausea, vomiting, diarrhea, abdominal pain, or rash. Avoid starting medication or increasing dose if active flare present.

Adapted from Comerford, K. C., & Durkin, M. T. (2020). *Nursing 2020 drug handbook*. Philadelphia, PA: Wolters Kluwer.

Nursing Management

Research indicates that providers overestimate patient knowledge of gout and that patients prefer the use of both written and verbal materials (Abhishek & Doherty, 2018). Therefore, the nurse takes every opportunity to educate and reinforce knowledge of gout verbally and in writing. Severe dietary restriction is not necessary; however, the nurse encourages the patient to restrict consumption of foods high in purines, especially organ meats, and to limit alcohol intake. Maintenance of normal body weight should be encouraged. In an acute episode of gouty arthritis, pain management with prescribed medications is essential, along with avoidance of factors that increase pain and inflammation, such as trauma, stress, and alcohol. Medication adherence is critical but poor among patients prescribed urate lowering therapies (Scheepers, van Onna, Stehouwer, et al., 2018). The nurse reinforces the importance of taking prescribed medications. Between acute episodes, the patient feels well and may abandon medications and preventive behaviors, which may result in an acute attack. Acute attacks are most effectively treated if therapy begins early.

Fibromyalgia

Fibromyalgia is a chronic pain syndrome that involves chronic fatigue, generalized muscle aching, stiffness, sleep disturbances, and functional impairment. It is estimated to affect more than 5 million Americans, representing 2% to 5% of the general population, with women affected more than men. Between 25% and 65% of patients with fibromyalgia have other rheumatic conditions such as RA, SLE, and AS (CDC, 2017).

Pathophysiology

The amplified pain experienced by patients with fibromyalgia is thought to be neurogenic in origin. The central nervous system's ascending and descending pathways that regulate and moderate pain processing function abnormally, causing amplification of pain signals. Some describe this as if the "volume control setting" for pain were abnormally high. Therefore, stimulation that may not normally elicit pain, such as touch, may do so. In addition, there are a number of predisposing factors to pain, including anxiety, depression, physical trauma, emotional stress, sleep disorder, and viral infection (CDC, 2017; Melin, Svensson, & Thulesius, 2018).

Assessment and Diagnostic Findings

Since fibromyalgia is a diffuse syndrome, standard diagnostic testing is often not useful except to rule out other conditions that may be causing the pain.

One study reported that two items, pain upon pinching the Achilles tendon using 4 kg of pressure for 4 seconds and an affirmative answer to the statement "I have a persistent deep aching all over my body," were the most useful in recognizing fibromyalgia (Jones, Aebischer, St John, et al., 2017). Positive responses to these screening items need to be followed by a comprehensive examination for confirmation of a diagnosis (Jones et al., 2017).

Medical Management

Treatment consists of attention to the specific symptoms reported by the patient. NSAIDs may be used to treat the diffuse muscle aching and stiffness. Tricyclic antidepressants such as amitriptyline and nortriptyline as well as sleep hygiene measures are used to improve or restore normal sleep patterns (CDC, 2017). Muscle relaxants such as cyclobenzaprine may also be used to help with relaxation and pain. Cognitive behavioral therapy is also useful in improving sleep and attentional dysfunction. In addition, serotonin norepinephrine reuptake inhibitors, such as duloxetine, venlafaxine, and milnacipran; selective serotonin reuptake inhibitors, including fluoxetine, paroxetine, and sertraline; as well as anticonvulsants such as gabapentin and pregabalin may be effective. Individualized programs of exercise are used to decrease muscle weakness and discomfort and to improve the general deconditioning that occurs in affected patients. There has been some promising research in complementary, alternative, and integrative health therapies, such as acupuncture (Kim, Kim, Lee, et al., 2019).

Nursing Management

Typically, patients with fibromyalgia have endured their symptoms for a long period of time. They may feel as if their symptoms have not been taken seriously. Nurses need to pay special attention to supporting these patients and providing encouragement as they begin their program of therapy. Patient support groups may be helpful (Melin et al., 2018). Careful listening to patients' descriptions of their concerns and symptoms is essential to help them make the changes that are necessary to improve their quality of life.

Miscellaneous Disorders

The last category in the classification of the rheumatic diseases is aptly labeled miscellaneous disorders because it contains a mix of disorders that are frequently associated with arthritis and other conditions. These include the direct consequences of trauma (including internal derangement and loose bodies of joints), pancreatic disease (related to avascular necrosis or

osteonecrosis), sarcoidosis (a multisystem disorder particularly of the lymph nodes and lungs), and palindromic rheumatism (an uncommon variety of recurring and acute arthritis and periarthritis that in some may progress to RA but is characterized by symptom-free periods of days to months). Other conditions include villonodular synovitis, chronic active hepatitis, and drug-related rheumatic syndromes. The nursing interventions related to these varied conditions are specific to the multisystemic problems experienced by the patient. However, the musculoskeletal components should not be neglected or overlooked. Further information about these rare disorders can be found in specialty references.

CRITICAL THINKING EXERCISES

1 pq Your patient, a 52-year-old male with RA, is being discharged from the medical surgical unit where you work. He smokes 1 pack of cigarettes a day and drinks alcohol on occasion. He is 6′0″ and weighs 240 lb. Identify the priorities, approach, and techniques you would use to provide discharge education to this patient. What lifestyle modifications are a priority for this patient?

2 ipc A 28-year-old patient who was recently diagnosed with SLE comes to the clinic where you work for a follow-up appointment. She tells you that she is planning to become pregnant soon. What additional members of the health care team should be included in the care of this patient given her childbearing plans?

3 ebp You are the nurse taking care of a woman newly diagnosed with fibromyalgia. What is the evidence for symptom management for this patient? What criteria would you use to assess the strength of the evidence? What is the evidence for complementary therapy options to improve her symptoms?

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*Asterisk indicates nursing research.
**Double asterisk indicates classic reference.

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Resources

American College of Rheumatology and Association of Rheumatology Health Professionals, www.rheumatology.org
American Fibromyalgia Syndrome Association (AFSA), www.afsafund.org
Arthritis Foundation, www.arthritis.org
Centers for Disease Control and Prevention, www.cdc.gov
Lupus Foundation of America, www.lupus.org
National Institute of Arthritis and Musculoskeletal and Skin Diseases, National Institutes of Health, www.niams.nih.gov

Scleroderma Foundation, www.scleroderma.org
Sjögren's Syndrome Foundation, www.sjogrens.org
Spondylitis Association of America, www.spondylitis.org

UNIT 8 Musculoskeletal Function

Case Study

IMPLEMENTING EVIDENCE-BASED PRACTICE IN PAIN MANAGEMENT

You are a nurse working on an orthopedic unit caring for a 76-year-old female with osteoporosis who had fallen at home and underwent a right hip replacement. She is 2 days postoperative,

recovering from her surgery without complications, and you are discussing plans for her transition to a skilled rehabilitation unit. However, the patient does not want to get out of bed and participate in physical or occupational therapy because she is in pain. Despite having spoken with the pain team, she states she does not want to take any medications that may cause her to become addicted. You need to develop an evidence-based plan of care that implements pharmacologic and nonpharmacologic strategies for pain management so the patient is able to participate in her physical and occupational therapies and thus help facilitate her recovery.

QSEN Competency Focus: **Evidence-Based Practice (EBP)**

The complexities inherent in today's health care system challenge nurses to demonstrate integration of specific interdisciplinary core competencies. These competencies are aimed at ensuring the delivery of safe, quality patient care (Institute of Medicine, 2003). The Quality and Safety Education for Nurses project (Cronenwett, Sherwood, Barnsteiner, et al., 2007; QSEN, 2020) provides a framework for the knowledge, skills, and attitudes (KSAs) required for nurses to demonstrate competency in these key areas, which include ***patient-centered care***, ***interdisciplinary teamwork and collaboration***, ***evidence-based practice***, ***quality improvement***, ***safety***, and ***informatics.***

Evidence-Based Practice Definition: Integrate best current evidence with clinical expertise and patient/family preferences and values for delivery of optimal health care.

SELECT PRE-LICENSURE KSAs	APPLICATION AND REFLECTION
Knowledge	
Explain the role of evidence in determining best clinical practice	Differentiate between evidence-based guidelines in managing acute postoperative pain verses chronic osteoporosis pain. Evidence-based practice guidelines include adherence to pharmacologic and nonpharmacologic interventions to promote recovery after surgery. How does managing the patient's pain reduce postoperative complications, including risk for blood clot, pneumonia, and gastric complications?
Skills	
Locate evidence reports related to clinical practice topics and guidelines	What additional strategies might you use to educate this patient on controlling acute postoperative pain? Differentiate between the various types of pain medications, including opioid and nonopioid analgesics, that are used to decrease pain. Evidence-based pain management includes the use of pain scales. Which scale would be the best to evaluate this patient's pain?
Attitudes	
Value the need for continuous improvement in clinical practice based on new knowledge	Reflect on your attitudes toward patients who are prescribed opioid medications postoperatively for pain control. Because this patient may have chronic pain due to her osteoporosis, how can your approach regarding acute and chronic pain management reflect evidence-based practice guidelines?

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35 Assessment of Musculoskeletal Function

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the basic structure and function of the musculoskeletal system.
2. Discuss the significance of the health history to the assessment of musculoskeletal health.
3. Recognize and evaluate the major manifestations of musculoskeletal dysfunction by applying concepts from the patient's health history and physical assessment findings.
4. Explain clinical indications, patient preparation, and other related nursing implications for common tests and procedures used to assess musculoskeletal function.

NURSING CONCEPTS

Assessment
Mobility

GLOSSARY

atonic: without tone; denervated muscle that atrophies

atrophy: decrease in the size of a muscle

bursa: fluid-filled sac found in connective tissue, usually in the area of joints

callus: cartilaginous/fibrous tissue at fracture site

cancellous bone: latticelike bone structure; trabecular bone

cartilage: tough, elastic, avascular tissue at ends of bone

clonus: rhythmic contractions of a muscle

contracture: abnormal shortening of muscle, joint, or both; fibrosis

cortical bone: compact bone

crepitus: grating or crackling sound or sensation; may occur with movement of ends of a broken bone or irregular joint surface

diaphysis: shaft of long bone

effusion: excess fluid in joint

endosteum: a thin, vascular membrane covering the marrow cavity of long bones and the spaces in cancellous bone

epiphysis: end of long bone

fascia: fibrous tissue that covers, supports, and separates muscles (*synonym:* epimysium)

fasciculation: involuntary twitch of muscle fibers

flaccid: limp; without muscle tone

hypertrophy: enlargement; increase in the size of a muscle

isometric contraction: muscle tension is increased without changing its length; there is no associated joint motion

isotonic contraction: muscle is shortened without a change in its tension; a joint is moved as a result

joint: area where bone ends meet; provides for motion and flexibility

joint capsule: fibrous tissue that encloses bone ends and other joint surfaces

kyphosis: increase in the convex curvature of the thoracic spine

lamellae: mature compact bone structures that form concentric rings of bone matrix; lamellar bone

ligament: ropelike bundles of collagen fibrils connecting bones

lordosis: increase in concave curvature of the lumbar spine

ossification: process in which minerals (calcium) are deposited in bone matrix

osteoblast: bone-forming cell

osteoclast: bone resorption cell

osteocyte: mature bone cell

osteogenesis: bone formation
osteon: microscopic functional bone unit
osteopenic: refers to a reduction in bone mass to below-normal levels
paresthesia: abnormal sensation (e.g., burning, tingling, numbness)
periosteum: fibrous connective tissue covering bone
remodeling: process that ensures bone maintenance through simultaneous bone resorption and formation
resorption: removal/destruction of tissue, such as bone
scoliosis: lateral curving of the spine
spastic: having greater-than-normal muscle tone
synovium: membrane in joint that secretes lubricating fluid
tendon: cord of fibrous tissue connecting muscle to bone
tone: normal tension (resistance to stretch) in resting muscle (*synonym:* tonus)
trabeculae: latticelike bone structure; cancellous bone

The musculoskeletal system is composed of the bones, joints, muscles, tendons, ligaments, and bursae of the body. The major functions of this system are to support and protect the body and foster movement of the extremities. The components of this system are highly integrated; therefore, disease in or injury to one component adversely affects the others. For instance, an infection in a joint (e.g., septic arthritis) causes degeneration of the articular surfaces of the bones within the joint and local muscle atrophy.

Musculoskeletal disorders and injuries directly affect the quality of life of individuals and are a leading cause of disability in the United States. The annual cost to treat these conditions is estimated to be over $980 billion for direct costs as well as indirect costs, such as lost wages from loss of work time (United States Bone and Joint Initiative [USBJI], 2018). Arthritis is the chief cause of musculoskeletal-related disability in the United States, with an estimated 54.4 million adults diagnosed with this disorder. Because the incidence of arthritis increases with age, the number of adults with arthritis is expected to increase to 78 million by 2040 (Centers for Disease Control and Prevention [CDC], 2019). Nurses in all practice areas may encounter patients with complaints about or impairment of the musculoskeletal system.

Anatomic and Physiologic Overview

The musculoskeletal system provides protection for vital organs, including the brain, heart, and lungs; serves as a framework to support body structures; and makes mobility possible. Muscles and tendons hold the bones together, and joints allow the body to move. They also move to produce heat that helps

maintain body temperature. Movement facilitates the return of deoxygenated blood to the right side of the heart by massaging the venous vasculature. The musculoskeletal system serves as a reservoir for immature blood cells and essential minerals, including calcium, phosphorus, magnesium, and fluoride (Norris, 2019). More than 98% of total-body calcium is present in bone (National Institutes of Health [NIH], 2019a).

Structure and Function of the Skeletal System

There are 206 bones in the human body, divided into four categories classified by their shape: long, short, flat, and irregular. The long bones are found in the upper and lower extremities (e.g., the femur). Long bones are shaped like rods or shafts with rounded ends (Fig. 35-1). The shaft, known as the **diaphysis**, is primarily **cortical bone** (compact bone). The ends of the long bones, called **epiphyses**, are primarily **cancellous bone** (trabecular bone). During childhood and adolescence, there is a layer of cartilage known as the epiphyseal plate, or growth plate, that separates the epiphysis from the diaphysis. The epiphyseal plate nurtures and facilitates longitudinal growth. The epiphyseal plate is calcified in adults. The ends of long bones are covered at the joints by articular **cartilage**, which is tough, elastic, and avascular tissue (Norris, 2019).

The short bones are the irregularly shaped bones located in the ankle and hand (e.g., metacarpals). The flat bones are located where extensive protection of underlying structures is needed (e.g., the sternum or skull). Finally, because of their shape, the irregular bones cannot be categorized in any other group and include bones such as the vertebrae and bones of the jaw.

The shape and construction of a specific bone are determined by its function and the forces exerted on it. Bones are constructed of cortical or cancellous bone tissue. Cortical bone exists in areas where support is needed, and cancellous bone is found where hematopoiesis and bone formation occur. For example, long bones are designed for weight bearing and movement and tend to be composed primarily of cortical bone, whereas flat bones, which are important sites of hematopoiesis and frequently protect vital organs, are made of cancellous bone layered between compact bone. Short bones consist of cancellous bone covered by a layer of cortical bone. Irregular bones have unique shapes related to their function. Generally, irregular bone structure is similar to that of flat bones (Norris, 2019).

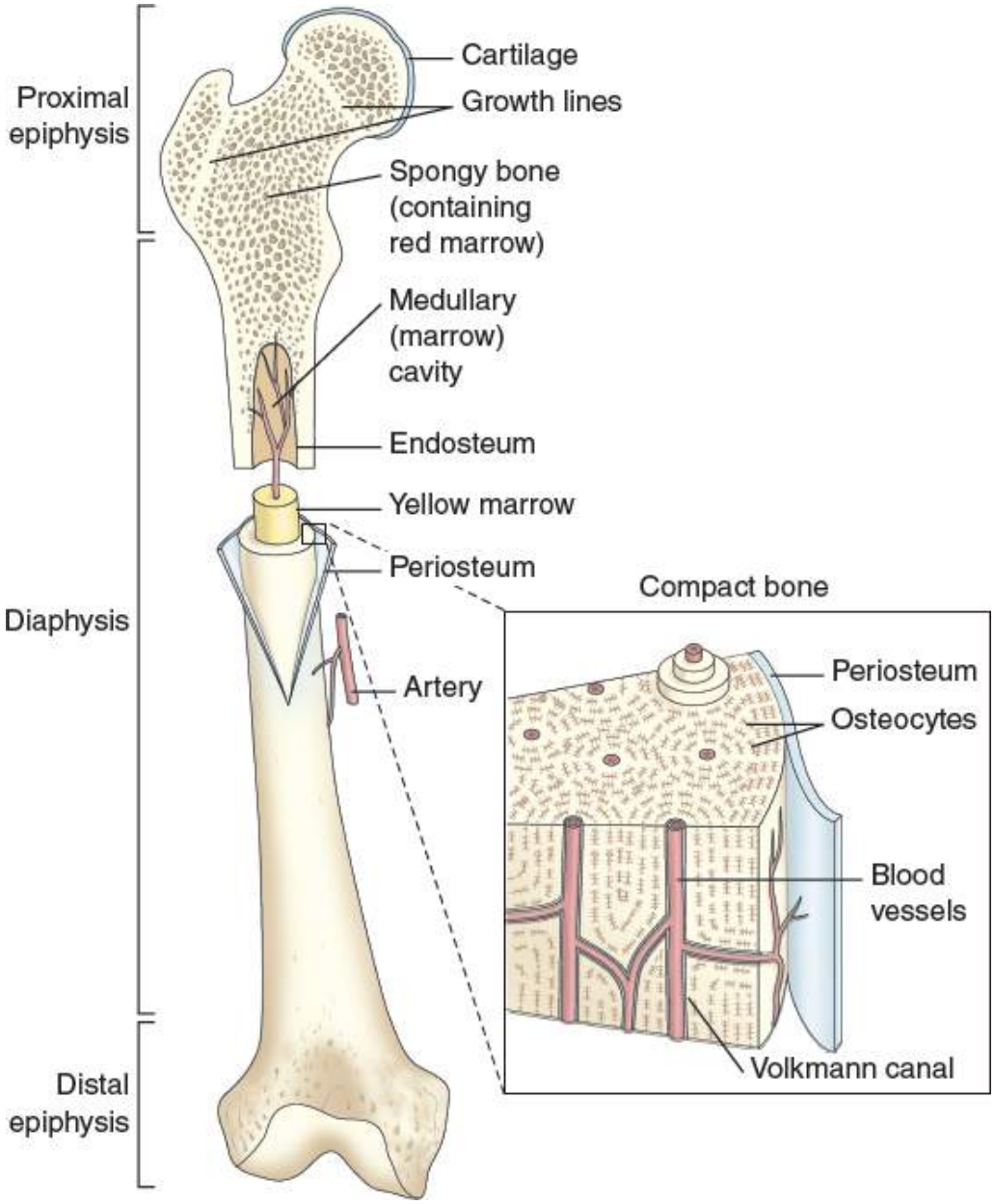

Figure 35-1 • Structure of a long bone; composition of compact bone.

Bone is composed of cells, protein matrix, and mineral deposits. The cells are of three basic types—osteoblasts, osteocytes, and osteoclasts. **Osteoblasts** function in bone formation by secreting bone matrix. The matrix consists of collagen and ground substances (glycoproteins and proteoglycans) that provide a framework in which inorganic mineral salts are deposited. These minerals are primarily composed of calcium and phosphorus. **Osteocytes** are mature bone cells involved in bone maintenance; they are located in lacunae (bone matrix units). **Osteoclasts**, located in shallow Howship's lacunae (small pits in bones), are multinuclear cells involved in dissolving and resorbing bone. The microscopic functioning unit of mature cortical bone is the **osteon**, or

haversian system. The center of the osteon—the haversian canal—contains a capillary. Around the capillary are circles of mineralized bone matrix called **lamellae**. Within the lamellae are lacunae that contain osteocytes. These are nourished through tiny structures called *canaliculi* (canals), which communicate with adjacent blood vessels within the haversian system. Lacunae in cancellous bone are layered in an irregular lattice network known as **trabeculae**. Red bone marrow fills the lattice network. Capillaries nourish the osteocytes located in the lacunae (Norris, 2019).

Covering the bone is a dense, fibrous membrane known as the **periosteum**. This membranous structure nourishes bone and facilitates its growth. The periosteum contains nerves, blood vessels, and lymphatics. It also provides for the attachment of tendons and ligaments (Norris, 2019).

The **endosteum** is a thin, vascular membrane that covers the marrow cavity of long bones and the spaces in cancellous bone. Osteoclasts, which dissolve bone matrix to maintain the marrow cavity, are located near the endosteum in Howship's lacunae (Norris, 2019).

Bone marrow is a vascular tissue located in the medullary cavity (shaft) of long bones and in flat bones. Red bone marrow, located mainly in the sternum, ilium, vertebrae, and ribs in adults, is responsible for producing red blood cells, white blood cells, and platelets through a process called *hematopoiesis.* In adults, the long bone is filled with fatty, yellow marrow (Norris, 2019).

Bone tissue is well vascularized. Cancellous bone receives a rich blood supply through metaphyseal and epiphyseal vessels. Periosteal vessels carry blood to compact bone through minute Volkmann canals. In addition, nutrient arteries penetrate the periosteum and enter the medullary cavity through foramina (small openings). Arteries supply blood to the marrow and bone. The venous system may accompany arteries or may exit independently (Norris, 2019).

Bone Formation

Osteogenesis (bone formation) begins before birth. **Ossification** is the process by which the bone matrix is formed and hard mineral crystals composed of calcium and phosphorus (e.g., hydroxyapatite) are bound to the collagen fibers. These mineral components give bone its characteristic strength, whereas the proteinaceous collagen gives bone its resilience (Norris, 2019).

Bone Maintenance

Bone is a dynamic tissue in a constant state of turnover. Throughout the lifespan, a process known as bone **remodeling** occurs, in which old bone is removed and new bone is added to the skeleton (formation). During childhood and the teenage years, new bone is added faster than old bone is removed; therefore, bones become larger, heavier, and denser. This continues until peak

bone mass is reached, typically by age 20 years. Remodeling maintains bone structure and function through simultaneous resorption and osteogenesis, and as a result, complete skeletal turnover occurs every 10 years (Norris, 2019).

The balance between bone **resorption** (removal or destruction) and formation is influenced by the following factors: physical activity; dietary intake of certain nutrients, especially calcium; and several hormones, including calcitriol (i.e., activated vitamin D), parathyroid hormone (PTH), calcitonin, thyroid hormone, cortisol, growth hormone, and the sex hormones estrogen and testosterone (Norris, 2019).

Physical activity, particularly weight-bearing activity, acts to stimulate bone formation and remodeling. Bones subjected to continued weight bearing tend to be thick and strong. Conversely, people who are unable to engage in regular weight-bearing activities, such as those on prolonged bed rest or those with some physical disabilities, have increased bone resorption from calcium loss, and their bones become **osteopenic** (reduced in terms of mass) and weak. These weakened bones may fracture easily (Meiner & Yeager, 2019).

Good dietary habits are integral to bone health. Daily intake of approximately 1000 to 1200 mg of calcium is essential to maintaining adult bone mass. Quality sources of calcium include low-fat milk, yogurt, and cheese. Foods with added calcium such as orange juice, cereals, and bread are also beneficial (NIH, 2019a). Vitamin D also plays a major role in calcium absorption and bone health. Young adults need a daily vitamin D intake of 600 IU, whereas adults 50 years and older require a daily intake of 800 to 1000 IU to ensure good bone health (NIH, 2019b). Dietary sources of vitamin D include vitamin D–fortified milk and cereals, egg yolks, saltwater fish, and liver.

Several hormones are vital in ensuring that calcium is properly absorbed and available for bone mineralization and matrix formation. Calcitriol functions to increase the amount of calcium in the blood by promoting absorption of calcium from the gastrointestinal tract. It also facilitates mineralization of osteoid tissue. A deficiency of vitamin D results in bone mineralization deficit, deformity, and fracture (Norris, 2019).

PTH and calcitonin are the major hormonal regulators of calcium homeostasis. PTH regulates the concentration of calcium in the blood, in part by promoting movement of calcium from the bone. In response to low calcium levels in the blood, increased levels of PTH prompt the mobilization of calcium, the demineralization of bone, and the formation of bone cysts. Calcitonin, secreted by the thyroid gland in response to elevated blood calcium levels, inhibits bone resorption and increases the deposit of calcium in bone (Norris, 2019).

Both thyroid hormone and cortisol have multiple systemic effects with specific effects on bones. Excessive thyroid hormone production in adults (e.g., Graves' disease) can result in increased bone resorption and decreased

bone formation. Increased levels of cortisol have these same effects. Patients receiving long-term synthetic cortisol or corticosteroids (e.g., prednisone) are at increased risk for steroid-induced osteopenia and fractures.

Growth hormone has direct and indirect effects on skeletal growth and remodeling. It stimulates the liver and, to a lesser degree, the bones to produce insulinlike growth factor 1 (IGF-I), which accelerates bone modeling in children and adolescents. Growth hormone also directly stimulates skeletal growth in children and adolescents. It is believed that the low levels of both growth hormone and IGF-I that occur with aging may be partly responsible for decreased bone formation and resultant osteopenia (Norris, 2019).

The sex hormones testosterone and estrogen have important effects on bone remodeling. Estrogen stimulates osteoblasts and inhibits osteoclasts; therefore, bone formation is enhanced and resorption is inhibited. Testosterone has both direct and indirect effects on bone growth and formation. It directly causes skeletal growth in adolescence and has continued effects on skeletal muscle growth throughout the lifespan. Increased muscle mass results in greater weight-bearing stress on bones, resulting in increased bone formation. In addition, testosterone converts to estrogen in adipose tissue, providing an additional source of bone-preserving estrogen for aging men (Kennedy-Malone, Martin-Plank, & Duffy, 2019).

During the process of bone remodeling, osteoblasts produce a receptor for activated nuclear factor-kappa B ligand (RANKL) that binds to the receptor for activated nuclear factor-kappa B (RANK) present on the cell membranes of osteoclast precursors, causing them to differentiate and mature into osteoclasts, which causes bone resorption. Conversely, osteoblasts may produce osteoprotegerin (OPG), which blocks the effects of RANKL, thereby turning off the process of bone resorption. T cells that may become activated as a result of the inflammatory process may also produce RANKL, overriding the effects of OPG and causing continued bone resorption during times of stress and injury, which can lead to loss of bone matrix and fractures (Takeno, Kanazawa, Notsu, et al., 2018).

Blood supply to the bone also affects bone formation. With diminished blood supply or hyperemia (congestion), osteogenesis, and bone density decrease. Bone necrosis occurs when the bone is deprived of blood (Norris, 2019).

Bone Healing

Most fractures heal through a combination of intramembranous and endochondral ossification processes. When a bone is fractured, the bone begins a healing process to reestablish continuity and strength. The bone fragments are not patched together with scar tissue; instead, the bone regenerates itself.

Fracture healing occurs in the bone marrow, where endothelial cells rapidly differentiate into osteoblasts; in the bone cortex, where new osteons are